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Public-Sector Collaborative Innovation Management in Thailand's GNSS CORS

by

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Declaration

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Signed: Saowanee Srichai

Date: March 2026

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ABSTRACT

Continuously Operating Reference Station (CORS) is a ground augmentation technology supplementary to the Global Navigation Satellite System (GNSS) to enable the excellence of positioning data to support high-precision work like construction and smart city. Consequently, many governments have invested in the CORS network to facilitate its utilisation in the private, public, research, and other sectors. However, function-based separate development of this technology has brought about over-investment and duplication problems in some countries, such as Australia and Thailand. Hence, this study focuses on CORS implementation in Thailand and searches for a way to alleviate the lack of effective collaboration on the CORS network between government organisations in Thailand.

This qualitative research was conducted using abductive reasoning through the lens of collaborative innovation, networked innovation, innovation ecosystem, and stakeholder theory. It used a pattern-matching algorithm to analyse the content of information gathered from the secondary data of documents in Australia and Thailand and the primary data of the interviews in Thailand. The focus groups, experts, and follow-up interviews were arranged to assemble the perspectives of the key persons from six government organisations and three universities involved in the CORS project in Thailand. The analytical works were undertaken by employing within-case studies and comparative analysis techniques. Eventually, the findings presented four core elements significant to inter-organisational and international collaboration on CORS: finance, human resources and responsibilities, plan and policy, and technology.

This study investigates the governments' experience in managing CORS implementation in Australia and Thailand to offer the proper solution for Thailand's government to direct the excellent move of its CORS system. The contribution offered by this study is that the experiences learned from Thailand could be helpful to other countries so they can avoid the difficulties encountered in Thailand or apply this model to fix entanglement in their countries.

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Chapter 1

INTRODUCTION

Resources are often the primary constraint in advancing innovation within individual organisations (Bloch & Bugge, 2013; Bommert, 2010; Sørensen & Torfing, 2011). As Ansell and Gash (2008) conclude, resource and power imbalances are commonly identified as major complications in collaborative governance. Collaborative resource-sharing across organisations, therefore, can substantially enhance the prospects for successful innovation management (Nambisan, 2008; Sørensen & Torfing, 2017). In many countries, technological development is predominantly initiated and managed by government agencies. However, when multiple organisations undertake similar projects, overlapping responsibilities frequently generate governance complexities and implementation challenges (Bommert, 2010; Sørensen & Torfing, 2011). Such fragmentation weakens coordination, reduces efficiency, and limits the public sector's ability to fully realise the benefits of technological advancement.

One area where these challenges are particularly evident is in the development of navigation satellite technologies. The benefits of such products have been recognised since 1994 (IGS, 2018), enhancing applications in navigation, engineering, and climate research through their accessibility and efficiency (Thomas et al., 2011). However, high-precision functions such as national mapping require improved signal quality, prompting the development of augmentation systems like Continuously Operating Reference Stations (CORS) (GPS.GOV, 2017). CORS strengthens signal reliability and supports geospatial applications, including location-based services (LBS) (Hausler and Collier, 2013a). Despite these advantages, challenges remain: nationwide coverage demands substantial investment and suitable infrastructure. In many countries, governments lead CORS development, though networks are often established by multiple agencies for diverse purposes. This fragmented ownership complicates coordination and resource integration, resulting in inefficiencies. In Thailand, CORS networks have expanded through various government organisations, but facilities are typically built for internal use without sharing plans or infrastructure, leading to duplication and over-investment (Rizos and Satirapod, 2011). Governance networks enable resource sharing, democratise public policymaking, and enhance innovation in the public sector by examining when, how, and why such networks foster innovative capacity (Sørensen and Torfing, 2010). Thus, collaborative innovation emerges as a viable approach for resolving the complexities inherent in CORS technology implementation.

This study investigates the nature and effectiveness of the collaboration on GNSS CORS technology implementation among Thai government agencies and investigates whether the LBS is suitable for inter-organisational collaboration management. Technical terms of the technologies associated with this research and the research goals are described in this chapter.

1.1 RESEARCH MOTIVATION AND OBJECTIVES

1.1.1 Research Motivation

This study has been primarily motivated by the desire for the public positioning evolution makings in Thailand. It began from a personal interest and relevancy in GNSS ground augmentation technology. The researcher has an educational background in Survey Engineering with a particular mastery of GNSS satellite application. Moreover, the researcher has work experience in implementing GNSS CORS base stations in government organisations. Currently, the researcher is working for the Geo-Informatics and Space Technology Development Agency (GISTDA) under the Ministry of Higher Education, Science, Research and Innovation supervision as an Engineer of the Space Industry Promotion Division, Space Economy Promotion Office. Subsequently, the researcher has taken part in the CORS development projects in Thailand. These opportunities highlighted the issues with these attempts. Over and above, as mentioned in the study of the GNSS CORS contribution in Thailand by Rizos and Satirapod (2011), the entangled situations in Thailand are on the grounds that various government agencies own the CORS infrastructure for internal use without a crossing boundary resource sharing policy. These complicated circumstances are the gaps that need to be bridged and fulfilled.

To achieve this, the researcher calls for a strategy to step up Thai's efforts to mobilise separate determinations into active solidarity. The advantages of collaborative innovation, if effectively organised and implemented, intrigued this study; it was consequently used to disentangle this problem. As concluded by Ferreira *et al.* (2011), certain defining characteristics of collaborative innovation networks are inter-organisational efforts bundled with co-working and partnership environments. The innovative endeavour with a common point to attain their ultimate aims requires resources and information implicit in the mutual relationship in conjunction with responsibilities and risk-taking. Collaborative innovation is a theory based in a variety of fields for stimulating multi-organisational coordination in maximising joint ventures' inventive and progressive potentialities. In a similar fashion, it is employed to manipulate the CORS system in many countries globally to leverage the best possible benefits of this technology.

The lack of effective collaboration on the GNSS CORS network between government organisations in Thailand is considered the main gap for this research project. For this reason, the research will continue with this initiative.

1.1.2 Research Objectives

A research objective is a statement of the study's purpose that serves as a roadmap for further investigation; it should clearly outline the study's intended plans (Thomas & Hodges, 2010). In the context of Thailand, duplication in the deployment of GNSS base stations has been identified as a critical issue. Rizos and Satirapod (2011) emphasise the necessity of inter-organisational coordination in CORS management

among state agencies to maximise the benefits of this technology. Building on this observation, the present study proposes two approaches to address this challenge. First, it will examine the critical success factors in fostering innovative collaboration among CORS-owning organisations, including public agencies and academia, particularly in relation to facility sharing. Second, it will evaluate whether Location-Based Services (LBS) can function as an appropriate mechanism for managing inter-organisational collaboration.

Accordingly, the overarching aim of this study is to support the adoption of a policy framework for GNSS CORS collaboration between government organisations in Thailand. This aim is pursued through the following research goals: (1) to assess how effectively GNSS CORS technology has been managed among government organisations in Thailand; (2) to examine the government's role in supporting and promoting GNSS CORS operational partnerships; (3) to gain a comprehensive understanding of the complex and multifaceted aspects of using LBS as an administrative tool for managing GNSS CORS collaboration; and (4) to evaluate the implications of implementing an adopted GNSS CORS management policy framework. In doing so, the study addresses existing gaps in knowledge and practice. Identifying the factors that contribute to effective CORS technology management is essential, as these factors can act as benchmarks for evaluation and form the foundation for a proposed framework to guide Thailand's future course of action. The research objectives are therefore established on this basis as follows:

1. To develop a sensible evaluation framework for this technology management based on the literature.
2. To evaluate Australia's experience based on the developed evaluation framework.
3. To evaluate Thailand's experience based on the developed evaluation framework.
4. To compare the different experiences between Thailand and Australia based on the developed evaluation framework.
5. To issue guidance for fitter implementation on GNSS CORS in Thailand.

The work linking the aims of this study is based on secondary data from the documents and primary data from the perspectives of the interview participants that reveal the circumstances between the CORS management and Thai government organisations. On top of this, the study employs multiple theories supporting inter-organisational collaborative management to underpin the proposition and prove the presented objectives.

1.2 DEFINITION

1.2.1 Global Navigation Satellite Systems (GNSS)

Global Navigation Satellite System (GNSS) is the generic name for a group of satellites that transmit global coverage information to users to acquire their current positions (GSA, 2018). The positioning data from multiple GNSS constellations, for instance, Global Positioning System (GPS), GLONASS, Galileo, and BeiDou, are widely applied in general geospatial technologies (Hausler, 2014). One of the most well-known applications is Google Maps - which combines the coordinates with attributes, for example, restaurants, parks, and roads. In addition to this, numerous sectors rely on these signals, for instance, transport, engineering, national security, social, and environmental. Roberts (2009) concluded that GNSS has a beneficial effect on precision agriculture, both Controlled Traffic Farming and inter-row sowing techniques. These technologies require sub-decimetre accuracy; hence, better signal performance is expected.

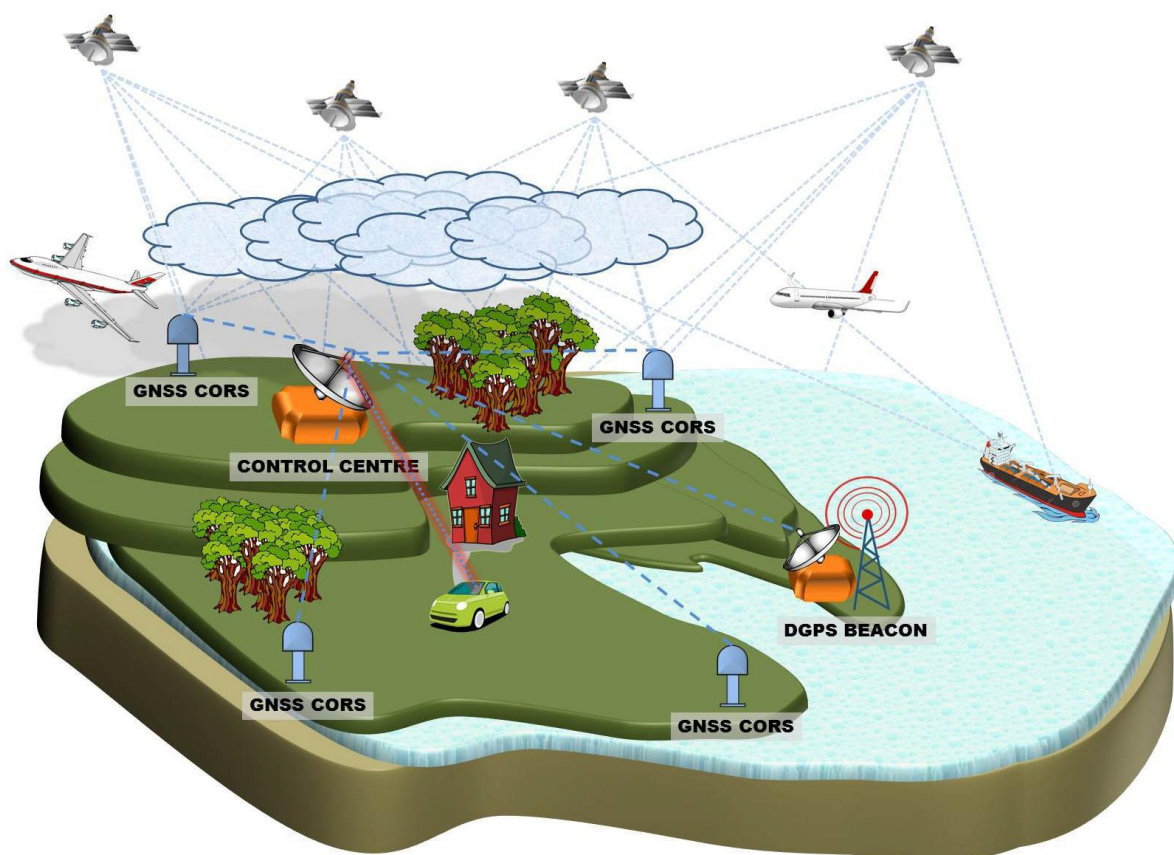


FIGURE 1.1 GNSS technology and the applications From: <http://gnss-integrity.angkasa.gov.my/about>

1.2.2 Continuously Operating Reference Stations (CORS)

The Continuously Operating Reference Stations (CORS) is a ground infrastructure technology initiated by the National Geodetic Survey (NGS) to provide high-quality GNSS data (NOAA, 2018b). The GNSS reference stations can satisfy users both from close range and far away from each station. Meanwhile, the CORS network has been formulated to maximise the usefulness of base station infrastructure. For example, data from thousands of CORS sites possessed and controlled separately by various

organisations have been shared through the National Geodetic Survey (NGS), an organisation under the National Oceanic and Atmospheric Administration (NOAA) that is responsible for contributing and distributing the final services. Global and local execution of the CORS networks has consecutively led to a centralised approach - which cooperative endeavour could reduce investment cost, expand service coverage area, and strengthen service excellence (Engfeldt, 2005; Hausler, 2014; Hausler and Collier, 2013a; Higgins, 2008; Roberts, 2009; Roberts *et al.*, 2004). For instance, ANZLIC, the Spatial Information Council, is a cooperative targeted at sharing data across borders (ANZLIC, 2014).

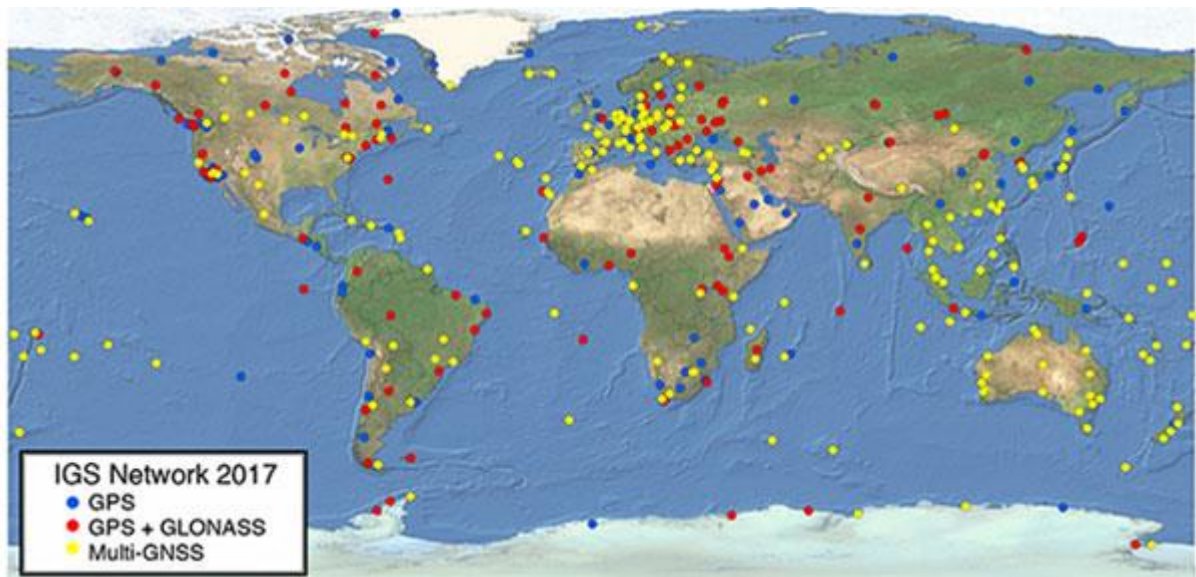


FIGURE 1.2 GNSS CORS map of IGS network 2017 From: https://www.gpsworld.com/the-international-gnss-service-25-years-on-the-path-to-multi-gnss/?utm_source=gps_navigate&utm_medium=email&utm_campaign=gps_navigate_09112018&eid=376813635&bid=2236178

1.2.3 Location-Based Services (LBS)

Location-based services (LBS) are solutions that rely on positioning data and mobile devices (Hirsch *et al.*, 2007). On that account, wireless cellular networks (Cell ID positioning), Wi-Fi positioning system (WPS), and GNSS satellite data are extensively obtained to corroborate the LBS services (Dhar and Varshney, 2011). More pertinently, Ryschka *et al.* (2016) pointed out that the consolidation of the location component and service delivery process is extremely valuable. It not only serves particular services to the users but also accompanies them through their daily lives. Applications like Google Maps, Runtastic, and Foursquare can link users with local search, navigation, health, and entertainment activities. Similarly, the LBS application has been used in controlling and measuring geospatial operations, including CORS handling, land surveying, and GIS. As a result, it could be an appropriately portable tool for CORS collaborative management.



FIGURE 1.3 LBS applications (developed by the author based on multiple sources; see Sources for Figures A)

HOW TRIMBLE RTX WORKS

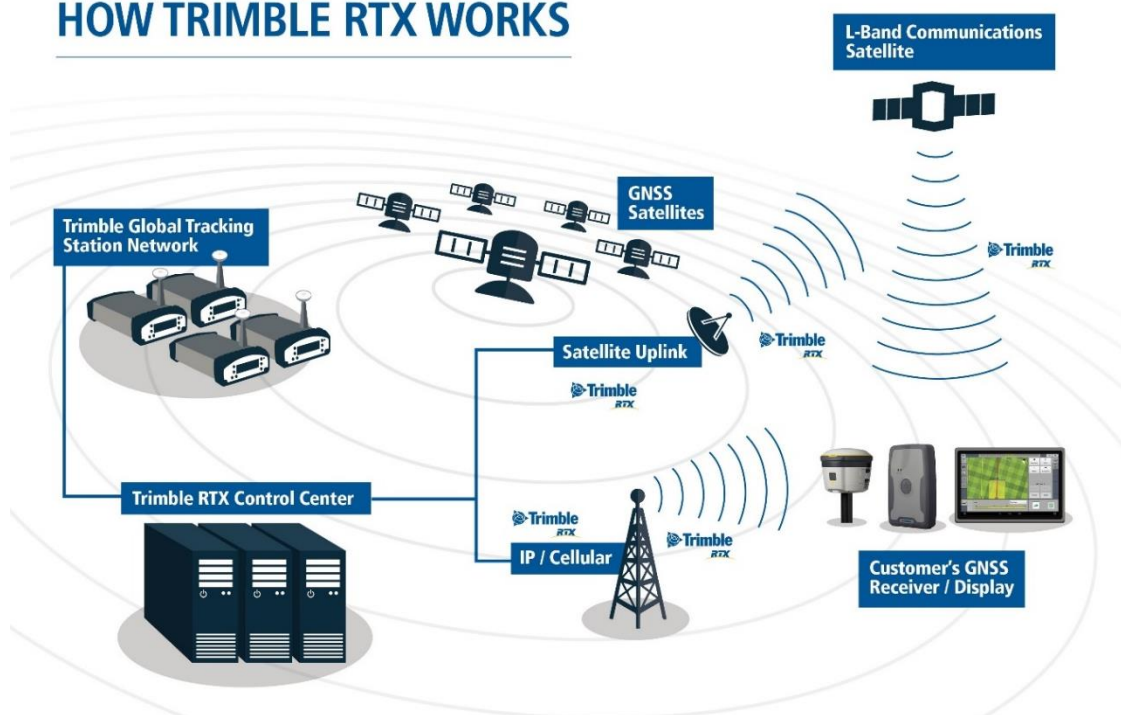


FIGURE 1.4 GNSS CORS and LBS applications From: http://trl.trimble.com/docushare/dsweb/Get/Document-892305/TrimbleRTX_HowItWorks.jpg

1.2.4 Platform Technology

As stated by Creative Common (2021), platforms refer to groups of technologies defined as a structure or a base for further complements. These open and interoperable systems support add-ons and interoperating applications constructed by other developers. They have become generally known for supporting information technology (IT); however, they also give encouragement to the whole technology type. Platform technology, a set of technological infrastructure freely available for extra top-ups, enables distinctly contrasting degrees of the model designed by builders to deploy on underlying resources for the end-user. It allows varying products to sit on top of a foundational set of technology and configures them into bundles of contextual blocks without the cost incurred in processing. Platform technologies are broadly applied in diverse sectors with multifaceted involvement, inclusive of agriculture, materials management, research and development, manufacturing, and healthcare (Roth *et al.*, 2007).

Sherman (2015) writes that the advent of information technology (IT) and the evolution of data integration and business intelligence (BI) have advanced innovation and powered the growth of analytical capabilities. As illustrated in FIGURE 1.5 and FIGURE 1.6 below, the innovation development of multiple technologies in connection with data integration and business intelligence, namely technology platforms, enterprise applications, and databases, has expanded continuously over time. In addition to this, the proliferation of technology platforms and other constituents, including the rise of the Internet of Things (IoT), has a significant influence on sustaining innovation. The positioning-bundled operational service, which aligns with more comprehensive function-oriented applications added to technology platforms, could be the motivating principle of this research project.

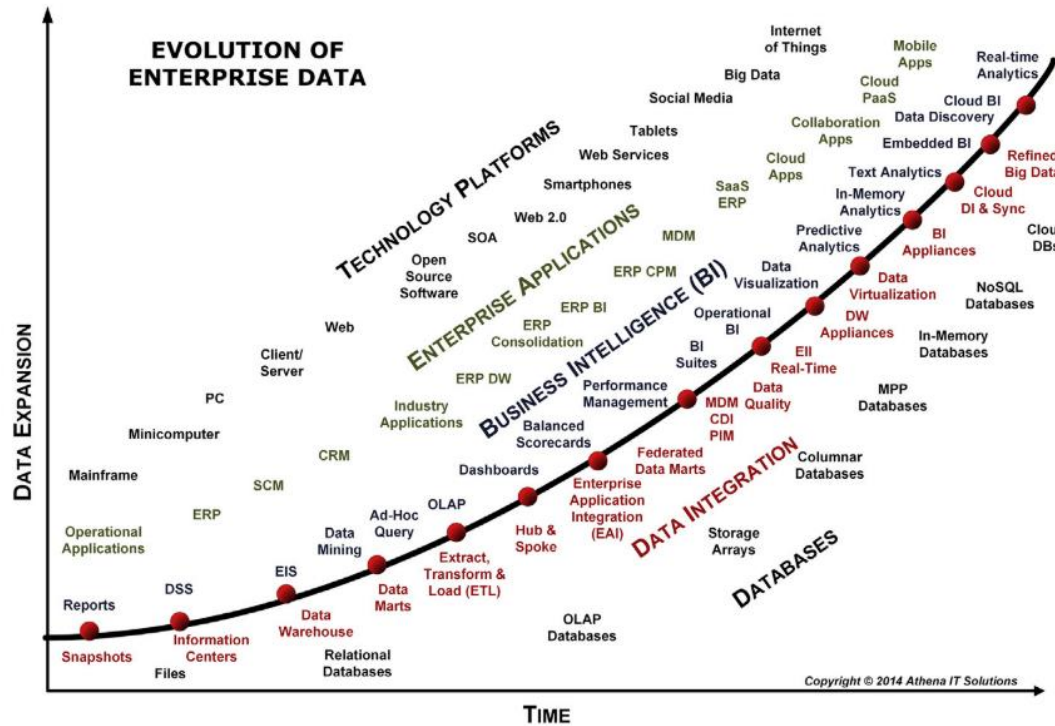


FIGURE 1.5 Evolution of enterprise data (Sherman, 2015)

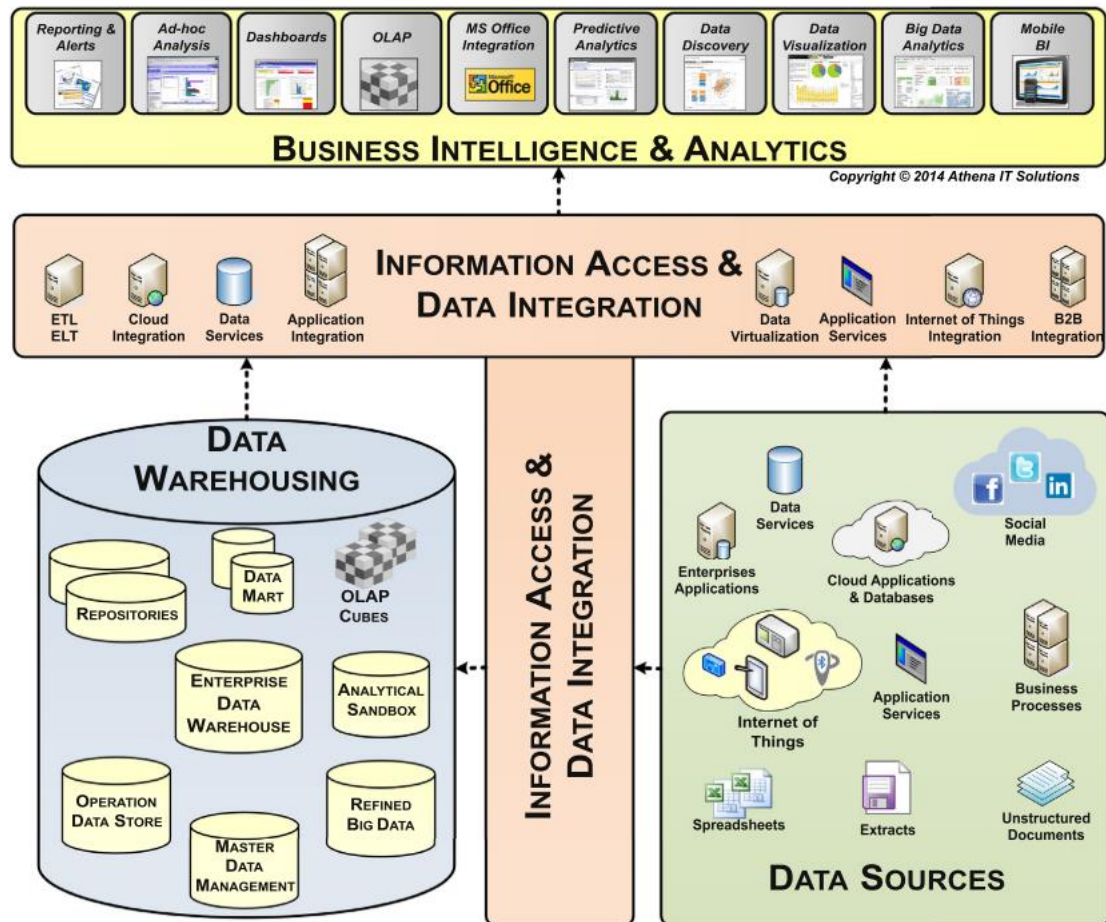


FIGURE 1.6 Technology architecture (Sherman, 2015)

1.3 CONTRIBUTION OF GNSS CORS

1.3.1 Thailand

In Thailand, GNSS CORS is considered an essential technology that is advantageous to diverse sectors, whether government, academic, or private. Numerous organisations have adopted such technology to serve their internal purposes, for example, surveying and mapping, coastal monitoring, research, and time synchronisation (Charoenkalunyuta *et al.*, 2012; Rizos and Satirapod, 2011; Yomwan, 2017).

The development of GNSS CORS in Thailand has been of interest to governmental and non-governmental organisations for decades. In 1996, the Department of Public Works and Town & Country Planning (DPT) was the first to initiate the GNSS CORS network in Thailand. They initially had eleven single base stations and subsequently extended to fifteen stations to form the network. The CORS was purposively brought to serve the national map preparation for urban planning and public works. In 2005, the Royal Thai Survey Department (RTSD) set up its first GNSS reference station for national control point surveying. The RTSD had renewed and expanded its network into 80 stations by 2020 to supply data to military surveying and mapping duty. After that, in 2007, the Thai Meteorological Department (TMD) installed five GNSS bases to support a tsunami and earthquake early warning system. The largest CORS network, which consists of 181 stations, was established by the Department of Lands (DOL). The DOL's CORS network was started in 2008, containing five stations, which performed Thailand's first RTK network to endorse the land rights document's approval all over Thailand. Successively, in 2008, Chulalongkorn University began its CORS station for research and learning. Afterwards, in 2016, the Hydro-Informatics Institute (HII) (formerly Hydro and Agro Informatics Institute, HAIL) activated six stations and shared one of them with the National Metrology Institute (Thailand) (NIMT). The HII's CORS was aimed to encourage water resource management tasks, whereas the NIMT's CORS was targeted as an international time synchronisation standard. Besides, GNSS bases were developed by many organisations, for instance, government organisations like the Geo-Informatics and Space Technology Development Agency (GISTDA), universities and research communities like King Mongkut's Institute of Technology Ladkrabang (KMUTL), private sector, and foreign organisations like the National Institute of Information and Communications Technology (NICT) of Japan (DOL, 2017a; DOL, 2018; HII, 2021; Rizos and Satirapod, 2011; Yomwan, 2017). As illustrated in FIGURE 1.7, GNSS CORS in Thailand involves multiple organisations.

Since those CORS have been put in place by multifarious organisations and the infrastructure and product formats were configured in accordance with their utilisation, the performance, specifically the coordinate accuracy, becomes one of the complications (Charoenkalunyuta *et al.*, 2012). In addition, a diversity of CORS owners affects cross-organisational resource sharing in terms of authorisation, accessibility, and exploitation. Separately operating on the CORS network not only caused the scattered GNSS infrastructure issue but also led to a shortfall in the smoothness of

data connectedness throughout the country to afford national missions and movements.

Furthermore, individual arrangements of CORS technology gave rise to monetary policy and budgeting difficulties. The Thai government has funded CORS to enable each organisation's initiatives without inter-organisational engagement administration. The unavailability of interoperating resulted in duplication and denseness of infrastructure in the same zone and sparseness of the technology in some areas. The recommendation from Rizos and Satirapod (2011) that Thailand should have an inter-partnership to alleviate these barriers was conferred as a consequence of this vagueness. However, CORS interoperability between organisations requires an administration tool that can manage a number of GNSS stations and share information interrelated with these stations.

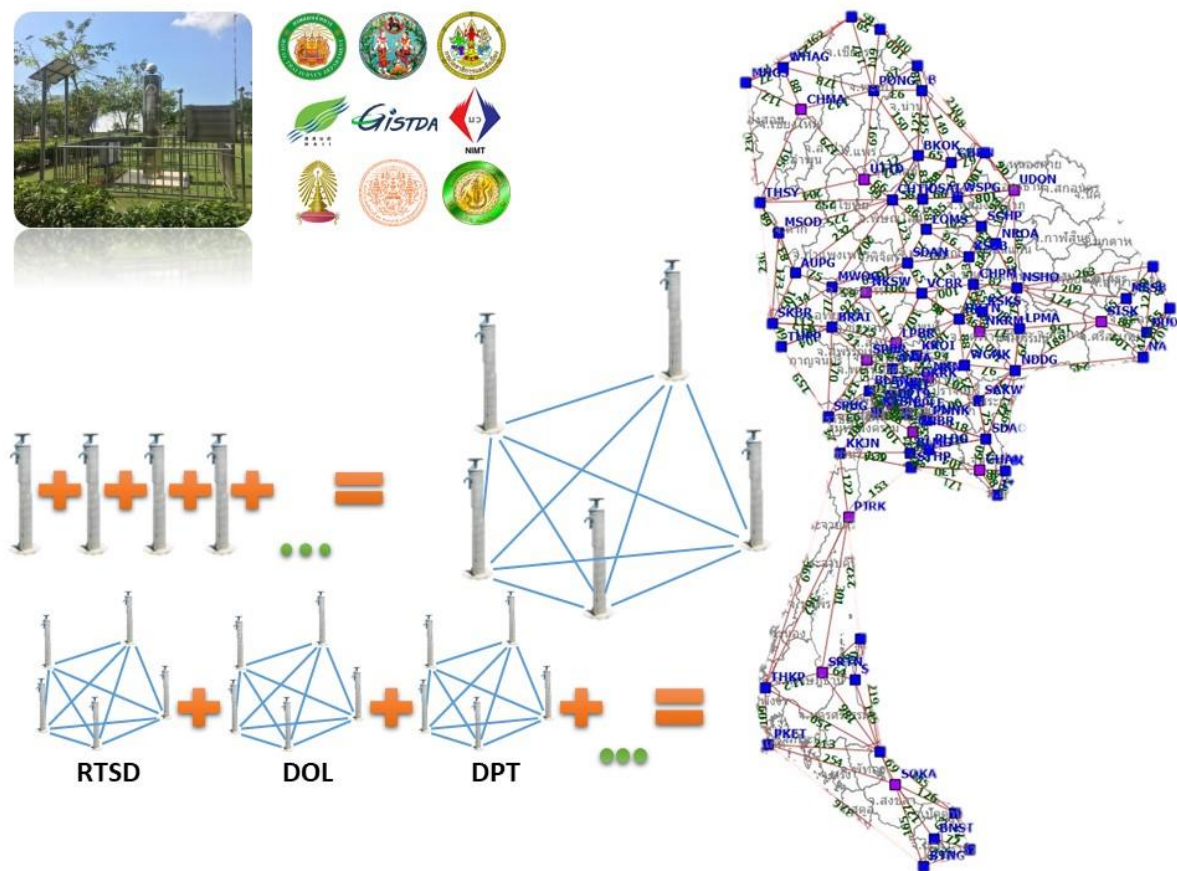


FIGURE 1.7 GNSS CORS in Thailand (developed by the author based on multiple sources; see Sources for Figures B)

1.3.2 Australia

Australia is a country that has implemented networks of CORS and has firmly sought to disentangle itself from CORS management difficulties (Hale, 2007). Therefore, it would be worthwhile to learn from its attempts. The Federation of Australia consists of six states and two territories with independent authority over their infrastructure. Therefore, the GNSS CORS and other infrastructure could be developed and supervised solitarily (Hale, 2007). Before adopting the national policy about the CORS

collaborative management functionality, Australia encountered the absence of GNSS facility sharing between governments due to uncoordinated efforts and duplicate investment in positioning infrastructure. The National Positioning Infrastructure (NPI) was instituted accordingly to settle positioning technology running policy and allocate discrete play roles to relevant organisations. By means of this, the problem-resolution procedure in Australia could be a thriving case to learn and execute the Thai context.

The evolution of GNSS CORS in Australia commenced in 1992. The Land and Property Information (LPI) initiated its first CORS station in Bathurst, New South Wales (NSW), for servicing aerial photogrammetry and surveying (Kinlyside and Yan, 2005 in Janssen *et al.*, 2010; Janssen *et al.*, 2011a; 2011b; 2016). Synchronously in July-August, the Australian Fiducial Network (AFN) was Australia's first CORS network established. The network combined eight CORS sites on the Australian mainland and Tasmania to support the International GPS Service for Geodynamics (IGS) Epoch '92 campaign and the modern GDA94 datum (Geoscience Australia, 2010; Morgan *et al.*, 1996 in Roberts and Stanaway, 2009).

Later, in 1994, by the Victorian Department of Sustainability and Environment (DSE), Victoria (VIC) was the first state to set up a CORS network and VICmap Position GPSnet from three inception sites. It was the earliest state that attained the accomplishment of providing state-wide and border-crossing services. The VIC's network comprises approximately 104 base stations all over the state and 12 shared CORS in 2013 (Hale, 2007; Hale and Ramm, 2007 in Hausler, 2014; Hausler, 2014; Roberts, 2009). 145 Vicmap sensors are currently available to subscribers (Vicmap, 2021). Years later, in 2001, Queensland (QLD) installed eight CORS stations in Brisbane and South East Queensland. Queensland's network was then taken part in the corporation with NSW's SydNet in 2004 (Roberts, 2009). The SydNet CORS network service emerged in 2004 by NSW to foster a positioning society. SydNet had linked seven new CORS stations with two existing stations: Bathurst and Newcastle. It later had the renewal and expansion into a range of coverage and was renamed CORSnet-NSW in 2009 (Hausler, 2014; Janssen *et al.*, 2010; 2011b; Roberts, 2009; Roberts *et al.*, 2007). CORSnet-NSW is a network established by LPI – a division of the NSW Department of Finance, Services and Innovation. It is the largest GNSS network that has been owned and controlled by the state (Janssen *et al.*, 2016). The CORSnet-NSW had enlarged to 102 base stations NSW-wide and 17 shared sites in 2013 (Hausler, 2014). As of May 2021, CORSnet-NSW delivered a service of 208 CORS sites (NSW Government, 2021).

Further, there was the CORS network establishment in other states and territories. In Western Australia (WA), the Western Australian Land Information Authority – a statutory authority operating under the business name of Landgate pursued joint investment with the AuScope project on 28 CORS stations throughout the state. There are small networks of four stations in Darwin and two stations in Alice Springs in the Northern Territory (NT). The NT Government's Department of Lands and Planning (DLP) is also a co-investment partner with the AuScope programme for 17 sites. Other than that, Tasmania (TAS) Government funded 20 base stations for the state-wide

network in 2010-2011. The funding, which ended in June 2011, was primarily intended for the Innovative Farming Practices Project. Still, the Department of Primary Industries, Parks, Water & Environment (DPIPWE) co-funded four AuScope sites. For South Australia (SA), the government, by the Planning and Land Authority (PLA) within the ACT's Environment and Sustainable Development Directorate (ESDD), made co-investing through AuScope for ten base stations, but there is no straight-through investment. With this, there is one Victorian GPSnet state-cross augmentation in Adelaide. Lastly, the Planning and Land Authority (PLA) within the ACT's Environment and Sustainable Development Directorate (ESDD) co-funded one AuScope CORS site in the Australian Capital Territory (ACT), with Geoscience Australia (GA) – an organisation located in the ACT, through the AuScope project (Hausler, 2014; Roberts, 2009).

Besides, some private-owned CORS networks have evolved in Australia. GPSNet Perth is the first CORS network owned and operated by the private sector. It is a network of 11 CORS bases spreading over Perth and environs in Western Australia (WA) since 2006. Leica Geosystems, accompanied by CRKennedy, also obtained the privately owned network called Smartnet Aus. Smartnet Aus targets users in prime capital cities as well as farming and mining zones. The user demand for Smartnet Aus in South Australia (SA) was significantly related to the scarcity of governmental resources. In the same manner, SunPoz (QLD), under the Department of Natural Resources and Water (QNRW) operation in Queensland, is comparable to Smartnet Aus. But it was taken a stake by Trimble and Queensland (QLD) government agencies. Likewise, GPSnet Perth is capitalised by Trimble and Western Australia (WA) (Higgins, 2008; Roberts, 2009). In conclusion, FIGURE 1.8 and FIGURE 1.9 show GNSS CORS that have been developed in Australia and New Zealand.

The shortness of collaboration on the CORS reference network between the state and territory jurisdictions became a weightiness at the national degree (Hale, 2007). It has taken into account investigation and given solutions by various scholars and government bodies. This complexity ended with the NPI policy framework in 2010 that concatenated all relevant sectors to join and share the innovation under the decisive agreement and supportive roles.

The similarity of occurrence between Australia and Thailand is the primary influence on selecting Australia's CORS management as the case study for this research.

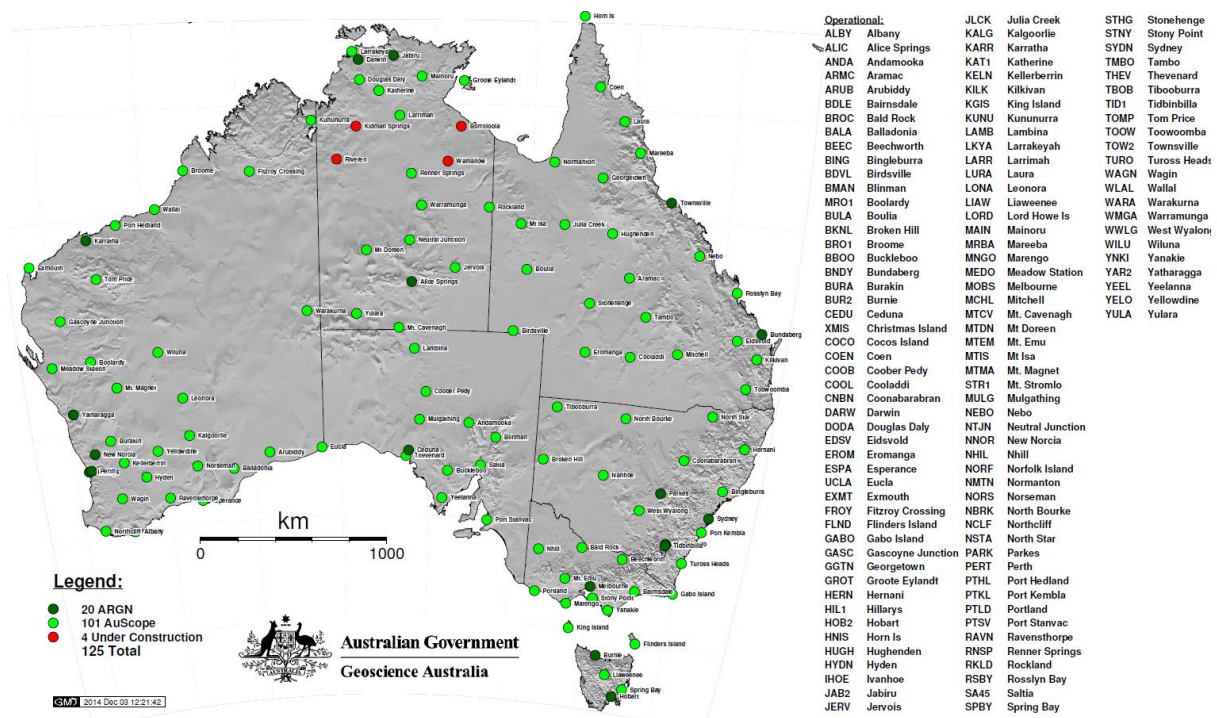


FIGURE 1.8 GNSS CORS in Australia and New Zealand From: ftp://ftp.ga.gov.au/geodesy-outgoing/gnss/pub/maps/argn_map.pdf

Jurisdiction	ARGN	AuScope		Responsible Authority (RA)	Other CORS	Total CORS
		GA	RA			
Victoria (VIC)	1	4	6	DEPI	93*	104*
New South Wales (NSW)	2	6	7	DFS - LPI	97*	112*
Australian Capital Territory (ACT)	2	0	0	ESDD - PLA	1	3
Queensland (QLD)	2	11	9	DNRM	11	33
Northern Territory (NT)	3	8	9	DLP	0	20
Western Australia (WA)	7	14	14	Landgate	0	35
South Australia (SA)	2	9	1	DPTI - LSG	0	12
Tasmania (TAS)	2	4	0	DPIPWE	0	6
Total Government CORS	21	56	46		202	325

FIGURE 1.9 State and territory GNSS CORS in Australia as of August 2013 (Hausler, 2014)

1.4 INTENDED CONTRIBUTION OF RESEARCH

This study focuses on the collaboration on GNSS CORS technology; thus, a policy framework underpinning the interactive endeavour is expected as the research outcome. Considering the process of establishing a Thai CORS collaborative network, the complicated issues, such as duplication and over-investment, are addressed in terms of equipment, specialists, technique, and policy. Further, the exploratory operation on the lack of GNSS facility sharing and unavailability of a technology management centre are considered, together with the

feasibility of using the LBS administration tool for a collaborative network. The consumption of this investigation will support the adoption of the policy for the Thai context. Therefore, these findings will be proposed to elaborate the policy framework for CORS collaborative arrangements in Thailand. The main contribution of this study is to understand the cause of the GNSS CORS management problem in Thailand and develop recommendations to overcome it. This knowledge will be a guideline for other countries to handle similar issues or avoid possible complications, just like in Thailand.

1.5 CHAPTER CONCLUSION

GNSS CORS is the primary technology targeted for this research. The development of this technology management is considered by studying the circumstances and events in Australia and Thailand. Along with this, LBS technology is investigated regarding its appropriateness in administering the GNSS CORS system in Thailand.

Chapter 2

STATEMENT OF THE PROBLEMS

As mentioned earlier in Chapter 1, GNSS CORS is a technology with multipurpose possibilities supporting applications in a variety of uses, which have been made in multiple sectors, including academic, government, and private. In Thailand, CORS has been employed in many government activities. Nonetheless, the development of this versatile technology brought about an issue of budgeting that led to the request for an inter-organisational sharing arrangement. This chapter will provide a statement of the complications caused by various independently owned and operated CORS management.

2.1 CONTRIBUTION OF GNSS CORS IN THAILAND

GNSS CORS is a fundamental technology globally that has been implemented to enhance positioning applications. Many countries have laid out large amounts of money to set up CORS networks, which are mostly arranged by governments. By the same token, in Thailand, the government agreed to exploit CORS benefits by making provisions for its development to the government agencies that requested budget allocation for the CORS implementation programmes. Consequently, several agencies have received monetary support to create CORS systems for internal use within their agencies.

Thailand has placed significance on the development of CORS technology for decades; the CORS implementation and management history is detailed in TABLE 1 below. According to the evidence collected, multiple government agencies have made independent plans for the creation of their CORS. Thailand started the first set of CORS in 1996 through the Department of Public Works and Town & Country Planning (DPT), two years after the United States Government originated the CORS technology. After that, various organisations, both governmental and non-governmental sectors, have developed their CORS. The following is an overall series of events connected with Thailand's CORS evolution, which is described by two main intentions: the development of CORS establishment and the development of CORS management.

TABLE 1 GNSS CORS development timeline in Thailand (Source: Author's own research)

Year	Content	Key Person
1978	The first satellite in the system, Navstar 1, was launched (Tennant, 1981)	The Department of Defense (DoD), USA
1994	The CORS network originated in early 1994 when the NGS installed a permanent GPS station in Gaithersburg (National Institute of Standards and Technology) (Stone, 2006)	The United States Government
1996	First Thai GNSS CORS network, 9 stations (Rizos and Satirapod, 2011)	The Department of Public Works and Town & Country Planning (DPT)

Year	Content	Key Person
2002	CORS in Bangkok is a part of the SouthEast Asia Low-latitude IOnospheric Network (SEALION) project for the purpose of monitoring and forecasting equatorial ionospheric disturbances, especially plasma bubbles in the Southeast Asia region. 1 station (Charoenkalunyuta <i>et al.</i> , 2012)	King Mongkut's Institute of Technology Ladkrabang (KMITL) Collaborated Partners: The National Institute of Information and Communications Technology (NICT)
2002	Japan has installed CORS in Thailand, 1 station. Bangkok (KMIT) 2002 – present (Rizos and Satirapod, 2011; Thai GNSS and Space Weather Information Data Center, 2020)	The National Institute of Information and Communications Technology (NICT)
2004	Japan has installed CORS in Thailand, 1 station. Chiangmai University (CIMU) 2004 – 2014 (Thai GNSS and Space Weather Information Data Center, 2020)	Chiangmai University (CIMU) Collaborated Partners: The National Institute of Information and Communications Technology (NICT)
2005	Installed GNSS base station, 1 station (Rizos and Satirapod, 2011)	The Royal Thai Survey Department (RTSD)
2005	Japan has installed CORS in Thailand, 1 station. Chumphon (CHPN) 2005 – 2014 (Rizos and Satirapod, 2011; Thai GNSS and Space Weather Information Data Center, 2020)	The National Institute of Information and Communications Technology (NICT)
2006	Japan has installed CORS in Thailand, 1 station. Phuket (PTAC) 2006 – 2014 (Rizos and Satirapod, 2011; Thai GNSS and Space Weather Information Data Center, 2020)	The National Institute of Information and Communications Technology (NICT)
late 2007	Installed CORS receivers as part of a tsunami and earthquake early warning system, 5 stations (Rizos and Satirapod, 2011)	The Thai Meteorological Department (TMD)
early 2008	First Thai's Real-Time Kinematic (N-RTK) GPS service (Rizos and Satirapod, 2011)	The Department of Lands (DOL)
2008	First Thai IGS station in Thailand supported by JPL and UNAVCO, 1 station (Rizos and Satirapod, 2011)	Chulalongkorn University (CU)
2008	Installed Nongkai (NKKI) CORS 1 station (2008 – 2019) (The National Institute of Information and Communications Technology, NICT)	Chulalongkorn University (CU) Collaborated Partners: Kyoto University
2009	Installed CORS 6 stations to DOL RTK GNSS Network. Total 11 stations (DOL, 2018)	The Department of Lands (DOL)
2011	Identified CORS problem in Thailand (Rizos and Satirapod, 2011)	Prof. Chris Rizos and Prof. Chalermchon Satirapod
2015	Upgraded CORS 9 stations to DPT RTK GNSS Network. Total 9 stations (Yomwan, 2017a)	The Department of Public Works and Town & Country Planning (DPT)
2015	Installed CORS 6 stations to DPT RTK GNSS Network. Total 15 stations (Yomwan, 2017a)	The Department of Public Works and Town & Country Planning (DPT)

Year	Content	Key Person
2016	Installed CORS 51 stations to DOL RTK GNSS Network. Total 62 stations (DOL, 2018)	The Department of Lands (DOL)
2016	Installed CORS 6 stations (DOL, 2018)	Hydro and Agro Informatics Institute (HAI)
2017 February 24-25	High Level seminar for defining the national geo-informatics movement guidelines, hosted by The National Geo-Informatics Board Discussions about - Creating the National CORS Data Center - Working under the National Subcommittee on GNSS Network (appointed by the National Geo-Informatics Board) - Qualification for the National CORS Data Center candidates - Government organisation - Ability to provide services to the public sector and private sector - Competence in encouraging a diversity of missions - Skilled staff - Technology to support the national infrastructure - The National CORS Data Center in the foreign countries - User: public sector/ private sector/ Hybrid Organisations - Fee: free/ pay - The national GNSS infrastructure - Concept: Network of CORS Networks - Key: non-CORS owner user either public sector or private sector - Problem: lack of national data centre to provide services - Solution: create the national data centre to provide application services in the EEC area - Make GISTDA the leader of the national GNSS infrastructure project - Responsible for the National CORS Data Center - Coordinate with China and Japan - Japan will fund the 200 CORS installation project	CORS owner RTSD, DOL, DPT, HAI, GISTDA
2017 March 30	- The National Geo-Informatics Board appointed the National Subcommittee on GNSS Network on 26th May 2017 to implement the National GNSS Infrastructure project under the Network of CORS Networks concept - The National GNSS Infrastructure links with five networks - Surveying and cadastral plan mission: DOL - Surveying, topographic mapping, and national defence mission: RTS - Town planning and Urban management mission: DPT - Water resource and disaster management mission: HAI and Japan - Research and innovation management mission: GISTDA and Universities - The National Subcommittee on GNSS Network appointed the National CORS Data Center to provide data services to the public sector, private sector, and civilian - GISTDA, as the National Subcommittee on GNSS Network secretary, will be responsible for coordination abroad	The National Geo-Informatics Board

Year	Content	Key Person
2017 June 7	The signing Ceremony of the Memorandum of Cooperation (MoC) on the Development of Integrated CORS between Thailand and Japan aimed to - Create a CORS data integration centre - Install CORS infrastructure - Found GNSS innovation centre	Deputy Prime Minister and Minister of Science and Technology (Dr. Atchaka Sibunruang) [Now: Ministry of Higher Education, Science, Research and Innovation (MHESI)] with Minister of Land, Infrastructure, Transport and Tourism (Mr. Keiichi Ishii)
2017 June 4-8	- The 3rd Meeting of the Thailand-Japan High Level Joint Commission: HLJC - Minister of Science and Technology (Dr. Atchaka Sibunruang) [Now: Ministry of Higher Education, Science, Research and Innovation (MHESI)] appointed - GISTDA to be accountable to the National CORS Data Center - HAIL to take responsibility for CORS installation	Ministry of Foreign Affairs (MFA) Ministry of Science and Technology (MHESI)
2017 June 29	GISTDA was committed to arranging the GNSS CORS coordination proposal (Application Form) at the meeting held to discuss an Agreement on Academic Cooperation	Ministry of Foreign Affairs (MFA) Ministry of Science and Technology (MHESI) (National Subcommittee on GNSS Network)
2017 August 4	- Japan (Japan International Cooperation Agency (JICA)) proposed the RTSD to be nominated for the National CORS Data Center - Japan (Geospatial Information Authority of Japan (GSI) + Japan International Cooperation Agency (JICA)) offered assistance in terms of CORS upgrades, technical visit - Japan International Cooperation Agency (JICA) is conducting a resurvey to alter some of the cooperation plans - Japan focused on providing CORS services to the private sector - HAIL raised that taking control of the CORS installation is quite beyond their capacity; they needed support from RTSD - RTSD is responsible for Smart map preparation to support Precision farming. The map was expected to be ready in 2019. - CU put RTSD forward as the provider of transformation parameters to unify a national geospatial reference frame - GISTDA presented the Roadmap for data services - GISTDA was appointed to arrange a discussion workshop dealing with the data services management	Japan International Cooperation Agency (JICA) Geospatial Information Authority of Japan (GSI)
2017 August 24	GISTDA proffered an Application Form to Thailand International Cooperation Agency (TICA), Ministry of Foreign Affairs (MFA) 1. Technical support 2. The National Service Data Center establishment 3. The National Mapping Data Center establishment 4. The GNSS CORS expansion installation	Ministry of Foreign Affairs (MFA) Ministry of Science and Technology (MHESI) (National Subcommittee on GNSS Network)

Year	Content	Key Person
	5. Human Resource Development	
2017 August	The Cabinet Office (11 organisations) of Japan suggested that GISTDA institute the GNSS Innovation Center (GiNNo) at GISTA Si Racha to showcase an exhibition of GNSS technology applications.	Japan GISTDA
2017 November 2	Guidelines on the management of the National CORS Data Center - Set up three government working groups 1. Implementation Working Group (IWG) to issue guidelines for the National CORS Data Center implementation: Chairman - Permanent Secretary of MHESI 2. National CORS Data Center Management Working Group: Chairman - Director of RTSD 3. Working Group on Thailand-Japan Joint Commission on CORS infrastructure development: Chairman - Deputy Permanent Secretary of MHESI - DOL and GISTDA will draw up the National CORS Data Center implementation project plan - RTSD will be the National CORS Data Center administrator	Permanent Secretary of the Ministry of Science and Technology (MHESI) Director of Royal Thai Survey Department (RTSD) Deputy Permanent Secretary of the Ministry of Science and Technology (MHESI)
2017	Installed 30 CORS stations for DOL RTK GNSS Network. Total 92 stations (DOL, 2018)	The Department of Lands (DOL)
2017 – 2018	Installed 80 CORS stations. Total 80 stations (DOL, 2018)	The Royal Thai Survey Department (RTSD)
2018 January 10	The kickoff of GNSS Innovation Center (GiNNo)	MHESI + NEC (Japan)
2018	Installed 30 CORS stations for DOL RTK GNSS Network. Total 122 stations (DOL, 2018)	The Department of Lands (DOL)

2.1.1 The Development of CORS Establishment

The establishment of CORS includes attempts to build CORS sites and infrastructure that support their operations. As coverage and density of reference stations are the dominant influences of CORS technology, increasing the extent of the service area and appropriate distribution of facilities will magnify the achievability of leveraging this technology. Accordingly, organisations already implementing this technology are still calling for more stations. The chain of events for creating GNSS reference stations in Thailand is detailed below.

Based on the history of the continuing buildout of CORS, Rizos and Satirapod (2011) concluded that the first Thai GNSS CORS began with nine stations by the Department of Public Works and Town & Country Planning (DPT) in 1996. Later, in 2002, King Mongkut's Institute of Technology Ladkrabang (KMITL) jointly formed one base station in Bangkok with the National Institute of Information and Communications Technology (NICT), Japan, for monitoring and forecasting equatorial ionospheric disturbances (Charoenkalunyuta *et al.*, 2012). Two years later, the NICT and Chiangmai University (CIMU) collaboratively founded one station in Chiangmai (Thai GNSS and Space Weather Information Data Center, 2020). The Royal Thai Survey Department (RTSD) started its first CORS station in 2005 (Rizos and Satirapod, 2011). After a while, the NICT added two more GNSS base stations in Chumphon and Phuket (Rizos and

Satirapod, 2011; Thai GNSS and Space Weather Information Data Center, 2020). Subsequently, the Thai Meteorological Department (TMD) installed five CORS receivers as part of a tsunami and earthquake early warning system (Rizos and Satirapod, 2011). In early 2008, the Department of Lands (DOL) initiated its first five CORS with a new type of service, Real-Time Kinematic (Rizos and Satirapod, 2011). Chulalongkorn University (CU) activated one GNSS base station at a later date in support of the NASA Jet Propulsion Laboratory (JPL) and UNAVCO to be part of the International GNSS Service (IGS) network (Rizos and Satirapod, 2011). Also, CU set up one CORS station in Nongkai under the encouragement of its collaborated partner, Kyoto University. A year later, the DOL expanded its CORS network to 11 stations (DOL, 2018). After a period of time, the DPT installed six additional CORS in 2015 and made its CORS fifteen stations in total (Yomwan, 2017a). The DOL once more added 51 stations to its RTK GNSS Network in 2016 (DOL, 2018). And then, within a short period of time, the HAI established six CORS stations (DOL, 2018). In addition, the DOL constructed an extra 30 stations for the DOL RTK GNSS Network (DOL, 2018). Moreover, the RTSD got going on its GNSS CORS with 80 stations in 2017 (DOL, 2018). Finally, the DOL increased 30 stations to the RTK Network, making its CORS network comprise 122 stations altogether (DOL, 2018).

2.1.2 The Development of CORS Management

The management structure to deal with the implementation of GNSS CORS in Thailand has been developed over time. After the evolution of CORS, which started in 1996 and continued growing with a number of reference stations by a variety of owners, the academics revealed the difficulties in leveraging this technology. The uncoordinated effort on CORS establishment by several different organisations was raised by Rizos and Satirapod (2011), and there was no procedural action to resolve it until 2017. As concluded from the meeting minutes, the first activity related to managing Thailand's CORS technology complications was introduced in 2017 in the High-Level seminar to define the national geo-informatics movement guidelines, which the National Geo-Informatics Board hosted. At a subsequent time, the National Geo-Informatics Board appointed the National Subcommittee on GNSS Network to implement the National GNSS Infrastructure project under the Network of CORS Networks concept. In order to create a collaboration between Thailand and Japan on CORS and GNSS technology, the Minister of Science and Technology (Thailand) and the Minister of Land, Infrastructure, Transport and Tourism (Japan) agreed to sign the Memorandum of Cooperation (MoC) on the Development of Integrated CORS in June 2017. Shortly after that, in the 3rd Meeting of the Thailand-Japan High Level Joint Commission, the Minister of Science and Technology appointed GISTDA to be accountable to the National CORS Data Center and HAI to take responsibility for CORS installation. In late June 2017, at a meeting held to discuss an Agreement on Academic Cooperation between the Ministry of Foreign Affairs (MFA) and the Ministry of Science and Technology by the National Subcommittee on GNSS Network, GISTDA was committed to arranging the GNSS CORS coordination proposal (Application Form) to submit to the Thailand-Japan High Level Joint Commission.

Later, in August 2017, Japan, by the Japan International Cooperation Agency (JICA), proposed that the RTSD be nominated for the National CORS Data Center of Thailand. In this meeting, RTSD was also requested to assist the HAI in the CORS installation mission and be responsible for Smart map preparation to support Precision farming. Alongside this, Japan by the Geospatial Information Authority of Japan (GSI) and JICA offered assistance in terms of CORS upgrades and technical visits to Thailand. GISTDA proffered the proposal of the Application Form to the Thailand International Cooperation Agency (TICA), MFA, after a while. In the ensuing meeting with Japan, the Cabinet Office of Japan suggested that the GISTDA found the GNSS Innovation Center (GiNNo) at GISTA Si Racha to showcase an exhibition of GNSS technology applications. A few months later, the guidelines on the National CORS Data Center management were instituted by setting up three government working groups. Furthermore, DOL and GISTDA will draw up the National CORS Data Center implementation project plan in conjunction with this, while the RTSD will be the National CORS Data Center administrator. Finally, in early January 2018, the GNSS Innovation Center (GiNNo) kickoff was held. The National Subcommittee on GNSS Network had a meeting again in 2019. Late this year, the national CORS management was underway by the three National CORS working groups, whereas none of the meetings between the National Geo-Informatics Board and the National Subcommittee on GNSS Network were arranged. As most of the predominant CORS owners have completed their CORS installation, the working groups focused on developing Capacity Building and Promotion. Lastly, in March 2020, the National CORS Data Center (RTSD) conducted a data connection test between relevant organisations, which initially yielded successful results.

The development of CORS establishment and management explains a timeline of the Thai government agencies' endeavour to build CORS assets and handle the points at issue, which is summarised in the table. The summary table presents the roles these relevant organisations play in the overall network in an effort to enlarge the available resources and enhance the effectiveness of manipulation of this GNSS ground augmentation technology. However, these movements that have taken action on CORS technology in the course of time have not yet reached their goals.

2.2 CHALLENGES OF GNSS CORS IMPLEMENTATION IN THAILAND

The implementation of GNSS CORS technology involves many factors required to fulfil the ambitions, either to gain the completion of hardware installation or to ensure thorough preparedness on both sides. These intentions can be satisfied by performing a complete procedure and connecting the entire system as networks. Nonetheless, these designs have not been effective in Thailand.

The details in the table above summarise the chronology of happenings regarding GNSS CORS development in Thailand. This summary evidences the attempts to resolve the complexity of uncoordinated CORS movements between government organisations.

2.2.1 What Were Some of the Main Challenges with the Implementation of the GNSS CORS in Thailand?

According to the summary of the implementation and actions shown in the table, there are some key challenges in developing GNSS CORS in Thailand. As Rizos and Satirapod (2011) mentioned, the main challenge affecting Thailand's CORS implementation is to ensure that effective collaboration between CORS stakeholders begins to happen. Yet, in spite of the fact that Thailand had encouraged the engagement of stakeholders in the CORS mutual effort in 2017, the initiative was not as successful as expected because it did not particularly highlight comprehensive CORS development problems. Insufficient cooperation has an influence on the fulfilment of infrastructure, particularly in terms of growing CORS without sharing a plan and access with others and the poor quality of network services.

Limited sharing of a plan and access

CORS is a positioning enhancement technology that provides constant and precise data. It can be applied in a variety of utilisations, for instance, seismic and deformation estimation, early warning systems, smart cities, precision farming, ionospheric propagation, aircraft guidance, surveying and mapping, and construction. As a result, the government organisations responsible for those missions need to employ CORS to serve their tasks. However, they are unable to establish their own infrastructure or can only partially initiate their CORS due to the inadequacies of the budget allocated by the government. Because of this, different agencies have different numbers of CORS stations. For example, the Department of Land (DOL), which uses CORS for land rights document approval, can create 134 stations, while the National Metrology Institute (Thailand) (NIMT), which benefits from CORS in time synchronisation application, can set up one station. Without cooperative endeavour, organisations that have CORS infrastructure exploit their assets but do not share their data with others.

The timeline of these movements can be summarised as shown in TABLE 2 below. From 1996 to 2018, multiple organisations in Thailand, either government agencies or universities, separately installed CORS with a different number of stations. Some of them finished the CORS establishment within the first action, while some expanded their programme to make a move on their installation many times. However, these actions were not taken under joint work between organisations. They did not share their ideas on the number of CORS, locations, technology specifications, and future expansion plans. Moreover, when the setups were done, they did not share access to their assets with others. Other organisations could not gain benefit from the established technology, but they demanded CORS services for their missions, so they had to make another attempt at the CORS creation budget request.

TABLE 2 GNSS CORS installation timeline in Thailand (Source: Author's own research)

Years	Organisation	Installation	Main point	Reference
1996	The Department of Public Works and Town & Country Planning (DPT)	9 stations	First Thai's GNSS CORS network	Rizos and Satirapod (2011)
2002	King Mongkut's Institute of Technology Ladkrabang (KMITL) Collaborated Partners: The National Institute of Information and Communications Technology (NICT)	1 station	CORS in Bangkok is a part of the SouthEast Asia Low-latitude Ionospheric Network (SEALION) project	Charoenkalunyuta <i>et al.</i> (2012)
2002	The National Institute of Information and Communications Technology (NICT)	1 station	Japan installed CORS in Thailand Bangkok (KMIT) (2002 – present)	Rizos and Satirapod (2011), Thai GNSS and Space Weather Information Data Center (2020)
2004	Chiangmai University (CIMU) Collaborated Partners: The National Institute of Information and Communications Technology (NICT)	1 station	Japan installed CORS in Thailand Chiangmai University (CIMU) (2004 – 2014)	Thai GNSS and Space Weather Information Data Center (2020)
2005	The Royal Thai Survey Department (RTSD)	1 station	First RTSD's GNSS base station	Rizos and Satirapod (2011)
2005	The National Institute of Information and Communications Technology (NICT)	1 station	Japan installed CORS in Thailand Chumphon (CHPN) (2005 – 2014)	Rizos and Satirapod (2011), Thai GNSS and Space Weather Information Data Center (2020)
2006	The National Institute of Information and Communications Technology (NICT)	1 station	Japan installed CORS in Thailand Phuket (PTAC) (2006 – 2014)	Rizos and Satirapod (2011), Thai GNSS and Space Weather Information Data Center (2020)
late 2007	The Thai Meteorological Department (TMD)	5 stations	CORS receivers as part of a tsunami and earthquake early warning system	Rizos and Satirapod (2011)
early 2008	The Department of Lands (DOL)	5 stations	First Thai's Real-Time Kinematic (N-RTK) GPS service	Rizos and Satirapod (2011)
2008	Chulalongkorn University (CU)	1 station	First Thai's IGS station in Thailand support from JPL and UNAVCO	Rizos and Satirapod (2011)
2008	Chulalongkorn University (CU) Collaborated Partners: Kyoto University	1 station	Nongkai (NKKI) (2008 – 2019)	Thai GNSS and Space Weather Information Data Center (2020)
2009	The Department of Lands (DOL)	6 stations	Total 11 stations	DOL (2018)

Years	Organisation	Installation	Main point	Reference
2015	The Department of Public Works and Town & Country Planning (DPT)	6 stations	Total 15 stations	Yomwan (2017a)
2016	The Department of Lands (DOL)	51 stations	Total 62 stations	DOL (2018)
2016	Hydro and Agro Informatics Institute (HAI)	6 stations	First HAI's CORS	DOL (2018)
2017	The Department of Lands (DOL)	30 stations	Total 92 stations	DOL (2018)
2017 – 2018	The Royal Thai Survey Department (RTSD)	80 stations	Total 80 stations	DOL (2018)
2018	The Department of Lands (DOL)	30 stations	Total 122 stations	DOL (2018)

As Rizos and Satirapod (2011) identified, CORS site distribution is one of the significant challenges in Thailand. It is another issue in relation to infrastructure planning and management that requires the advantage of collaboration to enhance the network capability. As they pointed out, this matter is a consequence of the separate installation of CORS in government organisations. These uncoordinated actions were made to keep up the divergent tasks of each organisation. Nevertheless, the implemented network is inadequate for its missions per its design. Over and above, each organisation's infrastructure is not satisfactory in terms of service coverage supporting its burden.

As seen in the table above, the CORS implementation undertakings were made separately by each of the different organisations. The CORS installations were done individually, without sharing ideas regarding CORS sites. This inharmonious technological development caused the CORS network's quality to be inappropriate. In view of the fact that the distances between GNSS reference stations impact the quality of CORS service, the design of its network should be prioritised (NOAA, 2018a). The CORS location plan, arranged by a single organisation, is thus easier to draw. Nonetheless, Thailand's CORS was developed by diverse organisations that did not work together on the implementation of this technology. Consequently, as FIGURE 2.1 illustrates, the CORS were placed unsystematically without a proper distribution plan throughout Thailand. Eventually, it led to a problem in the coverage of CORS services, either the low quality of data, the unavailability of service in some areas, or the duplicate of service in the same boundary. This poor service coverage has then become a barrier to Thailand's GNSS CORS development.

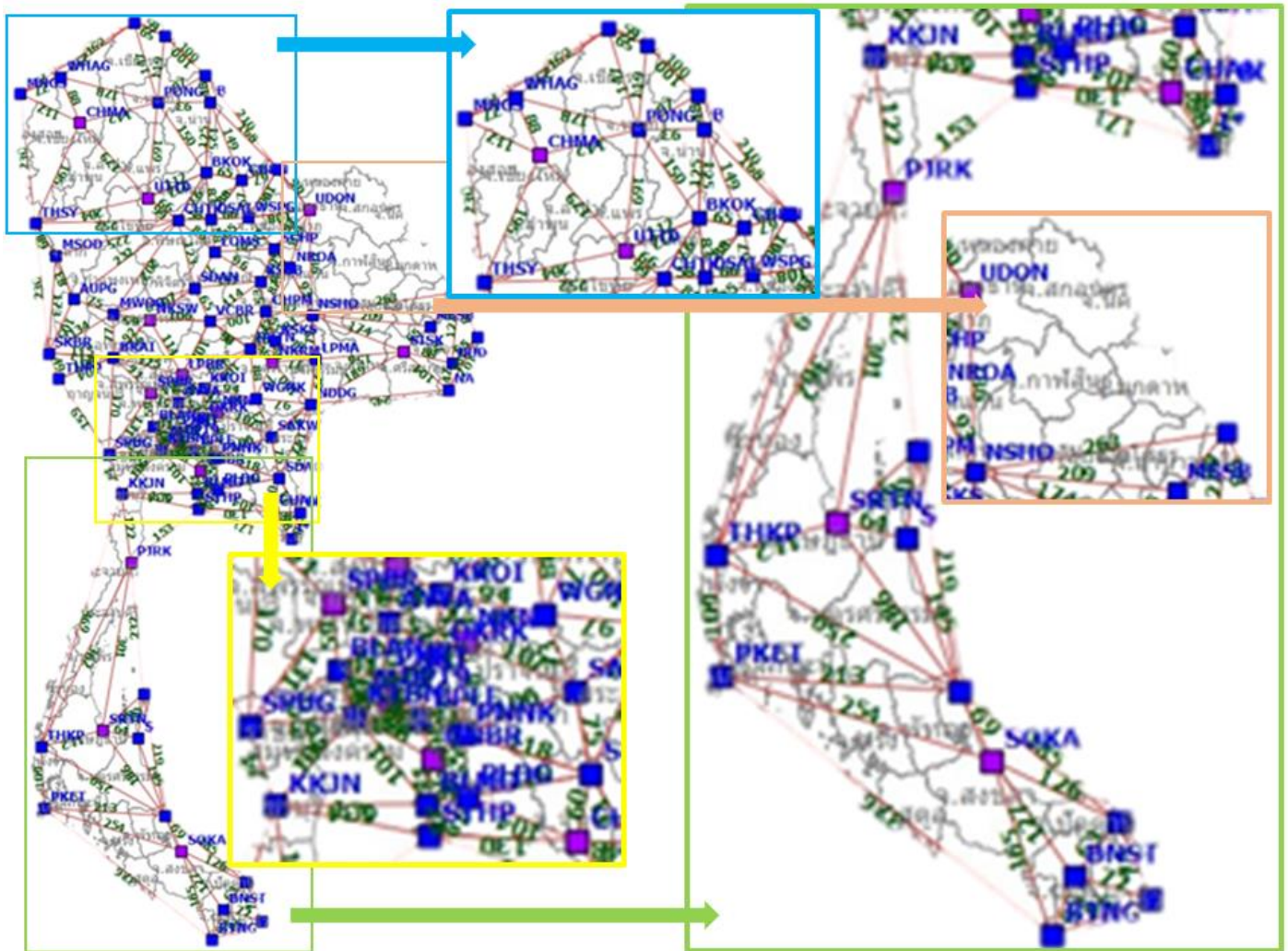


FIGURE 2.1 GNSS CORS network in Thailand (Source: Author's own research)

Duplicate monetary support request

The happenings of CORS implementation in Thailand, as described above, were run independently by organisations. As a consequence, the organisations that received some budget for their CORS investment but are still insufficient and those that have not yet had a budget for creating their infrastructure then request government monetary allocation for CORS. Besides, the CORS stations, with the support of the government, were installed in the same coverage area, and there are many areas without CORS service. Therefore, the government found the duplication issue in this technology investment and asked the relevant organisations to discuss and take steps to reach an agreement. As shown in the summary table below, the High-Level seminar was arranged in 2017 in order to pull the involved organisations into the discussion on solving duplication of budget requests on the CORS establishment issue.

TABLE 3 GNSS CORS management activity timeline in Thailand (Source: Author's own research)

Years	Activity	Key Person	Reference
2011	The academics identified the CORS problems in Thailand.	Professors	Rizos and Satirapod (2011)
2017 February 24-25	The National Geo-Informatics Board hosted a high-level seminar to define the national geo-informatics movement guidelines. The discussion includes: - Creating the National CORS Data Center - Working under the National Subcommittee on GNSS Network (appointed by the National Geo-Informatics Board) - Qualification for the National CORS Data Center candidates - Government organisation - Ability to provide services to the public sector and private sector - Competence in encouraging a diversity of missions - Skilled staff - Technology to support the national infrastructure - The National CORS Data Center in the foreign countries - User: public sector/ private sector/ Hybrid Organisations - Fee: free/ pay - The national GNSS infrastructure - Concept: Network of CORS Networks - Key: non-CORS owner user either public sector or private sector - Problem: lack of national data centre to provide services - Solution: create the national data centre to provide application services in the EEC area - Make GISTDA the leader of the national GNSS infrastructure project - Responsible for the National CORS Data Center - Coordinate with China and Japan - Japan will fund the 200 CORS installation project	CORS owner RTSD, DOL, DPT, HAI, GISTDA	National Geo-Informatics Board (2017)
2017 March 30	- The National Geo-Informatics Board appointed the National Subcommittee on GNSS Network on 26th May 2017 to implement the National GNSS Infrastructure project under the Network of CORS Networks concept. - The National GNSS Infrastructure links with five networks - Surveying and cadastral plan mission: DOL - Surveying, topographic mapping, and national defence mission: RTS - Town planning and Urban management mission: DPT - Water resource and disaster management mission: HAI and Japan - Research and innovation management mission: GISTDA and Universities	The National Geo-Informatics Board	National Geo-Informatics Board (2017)

Years	Activity	Key Person	Reference
	- The National Subcommittee on GNSS Network appointed the National CORS Data Center to provide data services to the public sector, private sector, and civilian - GISTDA, as the National Subcommittee on GNSS Network secretary, will be responsible for coordination abroad		
2017 June 7	The signing Ceremony of the Memorandum of Cooperation (MoC) on the Development of Integrated CORS between Thailand and Japan aimed to: - Create a CORS data integration centre - Install CORS infrastructure - Found GNSS innovation centre	Deputy Prime Minister and Minister of Science and Technology (Dr. Atchaka Sibunruang) [Now: Ministry of Higher Education, Science, Research and Innovation (MHESI)] with Minister of Land, Infrastructure, Transport and Tourism (Mr. Keiichi Ishii)	MFA (2017)
2017 June 4-8	- The 3rd Meeting of the Thailand-Japan High Level Joint Commission: HLJC - Japan – Thailand coordination in founding an Integrated Data Center of the GNSS CORS Network. - An agreement on signing a Memorandum of Cooperation (MOC) between the Ministry of Land, Infrastructure, Transport and Tourism of Japan and the Ministry of Science and Technology of Thailand on the Establishment of the Integrated Data Center. - Minister of Science and Technology (Dr. Atchaka Sibunruang) [Now: Ministry of Higher Education, Science, Research and Innovation (MHESI)] appointed - GISTDA to be accountable to the National CORS Data Center - HAIL to take responsibility for CORS installation	Japan Ministry of Foreign Affairs (MFA) Ministry of Science and Technology (MHESI) GISTDA HAIL	MFA (2017); National Geo-Informatics Board (2017)
2017 June 29	GISTDA was committed to arranging the GNSS CORS coordination proposal (Application Form) at the meeting that was held to discuss an Agreement on Academic Cooperation.	Ministry of Foreign Affairs (MFA) Ministry of Science and Technology (MHESI) (National Subcommittee on GNSS Network)	National Geo-Informatics Board (2017)
2017 August 4	- Japan (Japan International Cooperation Agency (JICA)) proposed that the RTSD be nominated for the National CORS Data Center.	Japan International Cooperation Agency (JICA)	MFA (2017)

Years	Activity	Key Person	Reference
	- Japan (Geospatial Information Authority of Japan (GSI) + Japan International Cooperation Agency (JICA)) offered assistance in terms of CORS upgrades and technical visits. - Japan International Cooperation Agency (JICA) was conducting a resurvey to alter some of the cooperation plans. - Japan focused on providing CORS services to the private sector. - HAI raised that taking control of the CORS installation is quite beyond their capacity; they needed support from the RTSD. - RTSD is responsible for Smart map preparation to support Precision farming. The map was expected to be ready in 2019. - CU put the RTSD forward as the provider of transformation parameters to unify a national geospatial reference frame. - GISTDA presented the Roadmap for data services. - GISTDA was appointed to arrange a discussion workshop dealing with data services management.	Geospatial Information Authority of Japan (GSI)	
2017 August 24	GISTDA proffered an Application Form to the Thailand International Cooperation Agency (TICA), Ministry of Foreign Affairs (MFA), which includes: 1. Technical support 2. The National Service Data Center establishment 3. The National Mapping Data Center establishment 4. The GNSS CORS expansion installation 5. Human Resources Development	Ministry of Foreign Affairs (MFA) Ministry of Science and Technology (MHESI) (National Subcommittee on GNSS Network)	National Geo-Informatics Board (2017)
2017 August	The Cabinet Office (11 organisations) of Japan suggested the GISTDA form the GNSS Innovation Center (GiNNo) at GISTA Si Racha to showcase an exhibition of GNSS technology applications.	Japan GISTDA	National Geo-Informatics Board (2017)
2017 November 2	Guidelines on the management of the National CORS Data Center - Set up three government working groups 1. Implementation Working Group (IWG) to issue guidelines for the National CORS Data Center implementation: Chairman - Permanent Secretary of MHESI 2. National CORS Data Center Management Working Group: Chairman - Director of RTSD 3. Working Group on Thailand-Japan Joint Commission on CORS infrastructure development: Chairman - Deputy Permanent Secretary of MHESI - DOL and GISTDA will draw up the National CORS Data Center implementation project plan. - RTSD will be the National CORS Data Center administrator.	Permanent Secretary of the Ministry of Science and Technology (MHESI) Director of Royal Thai Survey Department (RTSD) Deputy Permanent Secretary of the Ministry of Science and Technology (MHESI)	National Geo-Informatics Board (2017)
2018 January 10	The kickoff of GNSS Innovation Center (GiNNo)	MHESI + NEC (Japan)	National Geo-Informatics Board (2017)

2.2.2 What Did Not Work Well?

As mentioned above, CORS is a technology that many organisations set their sights on to strengthen their missions. However, the insufficient budget for its creation has brought complications in harnessing its full advantage. Even though some organisations have CORS stations, they do not have as many as necessary. Therefore, they will keep on with plans for the budgetary allocation for CORS expansion. Eventually, a budgetary constraint led to the idea of a meeting for CORS cooperation between government agencies to consider mutually beneficial sharing.

Thailand's CORS inexpedient management issue was brought forward by Rizos and Satirapod (2011). They stated that the issue with the GNSS reference stations in Thailand is that multiple organisations built their own CORS, and several more expect to formulate them without sharing a plan and access. The history of the CORS evolution, as given in the table, is evidence that the Thai government organisations aspired to establish their own CORS structure rather than seeking cooperation with others to share the installation plan and accessibility of CORS. That is, different stakeholders did not share technology with others and also did not share access to the technology. So, the stakeholders who do not have CORS try harder to have it. Similarly, the stakeholders with unsatisfactory CORS networks are working on scaling up their CORS operations.

More than that, the installed assets have a poor quality of density; most of them were put in the same area, Bangkok and nearby. This is because the CORS technology is not affordable for any organisation; the organisations that were granted this programme then started their first set of CORS at the heart of Thailand, Bangkok. This behaviour resulted in the duplication of service coverage zones and the service gaps in some areas. Unsmoothed data spreading causes the unavailability of CORS service in some regions, which entails less potential to obtain the benefit of CORS. Due to this, it is necessary to have seamless data transmitted from the optimum distribution of CORS sites.

As a result, Rizos and Satirapod (2011) recommended collaboration between government organisations for Thailand to reap the greatest fruitfulness of CORS technology and further GNSS advancement. Such a thorough attempt comprises sharing the CORS development plan for making joint decisions between the stakeholders involved in this technology and the sharing of CORS access to allow partners to acquire services from Thailand's CORS. If so, the collaboration will alleviate the issues of the lack of data provided due to a shortage of reference stations, the absence of sharing between CORS owners, and the inappropriate distribution of CORS. Thus, Thailand will gain the maximum potential for this technology. However, this study started in 2017, during which the Thai government had a go at creating collaboration on CORS between stakeholders and found that the government's endeavour has not yet been successful.

2.2.3 What Is Going Wrong?

The tables above show the summary of GNSS CORS implementation in Thailand, including the installation progress and management history. Even though the overall information presents a series of actions that look fine, the CORS technology development in Thailand does not have satisfying results, as it seems. The list of activities that revealed a number of things that multiple groups of people have done makes it feel that everything is in a satisfactory way. Nonetheless, things are not going well because the benefits for society as a whole have not been maximised. As summarised in TABLE 4, the outcomes of the actions performed by several organisations are not as expected.

TABLE 4 Summary of GNSS CORS history in Thailand (Source: Author's own research, developed from TABLES 1, 2, 3, and A-12)

Years	Activity	Explanation	Outcomes
1996 – 2018	CORS installation	Government agencies and universities had separately installed their own CORS with or without collaboration.	• No technology sharing. • Poor service coverage. • Duplicated monetary support request.
2011	Academic publication	The academics pointed out Thai CORS issues and recommended inter-organisational collaboration as a strategy to deal with these issues.	Thai CORS development issues were revealed.
2017 – 2020	Government action	The Thai government took action to resolve CORS development issues.	• The National Geo-Informatics Board appointed government bodies to undertake the resolution. • Multiple units were assigned: ▪ The National Subcommittee on GNSS Network ▪ CORS working groups ▪ The National CORS Data Center
2017 – 2018	International collaboration	The Thailand-Japan High Level Joint Commission (HLJC)	• Thailand and Japan signed the Memorandum of Cooperation (MoC) on the Development of Integrated CORS. • Thailand and Japan co-founded the GNSS Innovation Center (GiNNo).

Firstly, the CORS installation work that various organisations have undertaken without cross-boundary cooperation resulted in the issues of a lack of technology sharing, poor

service coverage, and duplicated monetary support requests. Due to the unavailability of cooperation between organisations, the CORS owners do not share access to their technology with others. As a result, the organisations that necessitate GNSS CORS for their tasks demand the set-up of their own systems. This individualised buildup did not get moving under joint planning on the matter of the location of CORS sites, and each organisation designed its CORS location internally without considering others' CORS networks. The service coverage of each station has an influence on the whole extent of this technology. As the range of each CORS service has a limit, like other radio frequency technologies, the distance between stations impacts the accessibility of CORS. Some of the CORS stations from different organisations were installed in the same areas, while some areas do not have CORS. Consequently, duplicate boundaries and missing gaps in service areas cause Thailand's CORS implementation to have poor service coverage. In addition, the CORS service shortage has become a challenge that many organisations desire to resolve. Many organisations have tried establishing their own CORS to exploit its service to fulfil their work or add more CORS to broaden the existing networks. However, the government organisations need to request a CORS development budget from the Thai government; they propose requests for monetary support to initiate or expand this technology individually. Therefore, duplication of requests in the budgetary allocation for CORS implementation is one of the challenges that occurred in relation to these activities.

Secondly, the professors in Thailand and Australia who specialised in GNSS technology worked together on a paper that concentrated on Thailand's CORS contribution. They highlighted the issues in the development of GNSS CORS in Thailand and indicated that the absence of co-working endeavours brought about the lack of CORS access sharing and poor service coverage problems. Also, they recommended inter-organisational collaboration to tackle these complications. Thirdly, on the grounds of these, the Thai government has made a move to disentangle Thailand's CORS issues. Multiple courses of action have been taken to find a solution for Thailand's CORS technology, including meeting arrangements and partnership campaigns. The meetings were held several times to accelerate the progress toward finding a well-suited solution. The National Geo-Informatics Board, which is officially assigned by the Cabinet and composed of qualified experts with experience in space technology and geo-informatics, then hosted the High-Level seminar to kick off the association between the relevant organisations. In relation to this movement, the Board established a committee and subcommittees to take the lead in brainstorming and coordinating diverse organisations, in conjunction with appointing working groups to act on the direction of those bodies. The problem-solving activities on multiple ownership of CORS thus got going and kept on with the effort to initiate the National Data Center, which will be a centre that integrates data from the members and provides services for them and other customers. Nevertheless, the undertaking has not yet been accomplished, and the National Data Center has not been founded.

Lastly, Thailand has attempted to get international cooperation with some countries. The Thai government signed the Memorandum of Cooperation (MoC) on the

Development of Integrated CORS with Japan under the Thailand-Japan High Level Joint Commission (HLJC). Furthermore, they had joint work to create the GNSS Innovation Center (GiNNo) in Thailand. Even though the collaboration was already made under the signed MOU and some programmes were already taken steps, like the formation of GiNNo, the joint effort has not yet encouraged Thailand's initiative to proceed with the CORS network across government organisations.

2.3 CHAPTER CONCLUSION

This research examines the development of GNSS CORS technology in Thailand, a process involving multiple organisations, particularly government agencies and universities. The phenomenon is inherently complex and could be analysed through various theoretical perspectives. However, among several potential approaches, this study adopts the concept of collaborative innovation as its theoretical foundation, as it provides a logical and contextually relevant framework for understanding the intricate relationships and coordination challenges among multiple stakeholders. While the historical progression of CORS initiatives in Thailand may appear substantial, the underlying issue lies in the absence of genuine collaboration. Despite numerous activities and investments, the lack of collaborative innovation has hindered the effectiveness and efficiency of CORS implementation. Thailand's CORS development reflects a sequence of disconnected efforts rather than an integrated, cooperative strategy. Although multiple organisations have engaged in building infrastructure and promoting technological advancement, their actions have largely been isolated, leading to overlapping investments, resource duplication, and fragmented coverage. The societal benefits of CORS technology have therefore not been fully realised. Instead of functioning as a unified national network serving broad public interests, CORS facilities have often remained institutionally owned and internally managed. In contrast, effective collaboration—particularly when led by the government—has the potential to maximise collective benefits and ensure that technological innovation serves national rather than individual institutional goals. The failure to achieve such coordination underscores a significant gap in Thailand's governance approach to CORS.

Evidence from the historical review in Chapter Two further confirms that inadequate collaboration has been the principal barrier to Thailand's progress. Various attempts at cooperation were made, yet these initiatives did not yield sustainable results or lead to integrated management structures. The persistence of resource imbalances, limited information sharing, and an absence of a clear leadership framework have collectively weakened inter-organisational synergy. To address these deficiencies, it is essential to understand how collaborative innovation can emerge, the challenges that impede its formation, and the mechanisms through which it can be strengthened in complex technological environments such as GNSS CORS. In comparison with alternative frameworks that primarily emphasise technical or managerial factors, the collaborative innovation approach provides a more comprehensive lens for examining the interaction between governance, resources, and societal outcomes. It highlights not only the importance of what technical and financial resources are in place but also how these resources are coordinated

and shared across institutions. As CORS development requires joint investment, shared infrastructure, and cooperative management, collaboration becomes the determining factor for success. Where collaboration fails, as in Thailand's case, inefficiency and duplication prevail.

In conclusion, Thailand's limited progress in CORS development stems primarily from the absence of effective collaboration among key stakeholders. Government agencies have independently established assets without sufficient coordination, resulting in fragmented networks, poor service coverage, and repetitive budget allocations. The lack of a strong governmental leadership role in integrating these efforts has further constrained national benefit. Despite multiple calls for multi-stakeholder engagement, genuine collaboration has not been achieved. Hence, this study focuses on exploring the dynamics of collaborative innovation—how it can be fostered, what barriers impede it, and what lessons can be drawn to improve the situation. The next chapter, therefore, reviews relevant literature on collaborative innovation to establish the theoretical framework that will underpin the analysis of Thailand's CORS development and guide the proposal for an effective, integrated collaboration model.

Chapter 3

LITERATURE REVIEW

Several management strategies based on innovation development have been referenced in many studies within a variety of contexts. For example, studies by da Silva *et al.* (2016) and Ottenbacher and Harrington (2007). A number of these studies have shown that the collaborative innovation model is one of the practical approaches used to fill research gaps (Baldwin, 1995; Bommert, 2010; Greer and Lei, 2012; Sørensen and Torfing, 2011, 2017; Torfing, 2016). As the innovation adoption process is drawn in sequence and progression with multi-dimensional decision-making proportions, theoretical perspectives underlined in innovative collaboration projects are crucial to shaping this exploration direction. This chapter aims to provide a summary of the literature assessment of GNSS CORS technology management and the relevant frameworks. The selected pieces of literature were determined by the scope of innovation and the principles that are connected to administering the disparate groups to work together to achieve common goals in CORS implementation. For this reason, the review has been immersed in the scholarly literature on co-working in public sector subjects. The information presented in this section includes the statement of meaning of each term related to innovation, the theories about innovation management strategies, and the formulation of the initial conceptual framework.

3.1 STATEMENT OF PURPOSE

The activities and several efforts that have been put into encouraging the GNSS CORS development in Thailand have given a feel of a more progressive CORS campaign. However, as described earlier in Chapter 2, the endeavours to implement CORS technology in Thailand were likely ineffective.

The timeline of GNSS CORS implementation in Thailand, as summarised in Chapter 2, shows a lack of impactful coordination among multiple organisations. From 1996 onwards, government agencies and universities separately installed CORS with varying numbers of stations, and they did not open up about their information regarding CORS amount, sites, technology details, and future augmentation designs. These uncoordinated actions resulted in a challenge of poor service coverage due to the absence of overall preparation for Thailand's network. Each network was manipulated to uphold the diverse responsibilities of each organisation without a plan to share access to its technology across different organisations. In so doing, many organisations that required this technology to facilitate and strengthen their work could not exploit CORS benefits from those who had already established them, thus pulling their ambitions to create their own. Also, the organisations that had some but had not yet fulfilled their requirements expected a more extensive network of CORS. These organisations consequently requested government allocation budgets to complete their expectations, which caused duplication in monetary support request issues.

As a result, a study in Chapter 2 has revealed that the CORS installation work undertaken without cross-boundary cooperation has led to various problems that hinder the effectiveness and efficiency of the GNSS CORS system in Thailand. Furthermore, it seemed indispensable for organisations to collaborate and share resources to ensure better service coverage and avoid duplicating efforts and costs. These barriers have also led to the failure to realise the business value of innovation, as demonstrated by the hindered achievement of the proper deployment of GNSS CORS technology in Thailand. The inability to overcome these obstacles has limited the potential value that GNSS CORS could have brought to Thailand.

Based on the history of this particular project regarding the implementation of CORS technology up to 2018, the researcher got the impression that the performance of this technology and the way it was implemented were not as good as they could be. Even though the researcher was aware that the Thai government had made an attempt to pull stakeholders together in 2017, the researcher did not know how successful that attempt was. Consequently, the purpose of this research is to know more about the factors necessary for the success of such a project. Also, the researcher needs to understand more about what factors are important for making this technology implementation work well and for the involved parties to collaborate effectively in implementing this technology. Therefore, consideration of these factors will aim at their significance in attaining the goals of making the project effective, either the stakeholders collaborating to innovate or the technology.

3.2 LITERATURE REVIEW

When conducting a literature search for research, there are two stages considered. The first stage involves using keywords to search for relevant literature. However, during the search procedure, the initial keywords may need to be adjusted if they are not straight to the point or they are either too broad or too narrow. Secondly, the snowball method was utilised by examining the references of interesting papers to find other related works.

The justification for why the papers should have been selected and why they are particularly interesting and important for this research is fundamentally designed according to the research focus. In so doing, the paper selection for this research started with some majorly basic concepts about innovation management, which primarily came from the Tidd and Bessant book (2020). As this research specifically concentrates on how innovation management can be achieved if there is more than one party involved, the literature regarding multiple stakeholders taking part in innovation is prioritised. This is on the grounds of its significant link with the case of the Thai situation. In addition to this, there are further searches and critical assessments on the relevance, such as open innovation, collaborative innovation, the role of the government or government agencies in innovation, business models for tackling innovation, and other matters connected with this aim to manage innovation effectively. Over and above, not only collaborative innovation and similar concepts are at the centre of attention, but also specific technologies like CORS technology, are crucial for understanding and addressing a unique set of circumstances conformable to that in Thailand.

In this case, it is essential to establish why certain papers on innovation management, stakeholder involvement, open innovation, collaborative innovation, and CORS technology are crucial for understanding Thailand's context. Moreover, a thorough literature review of academics written about how CORS technology is managed, how it could have been applied suitably and what kind of factors matter the CORS technology management is indispensable for this research.

Database selection

When choosing databases for research in management, the standard method has been employed to focus on academic databases, particularly Scopus and Web of Science. While there is some overlap between the two, they each offer unique resources. These databases are preferred because they primarily feature peer-reviewed literature, ensuring that the information has been vetted by experts in the field. Utilising keywords and snowball searching within these reliable databases allows for a comprehensive exploration of relevant articles and citations. It is essential to prioritise using reputable sources when conducting research in order to ensure accuracy and credibility.

Google Scholar is another database that many people use, including the researcher. However, it is important to note that Google Scholar does not only contain peer-reviewed papers. In fact, it includes a wide range of content from both academic and non-academic sources. Therefore, it is crucial to approach Google Scholar with caution and be discerning of the information extracted from it. While it gives some ideas that can lead to interesting findings not yet available in other reputable databases such as Scopus or Web of Science, it needs to be exercised with careful consideration when using it for management research purposes. On account of this, it is imperative to direct the attention exclusively to these three options in order to ensure efficiency and consistency in this database management.

Further to the above-mentioned options, ProQuest offers access to a variety of databases, including newspaper and magazine articles. It is essential to be aware that while newspaper articles are rarely peer-reviewed, magazine articles are not peer-reviewed. These sources can be considered secondary literature and may provide some insight into a topic, but might not be relied upon for academic study. For example, if there were interest in the latest developments in CORS technology in Thailand, it might be useful to consult Thai newspapers for an overview of current events within that specific context. However, it is important to recognise that this information is not scholarly research and should be used accordingly. That is just to get some idea of typically the most latest developments in a particular situation. When using databases like ProQuest for literature searches, obtaining an overwhelming number of results often indicates that the search parameters are either too broad or not well-defined. In this case, the term "innovation" is exceedingly general and encompasses a wide range of topics, leading to an unmanageable quantity of hits. The effectiveness of a literature search hinges on the precision of keywords and the relevance of the database's indexing. Over and above, proper selection of the databases is indispensable.

Search procedure

When exploring the multifaceted concept of innovation, starting with a general keyword like “innovation” from broad resources is an initial process to gain a foundational understanding. Nonetheless, focusing on a specific topic is decisive and brings about more effective results. For instance, beginning with a comprehensive textbook like the one by Tidd and Bessant provides a general idea of innovation. Rather than looking at innovation as a keyword for a wide-ranging overview of various forms and aspects of innovation, it will be more viable to refine the search by getting down to particular subcategories, such as innovation creation. Then look for detailed keywords like open innovation, business model innovation, and other types of innovation in the role of public sector innovation. As it is narrowed down, increasingly precise terms like collaborative innovation, networked innovation, innovation ecosystems, and stakeholder theory are centralised. This approach helps to progressively fix attention to the search, moving from general concepts to detailed studies relevant to research interests. The more narrow forms or combinations of keywords pointed out how the outcome has been developed. For example, after understanding the main ideas of innovation creation in terms of the key environment, including ownership, power, interaction and technologies, and collaboration arrangement, this study has been refocused particularly on CORS in Thailand. The search then hones in on the role of GNSS CORS development in Thailand, or more broadly in similar contexts regarding CORS. This structured approach allows for a more targeted and meaningful literature review, ensuring that the search results are both relevant and manageable.

Thailand's GNSS CORS

Based on the earlier history of GNSS CORS implementation in Thailand before 2018, the researcher had a strong feeling that this collaboration was not working effectively. Besides, the researcher was not adequately confident about the role of the public sector, which is the Thai government. Correspondingly, it leads to the researcher needing to know the critical factors that make collaborative innovation happen and what role the public sector or the government plays in such cooperation. In so doing, a theoretical framework is needed and becomes necessary when looking at the literature.

When delving into the complexities of CORS implementation in Thailand, it is essential to first address any potential confusion surrounding the terms “technology” and “innovation.” These words are often used interchangeably, yet they carry distinct meanings in a particular context. Therefore, it is crucial to establish a clear understanding of these concepts before embarking on a quest to understand the literature on this subject. Once this foundation is established, one can effectively navigate through the literature to gain a comprehensive understanding of CORS implementation difficulties in Thailand. In addition, collaborative innovation has emerged as a prominent theme for more clarification as it may be involved in the efforts to establish coordination between government organisations in Thailand. The summary of attempts made in 2017 highlights this strategy, emphasising the importance of working together to foster innovation and progress. So, collaborative innovation could possibly be a striking key to pursuing coordinated actions that leverage limited resources and promote knowledge sharing across sectors while fostering unity towards shared objectives. Besides, a

non-profit organisation like a non-governmental organisation (NGO) is also interesting in terms of its involvement in development objectives. This organisation may not be registered as part of the government, but it sometimes works alongside the government or receives some support from the government. It advocates on behalf of the people to monitor the movements of the government, particularly in technological project management, which requires significant investment. CORS development is a project undertaken by government organisations that necessitates a large amount of subsidy, and it may interest the NGO; it should be drawn to this study's attention accordingly.

These term interests may involve seeking out scholarly articles, government reports, and expert opinions to form a well-rounded perspective on the topic at hand. On the grounds of this, the researcher will better equip herself with the knowledge necessary to navigate and address challenges related to CORS implementation in Thailand. Correspondingly, this study's literature review focuses on defining the terms concerning collaboration that apply to the technological landscape. It was initially started by searching multiple databases such as ProQuest, EBSCOhost, Gale Business Insights: Global, Emerald Insight, Inspec database, Engineering Village Databases, and Web of Science Core Collection, and expanded to other databases for further searches, such as ScienceDirect, Scopus, and Google Scholar. In the pursuit of collecting a wide range of topics related to technological management, these databases were discovered based on their availability and relevancy to knowledge in the fields of interest: innovation management, CORS technology, and the public sector. Thus, the first set of keywords used in the search are technology, innovation, collaborative innovation, and NGO. By employing such comprehensive search criteria, technology was taken to explore the literature in any field of the applied sciences to broadly and imprecisely compile all possible information. Specifically, this study concerns GNSS CORS, one of the space technology augmentations, so it is a subset of the term technology. On the other hand, innovation, which reflects an evolution of ideas, was deliberately selected to gather theories and research practices from diverse databases. Although the term innovation is closely connected to technology, it has been found in different meanings of references and was specified to particular applications introduction. Therefore, the literature of GNSS CORS, an innovation of satellite positioning advancement on the ground, appeared significantly in search results. Other than that, as earlier mentioned, the supposition of the probably ineffective CORS collaboration in Thailand, the term collaborative innovation was defined to consider cross-boundary work on innovation in general. Besides, literary works linked to the aspects of the NGO were selected for review in order to overview the bonds between this term and collaboration in the public sector.

The search results in ProQuest as of 16 February 2018 returned more than fourteen million resources relevant to technology and had similar results for other keywords. The researcher once overviewed the overall search results and considered that the breadth of keywords limited its depth and specificity. The word technology is far too broad as a keyword to be useful because it returned millions of hits. This ending may not reflect the sensible relevancy of the key and projections expected to come. For this reason, the keywords should be identified more precisely to hit the accurate and outright content literature. Through that, the search could probably use words like CORS technology or some other qualifier to the word

technology that enables the researcher to look more specifically. By the same token, a review of a whole series of papers on innovation established evidence that the word innovation was not always used in the same way. It sometimes meant the other thing about innovation. That is why it is substantive to clarify what the researcher means by innovation to show grounds for the one picked from those diverse meanings to express the things the researcher is really interested in. On account of this, the identifier search terms needed to be refocused to aim at the goal of this study straightforwardly. The systematic literature review technique was then applied to filter and narrow the search to get to the points specific to this research. Although the search process returned results that were also linked to the terms technology management, project management, infrastructure management, innovation management and other management fields, this study keeps on highlighting innovation in the public sector as the main point.

Commencing the particular literature search

Innovation is a vital aspect of this study, and understanding the various themes and concepts surrounding it is essential for further investigation of a particular issue. Before commencing analytical work and searching for a comprehensive literature review, the researcher studied the framework Tidd and Bessant (2020) provided to grasp the fundamental elements involved in innovation. As Tidd and Bessant's framework outlined key components regarding innovation and this study focuses on innovation, the researcher then applied those terms they emphasised to move into a more targeted search. Searching terms according to Tidd and Bessant's perspective helped shape the researcher's understanding of innovation themes underpinning this exploration. Their framework not only serves as an invaluable guide for exploring these concepts but also offers clarity on how organisations can effectively manage innovative initiatives. That is why the researcher started with it to get ideas about the main themes that should be looked for. On top of that, as mentioned, this study is about innovation that sheds light on how innovation happens, either well or not well; how organisations manage innovation among others, either collaboratively or not; and what role the government plays in innovation matters. As a result, the researcher continued to give the following themes in the literature review: innovation, including its types and processes; innovation forms, including open innovation, innovation in the public sector, and business model; and innovation management that includes the concepts of collaborative innovation, networked innovation, innovation ecosystem, and stakeholder theory. That is, the views of Tidd and Bessant were used as a framework to explain some of the main things needed to reflect on innovation, especially the way of thinking that most innovations require a collaborative management structure. Therefore, collaborative innovation management became one of the keywords that was hunted through more closely. Similar themes that evolved from the understanding of innovation and innovation management from the pointer of Tidd and Bessant in the textbook were then set to delve into literature on collaborative innovation and other links in the papers. The literature review also took into consideration networked innovation, innovation ecosystem, and stakeholder theory. However, the main idea behind all of these approaches is that firms innovate by working together in some sense between companies or stakeholders. However, in collaborative innovation, typically, the government is expected to play a leading role in pulling people together or bringing

stakeholders together, whereas in other circumstances, that might not happen. These matters are significant for the investigation that needs to be connected to the literature search. Arranging to filter essence from the millions of hit results thus is challenging.

For that reason, the researcher put a systematic literature review method into the filtering process to organise how to do a literature review. This procedure, which took in keyword design, paper selection, and citing, gave more transparent decision-making in the literature review.

3.3 BASIC THEMES IN THE LITERATURE ON INNOVATION AND INNOVATION MANAGEMENT

Establishing a logical foundation in the existing literature within the extent of the field of study is vitally important for fostering a deeper understanding of relevant theories and concepts and positioning the research contribution. In the exploration of basic themes in literature for this study, the researcher has primarily turned to main textbook material like Tidd and Bessant (2020). The review of Tidd and Bessant's piece of writing discovered the key themes of innovation and innovation management in general. The work of Tidd and Bessant, among others, continues to shape the discourse surrounding these fundamental themes, making them a substantive part of scholarly inquiry. As such, the researcher needs to engage with this literature in order to gain a comprehensive understanding of the basic themes that underpin various literary works. Additionally, the assorted scholarly perspectives on the field have also been explored to enable the establishment of the main themes in the literature, such as Bommert (2010), Chesbrough (2003b), Nambisan (2008), Sørensen and Torfing (2011), and Teece (2006). This foundational literature has provided advanced insights into these essential concepts and has served as a valuable resource for further analysis and interpretation.

Specifically, this research has a particular concentration on organisations working together for innovation. Moreover, in the previous chapter, it has presented the principal concern in CORS implementation in Thailand and underlined the requisite of a co-working environment between different parties, which are major stakeholders. Later in this section will highlight the basic themes in the literature on innovation and innovation management.

In order to conduct a thorough and comprehensive study, it is imperative to establish the literature that has been consulted. The search on multiple databases is thus utilised to encompass various scholarly works and look at particular literature from an extensive range of perspectives that were explored. Eventually, key terms, as they are understood within the existing literature, have been derived from reputable scholarly articles and books. These terms will enable accurate comprehension of the concepts discussed throughout this research. The central point of this study is collaborative innovation in the public sector, so the investigation centres around technology implementation led by governmental entities. The role played by governments in spearheading technological advancements is taken into account because of their leading position in implementing the technologies. Furthermore,

collaborative innovation in the public sector necessitates a high quality of management due to its involvement of multiple stakeholders. Correspondingly, effective collaboration among various stakeholders is indispensable as the implemented technology should be delivered to its total capacity for the stakeholders to yield maximum benefits and for public society to gain the full potential of advantages. In so doing, it is essential to understand the link between crucial things and the key senses that enhance collective efforts vital for successful implementation. As a result of the deliberate term search and scholarly paper review, multiple themes came up in the literature, described below.

3.3.1 Innovation

Innovation can be described as the relevance of technologies, businesses and organisations toward the fad. As defined by Tidd and Bessant (2020), innovation is an effort in that the possibility has been mutated into creative inspiration and the development of practical solutions. Moreover, innovation is associated with imperative procedures and implements for turning thoughts into new production, results, services or commerce (Isaksen and Tidd, 2006).

Innovation is primarily driven by technology, developmental teams, and customer requirements. The innovative ideas to implement things are feasibly started from relations between things and their possibilities. On the other hand, both failure and leadership skills are incredibly significant for the innovation movement (Tidd and Bessant, 2020).

Innovation encompasses more than just high technology; however, it is undeniable that high technology, particularly digital innovation, plays a crucial role in driving progress and success in today's rapidly evolving world. As such, this research prioritises digital innovation to explore and understand more about CORS technology.

3.3.2 Forms of Innovation Creation

Recursive analysis of innovation development has shown multiple novel strategies in small established companies, inter-organisational collaboration and public management. However, innovation activities require features to transform an idea into a result. Some basic themes that are coherent to account for the trend in managing innovation are open innovation, innovation in the public sector, and business model innovation. These terms are significant in light of their fundamental conceptual thought, radical knowledge base, and applied and practical implications related to innovation evolution. That is, open innovation is the initiation of the idea of bringing in-house and external resources to share between firms. In this sense, it is essential to perform value capturing from openness and to evolve this concept to other practices. Correspondingly, it can be employed in managing innovation in the public sector. This action makes a sensible business model indispensable to the innovation arrangement.

On these grounds, the paradigm of open innovation and the creative pattern of the business model to cope with innovation transformation in the public sector are

founded to harmonise this research plan. So, this set of particular knowledge can entail any considerations for justifying the discovery of this technology management problem in the government sector study.

Open Innovation

The study of the company's research stories in developing innovative ideas and delivering them to market has raised a new theme of innovation called 'Open Innovation' (Chesbrough, 2003b). Open innovation since then has become widely known and customary to substitute an old strategy, 'Closed Innovation'. The 'Closed Innovation' refers to the process of creating fresh ideas and performing relevant operations in order to improve market share by utilising the internal resources of a single company. This strategy is situated in the context of the R&D investment focus, given the rationale that control is imperative for innovation accomplishment, thus heavily reinvestment in technological areas to bring embryonic conceptions to commerce further (Cassiman and Valentini, 2016; Chesbrough, 2003b).

Rather than continue running a business relying on the closed innovation concept and intensely investing in R&D, the logic of open innovation has changed the views of investors. Open innovation, in essence, is a concept that the company's internal knowledge and exchanged resources across groups of firms should be combined to pursue innovation development. Even so, it is not easy for research and application to serve "all things to all people" due to the lack of capability of envisioning and evaluating (Tidd, 2014). Although open innovation is driven by a permeable process on the basis that "there are many ways for ideas to flow into the process and many ways for it to flow out into the market". As either formal or informal relationships, it involves multi-players to deal with the inter-organisational resource exchange (Chesbrough, 2006). According to Tidd and Bessant (2018) and various research published after 2003, producing new creations and services, inventing technologies, and implementing business models should occur under a cooperative environment based on resource sharing that surpasses the boundaries of individual company constraints. Nevertheless, the most persistent notion of this study is from Huizingh (2011), who states that innovation could scarcely be 'closed' due to its burgeoning complexity in the multi-actor innovation development crossing corporation boundaries.

Innovation in the Public Sector

The term 'innovation' refers to the thriving success of not only in products but also in services, though the service innovation management in the service sectors resulted in less viable applications than in the manufacturing sectors. It provides distinct possibilities and demanding tasks to the public sector, for example, the enhancement of standard, efficacy and rapidity of care services (Tidd and Bessant, 2020; Tidd and Hull, 2006).

Encouraging innovation in the public sector is different from the private sector due to its unique characteristics in terms of environments, mechanisms, legislative rules, political hospitality, benefits, consequences, and volatility (Bloch and Bugge, 2013; Borins, 2001; Koch and Hauknes, 2005). As the nature of the innovation adoption process at the organisational level is presented in the sequential processing of decision-making to enactment, the broad range of variables impacts the creation of newness in the organisation (Pichlak, 2016). The societal and economic challenges thus have significant influences on the adoption of policies and the formulation of tactics to create public welfare.

Business Model Innovation

The business model involves the framework or design that organisations employ in order to meet customer requirements and return to profitability (Teece, 2006). As the business model theme is associated with the systems of value generation, value delivery, and value apprehension, the enterprise can apply it to make the desirables and dispatch them to clients and increase the potential gain. Hence, a relationship between value creation and value capture can be connected by value delivery (Casadesus-Masanell and Ricart, 2010; Teece, 2006; Tidd and Bessant, 2018).

3.4 INNOVATION MANAGEMENT

Regarding the reviews of the studies in a variety of disciplines, innovation management and policy matters, particularly paying attention to the responsibilities at the state and local level, have emerged since the 1980s (Fagerberg *et al.*, 2012). Also, the findings underpinned by the studies relying on qualitative and quantitative approaches show that Innovation Studies are found in interdisciplinary research programmes more than in Business and Management Schools (Rafols *et al.*, 2012). Acquiring and sharing internal and external organisations' priceless resources to grow the businesses or create new things is a basic knowledge of innovation; however, managing innovation needs explicit comprehension of how and when to undertake development. Notwithstanding the existing studies in the innovation management discipline, failure to form the research consistently increasingly leads to a tendency towards modern themes more than underlying oppositions and ideas (Tidd and Bessant, 2018).

Even though innovation management accomplishment can be measured by the company's transaction, proliferation, and employment, as well as the growth of innovative value for society, it is challenging to manage innovation automatically. Generally, training and guidance are potent tools for management in Business Administration term as the qualities of steadiness will continue. Also, fundamental knowledge and experience are insufficient for the innovative business and management field. Therefore, a theoretical and practical knowledge base is required (Tidd and Bessant, 2018).

Furthermore, an analytical study of the indicators of innovation – in terms of technology, organisation, and market – revealed that the nominated hands had impacted a model of innovation and their correlations. The study, which spotlighted the public area data, marked that technology-based factors can influence the local and national scale rather than the enterprise level. Besides, an investigation of the market-based measures reflected that a joint venture has significantly affected innovation more than a firm (Tidd and Driver, 2000). As a result, the technology management study should comprehensively review the broad range of multi-disciplinary works of literature.

As written above, the models of innovation for establishing the linkages between technologies and strategies that are the main frame of knowledge in this study are in the concept of cooperation. The literature shows some resemblance between those theories, which could cause confusion for the innovator. Innovation methods are typically differentiated by how the innovation is generated and its reliance on employing resources for innovation management strategies. Generally, as derived from literature reviews, the term open innovation is extant in various innovation types, such as user-driven innovation, crowdsourcing, co-creation, networked innovation, and collaborative innovation. The following sections will describe the meanings and interrelation between each innovation type and the theory in relation to innovation management.

As outlined earlier, the forms of innovation creation, which include open innovation, innovation in the public sector, and business model innovation, the literature shows some resemblance between those theories. While there are distinct differences among various models of innovation proposed in the literature, there are also significant commonalities that underscore certain fundamental principles underlying innovation creation. In the collection of these sources of literary works, a number of various literature have been searched within the above-mentioned databases and expanded range from the pieces of evidence obtained from search results to further scholarly literature. The search started with a broad and straightforward keyword like innovation collaboration in the public sector. The scores of hits returned the list of papers provided extensive aspects in regards to cooperative movements between diverse parties on public value contribution and management. These published literature were selected to be referred to in this research according to their compliance with the research purpose and liability as stated by their citation history count. Furthermore, the enquiry was ballooned with extra critiques presented in the selected literature to gain more evidence and expansive views on the search item.

The key themes of the study are generally derived from literature reviews, in particular, this study takes the keywords that Tidd and Bessant come up with like collaborative innovation. The prime themes then have been augmented towards networked innovation, innovation ecosystem, and stakeholder theory. Consequently, these terms are keywords that have been used for the literature review of this study.

3.4.1 Collaborative Innovation

According to Tidd and Bessant (2020), most innovations require a collaborative management structure to perform operations for financial gain or process of

advancement; nonetheless, the degree of success of co-working is still unsatisfactory. Apart from that, innovation does not solely refer to introducing business alternatives; the existing and fully developed ones can be proposed in different styles as well. As a result, it is challenging to manage innovation networks to leverage resources between different industries and create social value in public sector innovation.

To truly understand the concept of collaborative innovation in the public sector, it is essential to review the existing literature on the topic. Such that, the process of mining resources to critically evaluate and verify the reliability of the information presented in this literature engages credible databases through the input of keywords like collaborative innovation in the public sector, which subsequently links to innovation policy. Throughout this process, the researcher began with the textbook of Tidd and Bessant (2020), which explains fundamental ideas related to innovation. Basic themes derived from this book led to the discovery of a more specific term, collaborative innovation in the public sector. In particular, the innovation policy existing in CDC (2015), Lundvall and Borrás (2005) and other literary works cited in those sources relatively support the credibility and validity of the literature and demonstrate its potential impact on the development of innovative public value management among various stakeholders.

Commercial, Social and Economic Development

As Tidd and Bessant (2018) perceptively observe, a number of studies in innovation management have concentrated on the ways to take the strengths of innovation in terms of Open Innovation or Business Model Innovation. Notwithstanding, the term "management" is not merely referred to as "business". Innovation management on the basis of society and the economy is also achievable.

The research on open innovation mostly releases typical cases of the practice of for-profit organisations' innovation implementation, as the origin of this principle resides in business transactions. Whereas innovation is marked as the core business process of creating new products or services using internal and external knowledge and resources, developing optimal motivation requires a collaborative working environment. This form of innovation management leads to the growth of businesses and knowledge sharing while minimising time, expenditures and risk of production and marketing (Tidd and Bessant, 2020).

Innovation Policy

A policy is a system of decision-making guidelines containing a set of protocols or intents of the act to supervise the institutions, both in the government and other sectors. It can be within the range of implementation procedure or practice to regulation and law that can execute the organisational manoeuvre (CDC, 2015).

Type of policy

Generally, the policy can be categorised into several groups based on the lens used. Some principles divide it into seven types according to its formulation process. Yet, it can be narrowed into four main types for greater precision: Public Policy, Organisational Policy, Functional Policy, and Specific Policy (Kapisa, 2021). Furthermore, policies can also be classified into another group, namely the STI policy. STI consists of three components that have unique characteristics: science policy, technology policy, and innovation policy (Lundvall and Borrás, 2005). The three features of this kind of policy type are differentiated by considering the involved actors, the instruments applied, and the key data sets used to underpin the policies. These are the ideal types for structuring the type of policy from complex phenomena.

Science policy deals with the endorsement of scientific knowledge development, for instance, resource allotment. However, it also includes other objectives outside the area of pure science, like particular military objectives. It is occasionally presupposed that the research endeavours will provide the outturns in society and economy, either automatically or not (Chaminade and Lundvall, 2019; Jaffe and Jones, 2015). On the contrary, technology policy aims to encourage the advancement and exploitation of defined technologies that are strategically significant to the country. Therefore, this policy evolves from explicit strategic technologies that influence the objectives of both societal and economic aspects. Moreover, it draws attention to building and improving such technologies or adopting them more extensively. These technologies can be both general and specific to the activities of the economy (Chaminade and Lundvall, 2019). Over and above, innovation policy is an integration of science and technology policy. It takes place in the entire innovation process, starting from scientific discovery to the particularly applied technology, commercialisation, and utilisation. Furthermore, innovation policy also concentrates on the institutional framework and expanded evolution to transform innovations into markets and applications.

FIGURE 3.1 below illustrates the major characteristics of the STI policy.

	Science policy	Technology policy	Innovation policy
THEORY	Neoclassical	Evolutionary	Evolutionary
OBJECTIVES	Research (invention)	Technology (sectors)	Innovation (commercialization, generic competences)
ACTORS	R&D Labs Universities	Industry	R&D labs Universities Incubators...etc
EXAMPLES OF INSTRUMENTS	R&D Tax incentives Subsidies to public research Research infrastructure	Technology transfer programs R&D incentives IPR laws	Incubators Technology transfer programs
DATA & INDICATORS	R&D expenditures R&D Personnel R&D SURVEYS	R&D and technical personnel R&D in certain industries	Innovation expenditures Organizational innovation Innovation surveys

FIGURE 3.1 A summary of the main differences between science policy, technology policy, and innovation policy developed based on Lundvall and Borrás (2005) by Chaminade and Lundvall (2019).

Innovation policy

According to EUROPA (2021), an innovation policy can be described as the connection point between research and policies, and this can be either technological development or industrial policies. Similarly, through the lens of the European Parliament and the Council, innovation policy has a significant articulation with EU policies. It offers preferable results of the links between the research outcomes and marketing. This contributive framework has also been built on a strong desire to achieve the goal of transforming ideas into commercials. As evidenced in the literature, Abernathy and Clark (1985) concluded that Rosenbloom recommended combining the firm's policy with technology knowledge to satisfy investment and employment fitness. Though there are some constraints in formulating a policy framework as innovation is not a uniform structure, innovation is capital to various policy deliberations to support the national system (Tidd, 2006). Consequently, innovation policy has become the central part of the connection between policies, for instance, policies on the environment, energy, industry, employment, and competitiveness (EUROPA, 2021). Moreover, many countries practically integrate demand and supply components to fulfil their different innovation policy objectives, which comply with their business capability (Dutz *et al.*, 2014).

The policies-success relationship was revealed by Baldwin (1995), who indicated that the appropriate integration of techniques and the enactment of these selections are highly correlated. In terms of small businesses, these interconnections are associated with objectives, strategies, actions, competitiveness, growth factors, finance, and education, which are the keys to success. Besides, as Tidd and Bessant (2020) stated, success is correlated with innovation, and innovative organisations could attain more advanced success than the ones who are deprived of innovation. They also mentioned that innovative enterprises could control the portion of a market and return more profits. Additionally, understanding the basic innovation concepts would suffice the policy context necessities to a greater degree (Tidd and Bessant, 2018). As a result, contemporaneously working on the problem-solving endeavour, the policy deadlocks should be removed (Torfing, 2016). This study aims to provide a recommendation to support a policy framework for managing GNSS CORS technology implementation. Therefore, innovation policy is the proper domain leading to shareable orientation, sustainable growth and viable technology-to-market strategy for this study. However, as Lundvall and Borrás (2005) concluded, it is impossible to devise a viable innovation policy in the absence of the analysis of a national innovation system in terms of how it builds knowledge and skill. Thus, the policy formulation in this study needs the investigation of GNSS CORS management in Thailand.

On the whole, an important part of collaborative innovation is its crucial aspect of driving progress and growth in technological employment. It demands various factors to commence cooperative work and strong bonds of relationship to carry on with shared initiatives. Typically, the government has been seen as the leading force in fronting collaborative innovation efforts. Therefore, collaborative innovation involves the government, which often plays a significant role in bringing people together and fostering collaboration. This is despite the fact that some concepts, like networked innovation or innovation ecosystem, have also been acknowledged as essential behind innovation management. The ideas are mainly about innovating with the companies or stakeholders that work together in some sense. It can be understood that these concepts deal with innovation operations without direct public sector involvement. As a result, collaborative innovation under the direction of the government's role is considered vital for driving the success of impactful innovations.

3.4.2 Networked Innovation

The characteristic of networked innovation that is like open and collaborative approaches in connection to innovation in the public sector is that it has to consider diverse actors' engagement in innovation activities. However, networked innovation has a particular role in the production process, while collaborative innovation encourages firm processes in public innovation (Bommert, 2010; Moore, 2009; Sørensen and Torfing, 2011).

According to Chesbrough (2003b), open innovation has been adopted over decades by innovators in the commercial enterprise sector through liaison with partner dealings. Typically, the organisations that foster innovation can be categorised into

four characters: innovation discoverers, traders, designers, and missionaries. These broad networking relationships facilitate technological R&D, market opportunities, value generation, or nonprofit offerings, either formally or informally. The firms' openness in authorising the interconnections across boundaries is associated with their trust in economic transactions (Dahlander and Gann, 2010). Whereas networking has performed the principal function of innovation, the dynamic transaction costs involve the costs of engaging prospective allies who either have resourcefulness or scarcity of resources. In accelerating innovation, the inflows and outflows of knowledge are the essences of the open innovation model in ideas transfer (Cassiman and Valentini, 2016). As a result, Dahlander and Gann used inbound and outbound innovation strategies to investigate "how firms open up their innovation processes" to identify the range of openness in firms.

A study on Collaborative Innovation with Customers (CIC) revealed that networks bring advantages to numerous aspects, comprising customer relations, that, in turn, lead to products and knowledge improvement (Greer and Lei, 2012). In terms of customer experience relatedness, networked innovation helps in the furtherance of product design, initiation, and experiment. It necessitates the endorsement from organisational models as high degree as other structures, such as the virtual knowledge brokers (VKBs) or go-betweens. The studies on these linkages illustrated innovation advancement through partner preference measures and customer insight regarding roles, benefits, and participation. In a research society, networked innovation interrelates multi-disciplinary knowledge in the sense that different perspectives on the customer's interdisciplinarity could address the possible contradictions. These experiences learnt from customers through networking are important strategic points that firms use to facilitate the achievement of open innovation.

The Closed-to-Open Innovation transition process concerns the firm's openness to practices that correspond to four aspects: inter-organisational networks, organisational frameworks, analysis strategies, and knowledge management structures (Huizingh, 2011). Moreover, inter-organisational networks have significant benefits in reducing resource harnessing and increasing the capacity to gain intellectual property rights. Hence, the reason it is meaningful to collaborative innovation.

Inter-organisational network theory clarifies the power of the fellows' goals over the system of inter-partnership networks by that the firm's position in such networks exerts an influence on the firm's actions and solutions (Ahuja, 2000). Thus, the status of an individual firm in the industry network is linked to an interfirm collaborative effort in light of resource sharing. The result of a study on the optimal system structure in social capital characterised a network component into three categories: partners with limited bonds to others, partners with multiple interconnection and expendable bonds, and numerous disjointed bonds.

3.4.3 Innovation Ecosystem

The conception of the innovation ecosystem principle can encourage companies to pursue innovation actively. This concept involves idea generation, idea-to-value conversion, and commercialisation processes (Adner and Kapoor, 2010; Olsson and Bosch, 2016). It is an idea-to-business transfer that includes stakeholders, upstream and downstream partners, and clients of an innovation.

Innovation can be conventionally categorised into three types based on ideas generation: internal innovation, external innovation, and collaborative innovation (Adner and Kapoor, 2010; Poot *et al.*, 2009; Olsson and Bosch, 2016; Vanhaverbeke *et al.*, 2008). Internal innovation involves ideas generation within the boundaries of the firms and is generally motivated by a technological focus. On the other hand, external innovation is the adoption of innovative ideas developed outside organisations, which stakeholders drive. Finally, collaborative innovation engages ideas creation on the basis of multi-company interaction and is induced by the agreement between partners to share and take. The capability of firms in market share is not only about value building but also relates to the flexibility of adaption. Within this context, innovation ecosystems could be a helpful strategy to underpin firms' dynamic movement. Even so, selecting the appropriate approach to reflect the optimum of the mixed method of innovation type could be challenging for firms (Olsson and Bosch, 2016).

The innovation ecosystem concerns itself with the formation of the idea, the idea-to-value conversion process, and commercialisation. It benefits the projects in terms of a variety of alternatives, a range of investments, and commodification of initiative. Naturally, the innovation ecosystem comprehends stakeholder engagement and networks of the focal firms, upstream and downstream collaborators, and consumers to enable the partnership for sharing the risks and funding in building innovation (Adner and Kapoor, 2010; Olsson and Bosch, 2016). Initially, studies on the ecosystem were arranged to identify the relationship between the physical organism and its surroundings. The development of the ecological system has been intensified to scrutinise the construction, transformation, and maintainability. Eventually, the innovation ecosystem becomes the vital complex used to specify the essential elements for thriving business success and maintaining the sustainability of an economy. The innovation ecosystem needs deliberation over the matters of the system structure, namely innovation networks and knowledge clusters (Carayannis and Campbell, 2009), as well as the system process, for instance, the flows of inputs and outputs (Adner and Kapoor, 2010). It requires the system evaluation, such as the risk assessment steering by the system components: the innovation, actors, representatives and organisations, straightforward innovation process, and stimulant organisational culture. Along with these, it demands strategy manipulating over marketing, financial management, materials, human capital, and logistics (Adner, 2006; Adner and Kapoor, 2010; Carayannis and Campbell, 2009; Jackson, 2011; Jones *et al.*, 1994; Odum, 1969; Smith, 2006).

3.4.4 Stakeholder Theory

Innovation management in the public sector engages diverse stakeholders to supply materials and clarify complex phenomena (Nambisan, 2008). Thus, stakeholders are viewed as the keynote of innovation in organisational theory and change management (De Vries *et al.*, 2018). Stakeholders are defined as groups of valid members in the company founded for the purpose of trading connections. Sharing resources among the groups will encourage the enterprise to contribute to meeting expectations; nonetheless, the significance of stakeholders will depend on the magnitude of their shares. As a result, the different power of stakeholders is caused by unequal dependence. Moreover, market stability and competence are subsequently changed regarding stakeholders' balance of power (Hill and Jones, 1992). Similarly, the groups of legitimate interest members are directly related to the managerial approach in the corporate objectives, but it is not necessary that every stakeholder would have equal power in management (Donaldson and Preston, 1995). These notions appeared in the literature that it is imperative to consider 'who' should be the owner of the open and collaborative innovation and 'who' should entail the responsibilities, where collaboration encouragement is the greatest significance for achieving accomplishment in the collaborative innovation (Sørensen and Torfing, 2011). Contrarily, the apprehensive orientation of the facilitation of the collaboration or the theories that explain how to do facilitation completely is often very restricted.

Scholl (2001) concluded that although applying stakeholder theory to the public sector was uncertain due to the concepts and effects in private sector organisations being distinctive to the public sector organisations, the personal viewpoint of stakeholders impacts decision-making and organisations in the same way. The core role of open and collaborative innovation is to bring in stakeholders to manage innovation coherently. The management of stakeholders for collaborative innovation seems more complicated in the public sector than in the private sector due to transparency with limited regard for Intellectual Property (IP), the less comprehensive knowledge, and the political power that is latent in the activities (Mergel and Desouza, 2013). On the other hand, the Multi-Stakeholder Partnership (MSP) is driven by governmental players as well as non-governmental players to build a win-win situation for the participating endeavour where the players are allocated their personal roles (Simon *et al.*, 2016).

Furthermore, as the stakeholder who plays the core role in the public policy process, the government could be the dominant force (Buchholz and Rosenthal, 2004). It was found that by exerting the stakeholder-based process in local administration governing, the actors appointed to have power over their organisations could influence decision-making (Gomes, 2006). Conjointly to De Vries *et al.* (2018), the variety of perspectives on innovation adoption from different stakeholders is crucial for innovation to raise awareness of possible prejudices. Therefore, adopting innovation in the public sector should value the stakeholders' distinctions to avoid bias.

The power distinction element may have a strong effect on the achievement of the collaboration, such as the thoughtfulness in the power of solitary managers and power-motivated comportments toward innovation (Cankar and Petkovšek, 2013). These power asymmetries may consequently run the risk of collaborative innovation implementation (Sørensen and Torfing, 2011). Five common elements concerning collaboration management that are introduced to solve the power differentials complexity are;

1. organisation,
2. associateship,
3. interaction process,
4. objective, and
5. temporal attribute.

The understanding of the players in terms of distinctiveness, insight, area of interest, divergent portion, and abstract logic is a requisite for investigating the functions of each of the stakeholders. It is also needful to gain the following necessities: to attain the public value management on the things that require a cooperation process; to obtain legality and endorsement pulled in the congruent attitudes and different directions; and to build the competence of public value co-producing, in particular, the capacity of delivery and conjoint involvement system in respect to the paramount routes, contrasting resources, and contrastive time frames (Bryson *et al.*, 2017).

3.4.5 Collaborative Innovation in the Public Sector

Collaborative innovation in the public sector refers to the deliberate opening of the innovation cycle—idea generation, selection, implementation, and diffusion—to a heterogeneous constellation of actors operating beyond traditional bureaucratic hierarchies. Drawing conceptually on the logic of open innovation, it assumes that public value can be enhanced when governments mobilise knowledge, creativity, legitimacy, and resources that reside externally as well as internally, and match innovation tasks to the loci where these assets are most available rather than to formal organisational jurisdiction (Bommert, 2010; Nambisan, 2008). The approach is theoretically anchored in complementary literatures. Innovation studies emphasise the importance of inter-organisational networks and knowledge recombination for novel solution development (Tidd and Bessant, 2020). Planning and deliberative policy theory highlight the co-construction of problem framings and solution pathways through participatory processes (Healey, 2006). Meanwhile, public administration research on network governance demonstrates how collaborative arenas can institutionalise mutual learning and coordinated implementation—conditional on appropriate meta-governance to steward interaction, manage conflict, and safeguard democratic accountability (Sørensen and Torfing, 2011; Torfing *et al.*, 2021).

Empirically and conceptually, collaborative innovation is argued to address several deficits inherent in purely hierarchical or market-based approaches to public innovation. By widening participation, it increases the diversity of perspectives and the volume of ideas, thereby expanding the potential for creative breakthroughs. Through joint problem diagnosis and shared ownership, it strengthens legitimacy and the social acceptability of new policies, services, and technologies. Moreover, by pooling resources and distributing risk across actors, collaboration facilitates implementation and diffusion that often lie beyond the capacity or mandate of single organisations (Hartley, 2005; Bommert, 2010; Sørensen and Torfing, 2011). However, it is not an unqualified remedy. Collaborative innovation is highly contingent on enabling institutional conditions, clarity of roles, power-sensitive facilitation, and robust accountability arrangements capable of reconciling shared authority with constitutional requirements and equity concerns (Osborne, 2010; Sørensen and Torfing, 2011; Torfing *et al.*, 2021).

These insights imply a dual policy agenda. First, governments must purposefully build collaborative capacity—developing facilitation and brokerage skills, cross-boundary funding mechanisms, and reflexive accountability frameworks that enable experimentation without eroding public responsibility. Second, research and practice should advance comparative, evidence-informed evaluation of when and why collaborative innovation outperforms hierarchical or market alternatives, using measures that incorporate not only efficiency but also public value creation, inclusion, and democratic legitimacy (Hartley, 2005; Osborne, 2010; Torfing *et al.*, 2021).

3.5 INITIAL CONCEPTUAL FRAMEWORK

In the previous section, the researcher explored various forms of innovation creation, including collaborative innovation, networked innovation, and innovation ecosystems. Additionally, the stakeholder theory and its influence on the development of innovation between multiple players were presented briefly.

Section 3.5 serves as a summary of the key points discussed in section 3.4. It is a concise recap of the literature on different forms of innovation creation and the impact of stakeholder theory. Summarising these concepts would offer a clearer understanding of how they connect and influence one another within the broader context of inter-organisational innovation. Accordingly, the following tables demonstrate general information on those considerations.

In the initial review of the textbook, by Tidd and Bessant (2020), the focus was on the major issues in innovation and innovation management. TABLE 5 shows brief introductions of the review specifically delves into the forms of innovation creation, with a particular emphasis on innovation in the public sector among other innovation terms like open innovation, and business model innovation.

Upon closer exploration, while it involves collaboration between various parties and there is matter in association with business model innovation, the government plays a pivotal role in

the innovation adoption activities. Embodied elements of all three columns – open innovation, public sector innovation, and business model innovation – are fundamental themes captured from the literature on innovation and innovation management. However, this study is particularly looking at how organisations work together to create innovation, which does not fit squarely within open innovation. Although there are co-working endeavours between individuals, it is not likely that innovation contribution can happen. The collaborative nature is thus a noteworthy form of innovation making.

In the Thai case study, the role of the government in CORS is crucial. Developing business models for participants and ensuring benefits for all involved, including the government and the country as a whole, are essential considerations. The case incorporates elements of open innovation, innovation in the public sector, and business model innovation. However, it does not completely correspond to each of those three elements, it only fits partially to them. On the other hand, it is particularly emphasised in this context that collaborative innovation should be taken into account.

TABLE 5 Basic themes in the literature on innovation and innovation management (Source: Author's own research, summarised from Section 3.3)

Innovation	Innovation Types and Process		Forms of Innovation Creation		
	Innovation Types	Innovation Process	Open Innovation	Innovation in the Public Sector	Business Model Innovation
• Turning ideas into new production, results, services or commerce • Relate to technologies, businesses and organisations • Driven by technology, developmental teams, and customer requirements • Started with relations between things and their possibilities • Influenced by failure and leadership skills (Isaksen and Tidd, 2006; Tidd and Bessant, 2020)	• Product innovation • Process innovation • Position innovation • Paradigm innovation (Tidd and Bessant, 2020)	• Technological innovation • Organisational innovation • Commercial innovation (Tidd, 2006; Tidd and Bessant, 2020)	• The new theme of innovation in developing innovative ideas and delivering them to the market. • The company's internal knowledge and exchanged resources across groups of firms should be combined. • Driven by the idea that there are many ways for ideas to flow into the process and many ways for them to flow out into the market. • Involves multi-players to deal with the inter-organisational resource exchange.	• Innovation through service innovation management in the service sector has less viable results than in the manufacturing sector. • Innovation provides demanding tasks to the public sector. • Encouraging innovation in the public sector is different from the private sector due to its unique characteristics. • The innovation adoption process impacts decision-making and policy pursuit on public welfare.	• A business model is a blueprint for a company's organisational and financial structure that relies on the behaviour of costs and revenues as well as anticipated competition and consumer behaviour. • The business model involves the systems of value generation, delivery, and apprehension to meet customer requirements and increase profitability. • The relationship between value creation and value capture can be connected by value delivery.

Innovation	Innovation Types and Process		Forms of Innovation Creation		
	Innovation Types	Innovation Process	Open Innovation	Innovation in the Public Sector	Business Model Innovation
			• New creations and services, technologies, and business models should be under a cooperative environment based on resource sharing across company boundaries. (Cassiman and Valentini, 2016; Chesbrough, 2003b; Chesbrough, 2006; Huizingh 2011; Tidd, 2014; Tidd and Bessant, 2018)	(Bloch and Bugge, 2013; Borins, 2001; Koch and Hauknes, 2005; Pichlak, 2016; Tidd and Bessant, 2020; Tidd and Hull, 2006)	• A business model is associated with value creation by exploiting the business potentiality driven by the transaction of the content, structure, and governance of resource exchange between participated parties under their control. (Casadesus-Masanell and Ricart, 2010; Teece, 2006; Tidd and Bessant, 2018)

The literature on innovation and innovation management in TABLE 5 outlines essential themes for fostering innovation, including types, processes, and creation forms of innovation. For developing deeper comprehension according to TABLE 5, TABLE 6 inquires in more detail about different forms of innovation and identifies logical approaches established on those themes to facilitate innovation involving multiple parties or organisations. It also highlights the key desirable feature of these techniques that could possibly be applied to Thailand in dealing with CORS technology implementation to address the specific needs of the Thai context.

In order to drive innovation actively, it is indispensable to have adequate concentration on how stakeholders work together cohesively and what essential requirements need to come into existence to encourage them to collaborate effectively. On account of this, the main idea originated from Bommert's work that puts emphasis on the role of government in making innovation happen is radical for innovation adoption. His conceptual thought is particularly relevant to Thailand's circumstances on CORS technology implementation. As highlighted in Chapter 2, the Thai government played a pivotal role in driving the development of CORS technology. However, challenges arose due to stakeholders prioritising their individual interests, which hindered the players in their efforts to enable collaboration with the government and with each other. On top of that, those behaviours impeded the realisation of maximum benefits for the country as a whole. By working together harmoniously and aligning their endeavours with government initiatives, stakeholders can significantly contribute to fostering an environment conducive to innovation and progress in the context of Thailand. This contribution requires a willingness from all parties involved to set aside personal interests and work towards common objectives for the greater good of society at large, under the lead of the government.

To foster effective collaboration to make innovation happen, the themes of innovation management derived from the literature review, as concluded in TABLE 6, can be described as follows:

Collaborative innovation, networked innovation, and innovation ecosystem are similar concepts that emphasise the importance of people or organisations working together to support the happening of innovation. Collaborative innovation is an approach concerning joint working between individuals or organisations, which are stakeholders. However, typically, the government also has an important role in collaborative innovation. Likewise, networked innovation is an idea that innovation is not necessarily to be limited within a network of an organisation. It can be performed across this network with a belief that innovation does not need to be created only by a group of experts internally, but bridging the network of innovative partners beyond organisational boundaries can increase opportunities for new business development. Similarly, the innovation ecosystem is yet another theory closely related to that. When a firm seeks market possibility and designs to innovate a new thing, it demands information on surrounding circumstances to understand the situation around it. Thus, oftentimes, it has to come across partnerships with others to leverage shared resources. Other than that, stakeholder theory is more generally involved in how diverse stakeholders collaborate, either in the area of innovation involvement or outside innovation.

Ultimately, these concepts highlight the necessity of collaboration across groups, networks, and ecosystems to drive forward innovative solutions. It is imperative for the researcher, both for studying and working as part of the Thai government, to recognise this importance and actively work towards fostering collaborative environments that promote innovation for the betterment of society as a whole. Even though, these concepts encompass all the necessary conditions for successful innovation. However, the researcher is particularly interested in understanding how this can be applied to CORS technology, as it is this research-specialised topic. On the grounds of this, the innovation ecosystems mean all the conditions that are requisite to make innovation function optimally that this research will further carry on.

The process used to explore these themes of innovation management was conducted in light of the concept of collaborative innovation and search for relevant references. This can be achieved through various methods, containing defining search terms to look at different databases and employing a snowball approach. For instance, using a keyword like "collaborative innovation" had Tidd and Bessant (2020) and many papers as a return. For the term "networked innovation", the search resulted in Moore (1995) and a lot more. Innovation Ecosystem was a search title, which came up with the work by Adner and Kapoor (2010) with a number of literary studies. Finally, seeking stakeholder theory brought in Sørensen and Torfing (2011) as well as other published works. By identifying key papers, like those authored by Bommert (2010), Eggers and Singh (2009), and Nambisan (2008), which appeared in search results and were selected due to their reliability and relevancy to this study, the researcher also further expanded their understanding of the topic by examining both the references within these papers and other works that cited them. The undertaking that exploited the snowball strategy entailed several substantial literature, such as Sørensen and Torfing (2011; 2016), and Tidd and Bessant (2013; 2018).

TABLE 6 provides a broad overview of innovation, encompassing not only CORS innovation. The table formulation evolved from the papers that are examined on research particular interest. Conducting literature searches and utilising keyword and snowball search techniques to find relevant papers and references then contribute to a comprehensive understanding of the general sense of innovation management.

TABLE 6 Themes of innovation management (Source: Author's own research, summarised from Section 3.4 and TABLE A-4)

Collaborative Innovation	Networked Innovation	Innovation Ecosystem	Stakeholder Theory
• Collaborative innovation is a new form of innovation in the public sector. • Collaborative innovation encourages the innovation process in public innovation. • Collaborative innovation makes use of the innovation resources of a wide range of individuals and organisations to explore, create, and apply ideas both inside and outside of corporate boundaries. • Collaborative innovation involves various actors and assets in innovatively co-working across organisational boundaries to break down cultural barriers and provide social and political backing for innovation creation in the public sector. (Bommert, 2010; Eggers and Singh, 2009; Nambisan, 2008; Sørensen and Torfing, 2011; 2016; Tidd and Bessant, 2013; 2018)	• Networked innovation has a particular role in the production process. • Networked innovation gives emphasis to the collaborative innovation concept in using the assets of many actors beyond organisational boundaries. • Networked innovation's benefit is that various actors lead to generate a variety of alternatives for solving problems. • Networked innovation highlights the idea of collaborative innovation to a limited extent of boundary, which is within the public sector. (Ahuja, 2000, Bommert, 2010; Chesbrough, 2003b; Dahlander and Gann, 2010; Greer and Lei, 2012; Huizingh, 2011; Moore, 1995; 2009; Sørensen and Torfing, 2011)	• Innovation ecosystem relates to the flow of idea-to-business that involves surrounding systems to deliver success. • Innovation ecosystems involve multiple aspects of evolving sets of players and resources and their relationships in growing innovation. • Innovation ecosystem underlines pluralism's significance with a mixture of actors, organisations, and clusters. (Adner, 2006; Adner and Kapoor, 2010; Carayannis and Campbell, 2009; Jackson, 2011; Jones <i>et al.</i>, 1994; Odum, 1969; Olsson and Bosch, 2016; Poot <i>et al.</i>, 2009; Smith, 2006 ; Vanhaverbeke <i>et al.</i>, 2008)	• Stakeholders are the keynote of innovation in organisational theory and change management. • Diverse stakeholders are engaged to supply materials and clarify complex phenomena in innovation management in the public sector. • The management of stakeholders for collaborative innovation seems more complicated in the public sector than in the private sector. (Bryson <i>et al.</i>, 2017; Buchholz and Rosenthal, 2004; Cankar and Petkovšek, 2013; De Vries <i>et al.</i>, 2018; Donaldson and Preston, 1995; Gomes, 2006; Hill and Jones, 1992; Mergel and Desouza, 2013; Nambisan, 2008; Scholl, 2001; Simon <i>et al.</i>, 2016; Sørensen and Torfing, 2011)

From TABLE 6, the subject matters of innovation management that are found across all of these items can be summarised in the form of those four themes of innovation management in the public sector as features in TABLE 7, including ownership and governance, power asymmetries, interaction processes and supporting technologies and setting direction of collaboration. These themes serve as crucial components in understanding the underlying patterns and trends present within the data.

The theoretical framework refers to a system that consists of multiple components: concepts of work, research hypotheses, relevant reviews, beliefs, and theories related to the study (Abend, 2008; Asher, 1984; Swanson and Chermack, 2013). When establishing a theoretical framework for the research, it is crucial to justify the inclusion of certain things over others. Even though the existence of other frameworks, such as project management was acknowledged, this particular framework has been selected based on the recurring themes presented in the literature that are relevant to this research. Upon reviewing various sources, it became apparent that themes, such as ownership and governance, power asymmetries, interaction processes and supporting technologies, and setting direction of collaboration, consistently emerged. Those themes were captured by closely examining key details of literary works summarised in TABLE 6. Therefore, this specific framework shown in TABLE 7 has been preferred as it aligns with these logical and associated themes that are integral to this research.

TABLE 6, which shows four approaches encapsulated according to pieces of literature, has framed the focal structure that enables the researcher to identify connections between various details and their impact on overarching thematic concepts. This structure entails certain elements that contribute to precise thematic ideas within the context of this research interest, and open up to the design of methodology to perform research investigation.

TABLE 7 presents important themes summarised from scholarly works concerning innovation management to emphasise key components that influence the happen of innovation among multiple players in the public sector. It acts as the initial step in developing the conceptual framework, which has eventually evolved into the theoretical framework, for setting the foundation for further analysis and interpretation of the data.

In the light of ownership and governance, a number of written works highlight its importance in public sector innovation. It underlines the factors related to the government sector in working collaboratively to implement innovation effectively. To undertake the innovation possibility, power asymmetries should have been prioritised to consider the effect of authority imbalance that could accelerate or lessen the chance of success. In addition to that, interaction processes and supporting technologies are indispensable keys influenced by the connection between actors and the technology endorsed in the creation process. Lastly, it necessitates a practical management plan for setting the direction of collaboration between the organisations in the public sector to engage closely connected partners in increasing the attainability of innovation.

The paper of Sørensen and Torfing (2011) delivers the crucial concepts of innovation management involving collaborative innovation, networked innovation, and stakeholder

theory. In this context, the work of Bommert (2010) holds predominant significance for collaborative innovation in the public sector. The developed framework has evolved from Sørensen and Torfing (2011), which encompasses key themes of innovation management, including ownership and governance, power asymmetries, and interaction processes and supporting technologies. Substantially, Bommert's (2010) paper underlines how this framework links with these core ideas, thereby highlighting its relevance to the field. Besides, several scholarly literature strengthen these beliefs and ensure their relatedness. Overall, these works contribute to a framework for gaining a deeper understanding of collaborative innovation in the public sector and getting valuable insights for this research and scholars alike.

TABLE 7 Key themes of innovation management in the public sector based on the literature review (Source: Author's own research, summarised from Sections 3.4 and 3.5)

Ownership and governance	Power asymmetries	Interaction processes and supporting technologies	Setting direction of collaboration
• Innovation development became prioritised in many public sectors with challenges in administration. • Collaborative innovation highlights networks in the public sector to enhance effectiveness of the governance. • Achieving public sector innovation governance requires consideration of leadership type and adoption of collaborative innovation to link ideas and practice. • Governance types of working collaboratively in the public sector are different from private in terms of approach, process, laws, and rules. • In idea implementation, public innovators need to be well-prepared as there could be	• Power is one of the motivating factors applied for public sector organisations that motivates innovation creation. • The imbalances of power influence the effectiveness of North-South collaborations. • Power asymmetries are involved in the determination and assessment of the actors in collaborative innovation. • One of the factors required for successful collaborative innovation is keeping the influence of power asymmetry to a minimum. • Power asymmetries may be barriers to the development of	• Interactions of technological innovation adoption process should have also been proposed. • Interaction with partners serves linkages with networks and facilitates knowledge exchange. It provides benefits to cope with limited internal technologies. • The creation interaction process between the participating actors is an institutional design for undertaking metagovernance networks. • In innovation building, examination of business interactions in networking, cooperation, and	• Direction setting, management, and policymaking are key elements in the public value governance strategy considered for enhancing the possibility of reaping the full benefit of public values. • Forming a framework for improving performance in the management of public innovation connects with related settings. • Managers are important for the settings of public value creation and policy direction. • Multi-level settings are taken to perform collaboration between multiple organisations, and diverse types of actors may

Ownership and governance	Power asymmetries	Interaction processes and supporting technologies	Setting direction of collaboration
mistakes in changing things in which many tasks are required, including the ownership matter. • Ownership is one of the essentials in knowledge asset management, which also includes the creation, protection, and utilisation of assets. However, physical asset ownership remains a non-significantly different sign. • The New Public Management employed a competitive games strategy on hands-off metagovernance that resulted in ownership, confidence, and agreement problems in the metagovernance of governance networks. Similarly, applying involvement and management in hands-on metagovernance was ineffective due to inadequate arrangement and uncertain purpose.	shared ownership between stakeholders. • Stakeholders have different power to exert influence on local government decision-making. • Managing power asymmetry to foster collaboration needs to underline the awareness, knowledge, and relationship between partners concerning social divisions and national conflict. (Ansell and Gash, 2008; Cankar and Petkovšek, 2013; Gomes, 2006; Lutomia, 2019; Nambisan, 2008; Torfing <i>et al.</i>, 2009; Sørensen and Torfing, 2011; Desivilya Syna and Rottman, 2012)	competitiveness and business interactions with knowledge infrastructure. • The development of interaction between government organisations and the industrial sector in policy design and implementation relates to its success. • The supporting interactions in connection with innovation creation and innovation policy offer suitable institutional frameworks to endorse innovation at the national level. (Ahuja, 2000; Chaminade and Lundvall, 2019; Pichlak, 2016; Lundvall, 2007; Lundvall and Borrás, 2005; Sørensen and Torfing, 2011; 2017)	engage with different strategies in leading, action, and priority. (Bryson <i>et al.</i>, 2014; 2017; Crosby and Bryson, 2017; Crosby <i>et al.</i>, 2017)

Ownership and governance	Power asymmetries	Interaction processes and supporting technologies	Setting direction of collaboration
• Collaborative governance enhances a sense of ownership between the organisation and stakeholders to increase a degree of involvement in the decision-making and responsibility that could lead to trust. (Ansell and Gash, 2008; Bommert, 2010; Crosby <i>et al.</i>, 2017; Sørensen and Torfing, 2011; 2017; Teece, 2000; Torfing and Triantafillou, 2016; Torfing <i>et al.</i>, 2009)			

In the pursuit of understanding innovation management, it is indispensable to address the key research question to get to the point. The inquiry into how GNSS CORS in Thailand went prior to 2018 and the extent to which it has been effective are the questions for this study. These doubtful points brought about the idea to lay a crucial foundation for further investigation. In Chapter Two, it was made evident that the CORS implementation in Thailand did not perform as optimally as it could. In order to understand the underlying reasons for its incompleteness, a thorough examination is necessary. Through this process, the study will delve into the cause of the ineffective attempt and move forward to seek out alternative solutions to optimise results. Ultimately, it is imperative to gain insight into how to improve upon the existing situation to discover the path to more successful outcomes.

As described in Anfara and Mertz (2014) and Rocco and Plakhotnik (2009), a conceptual framework is essential for a study's orientation and justification. It can be developed from the theories and literature reviews or constructed as the variables to address the scope of research. It also can presume the relationships between the points of interest in the study. This study involves multi-disciplinary strategies consistent with the above-described theories. These cross-disciplinary fields engage relevant methodologies in minimising the complications of collaborative innovation management to strive for networking. The relationship between the disciplines can be described in FIGURE 3.2. This diagram illustrates the initial conceptual framework for this study. It outlines the key areas that significantly impact the research analytics constitution and demonstrates the guidelines in reference to research data analysis. This initial conceptual framework is a frame of ideas generated based on the reviewed literature in relation to innovation development in public sector issues. The reviews have been done in a particular context that rationalises the main constructs that link to the research problems of this study. These works of literature lead to conclusions about the connection between concepts and existing research on technology implementation management in the public sector, hence the identification of variables and research questions in this study.

The initial conceptual framework was formulated on the ideas of ownership and governance, power asymmetries, interaction processes and supporting technologies, and setting the direction of collaboration. These areas are consistent with the logic built on the impactful components that were drawn from the happenings on managing public sector innovation. Moreover, each idea presents a link to the evidentially literary work. Firstly, Sørensen and Torfing (2011) summarised that taking control of open and collaborative innovation necessitates comprehension of who is the one that holds and is responsible for innovation. This notion asserts the importance of ownership and administration over the success acquiring in collaborative innovation. Besides, concerning powerfulness matters, Gomes (2006) articulates that stakeholders who have been given power over the organisation can influence the decision-makers in local government administration. In addition to this, Cankar and Petkovšek (2013) confirmed that the power differential has weight on the attainment of the collaboration, such as consideration of the impact of power and power-

motivated behaviours on innovation. Also, Sørensen and Torfing (2011) underlined the risk in the collaborative innovation operation that is affected by power asymmetries. This influential distinctiveness is thus one of critical relevancy for collaborative innovation in the public sector.

In light of the interaction processes and supporting technologies, Sørensen and Torfing (2011) recommended five factors that support the collaboration notion in order to address these power disparities: objective, interaction process, organisation, temporal attribute, and associateness. These predetermined beginning conditions and proactive types of meta-governance define the institutional venues of interaction that offer a variable collection of drivers and obstacles that encourage and impede cooperation and innovation and, thus, the processes of collaborative creativity. On this account, it is imperative to set a direction of collaboration for co-working in the public sector, including policy inauguration. The definition of collaborative governance is the formal engagement of government organisations to create consensus on the adoption of public policies or the management of government resources or programmes (Ansell and Gash, 2008). Additionally, the body of research on developing policies and frameworks for implementing open innovation and collaboration in the public sector is expanding (Bloch and Bugge, 2013; Brown and Osborne, 2013; Crosby *et al.*, 2017).

Notwithstanding, collaborative innovation benefits the handling of complex social entanglement by eliminating impassable issues and policy deadlocks (Torfing, 2016). However, it is impossible to directly apply open and collaborative innovation to a public sector environment because of the cycles and policy processes that govern adopting new policies (Mergel and Desouza, 2013). Moreover, Nambisan (2008), Moore (2009) and Bommert (2010) strengthened the idea of implementing the model of collaborative innovation in the public sector that resource sharing should be performed across organisational boundaries. Therefore, plans and policies are inevitable parts that need to be settled alongside the formation of the collaborative innovation conception. Correspondingly, these constituents are all relevant and significant in encouraging the foundation of the model of collaborative innovation among organisations in the public sector to harness and share their resources and creativities.

Concerning this study, the central concern is *"How and why has Thailand not successfully dealt with the difficulties in the collaboration on GNSS CORS development between the government organisations?"*. The initial conceptual framework is the set of beliefs assumed to be involved in Thailand's context. It will be in the main for judging the things derived from the analysis. The following factors are stated as parts of the initial conceptual framework for further insight.

1. Ownership and governance: As Rizos and Satirapod (2011), many government agencies in Thailand created their internal CORS systems without a structured cross-boundary share of technology. Moreover, the system handling is solitarily subject to the typical vision of the owners.

2. Power asymmetries: The different scales of authority and power adversely affect the associateship between government organisations (Lutomia, 2019; Nambisan, 2008).
3. Interaction processes and supporting technologies: The strategies to encourage cooperativeness and technology enhancement are considered deficient (Rizos and Satirapod, 2011).
4. Setting direction of collaboration: It is demanding to stipulate certain conditions for the CORS collaboration in Thailand (Rizos and Satirapod, 2011).



FIGURE 3.2 Initial conceptual framework (Source: Author's own research)

FIGURE 3.2 serves as a summary of the information presented in TABLE 7. This alignment between visual and tabular representations underscores the connection between the literary assessment and the conclusion of its main ideas that have been used for conceptual framework development. The visual representation of the data summarised in the table facilitates a comprehensive understanding of the research structure, which could be applied to other studies on innovation management in the public sector in general. As a result, based on the research questions, it can be argued that FIGURE 3.2 depicts lin

kages for the purpose of summarisation this study's conceptual framework, specifically in representing the more general aspects of it.

The visual depiction provided in FIGURE 3.2 encapsulates key elements and relationships within the framework, offering a clear and concise overview for further exploration and analysis. Focusing on this specific aspect of the conceptual framework enables a broader understanding of the overarching concepts at play in this research. However, gaining more details of features aiming specifically at how to manage CORS innovation requires supporting conceptions. The theory that has particular relevance to this research, namely innovation ecosystems, was brought to encompass ideas to investigate the achievement of CORS technology implementation.

The initial conceptual framework sets out general assumptions based on existing literature on collaborative innovation, specifically considering Thailand's complications in co-working among government agencies regarding technology implementation. One fundamental belief assumed within this framework is that successful collaboration requires active participation from multiple stakeholders, including government agencies, non-governmental organisations (NGOs), local communities, academia, and private entities. Each stakeholder group brings unique perspectives, expertise, and resources that collectively contribute to innovative problem-solving strategies. Nonetheless, when delving into the more technical aspects of implementing new technologies, several critical factors demand meticulous evaluation. Moreover, financial, legal and human resources considerations play a pivotal role in successful implementation. The theoretical lens and the gap in academic knowledge cannot be relied on for entirely complicated happenings. Therefore, getting stakeholders to collaborate more effectively with the government taking a leading role in particular circumstances like CORS adoption in Thailand requires a theoretical model to endorse to know how to do it well in practice.

The research observations indicate that the implementation of the technology is not as effective as it could be, suggesting that there may be a lack of sufficient collaboration among the key stakeholders involved. This raises the question of what the likely reasons are for this apparent lack of collaboration. One possible barrier could be the absence of a cohesive theoretical framework to guide and facilitate the collaborative innovation process. Without a clear understanding of the essential factors that enable successful collaboration, the various parties may be struggling to align their efforts and work together productively. The previous chapter's incomplete set of observations leading up to 2018 further suggests that the performance and outcomes of the technology implementation have not been meeting expectations. This history points to the possibility that factors beyond just collaboration may be impacting the success of the initiative. Through additional research and fieldwork, it will be important to identify more specific issues related to the technology itself, the financial considerations, the human resources and the policy elements that are not optimally aligned. These interrelated components all need to be functioning well for true collaborative innovation to flourish.

The following section will describe the process of conducting a theoretical framework designed for GNSS CORS technology implementation under the cooperation of multiple stakeholders with the government's lead. According to the above-mentioned theories, several assumptions express the significance of managing innovation in the joint teaming environment. The theoretical framework for this study will be developed through these lenses. The literature review regarding concern points in establishing an innovation ecosystem provided a link of issues with the logical basis of the GNSS CORS involvement. Multiple aspects have been revealed to shoulder the initiatives in developing and sustaining the CORS system. The following tables are created with insights into the behaviour of the CORS ecosystem.

The tables above summarise the search results, beginning with a broad exploration of innovation before narrowing the focus to collaborative innovation, and ultimately concentrating on how CORS systems function. Chapter Two revealed a lack of sufficient collaboration in this area and suggested that government action could help foster more effective partnerships. Initially, the search examined a general framework, illustrated in FIGURE 3.2, which applies to any form of collaborative innovation. The search then shifted to include CORS as a keyword, targeting the interested studies to investigate how these works for CORS, how this technology is implemented, how it integrates into an innovation ecosystem and business models, and what type of business models are requisite for the successful operation of CORS.

As described, the research began with a general perspective on innovation, specifically focusing on collaborative innovation, which can be applied to any technology involving the public sector. However, this research aim is to understand how this framework particularly applies to GNSS CORS. To do this, it is necessary to delve into the literature on CORS to explore the connection between the general innovation framework, illustrated in FIGURE 3.3, and the specific aspects of CORS, shown in FIGURE 3.4. The initial conceptual framework for collaborative innovation in the public sector is based on a standard reference in innovation studies, Tidd and Bessant's textbook. Understanding how this established framework ties into CORS will help in analysing its role within public sector innovation.

In the process of analysing the general literature on innovation management in the public sector, as summarised in TABLE 5, 6, and 7, it has come to the realisation that these factors play an imperative role in various contexts, not just limited to Thailand. As the focus of TABLE 8 has shifted towards Thailand, it serves as a bridge between the developed theoretical framework and the specific case study material in subsequent chapters. It is particularly aimed at delving deeper into the influence of the highlighted themes. This theoretical framework has been established with an emphasis on the significance of ownership and governance, it has given greater attention to laying the foundation for an in-depth examination of case studies of this research. By drawing from existing literature specifically applicable within Thailand, this research seeks to distinguish between general literature on innovation and those that apply all over the world. Furthermore, it has sought out literature that pertains

directly to the situation in Thailand. TABLE 8 holds particular importance as it paves the way to the key diagram (FIGURE 3.7). It makes connections to this research's substance, such as an understanding of CORS technology and its implementation in Thailand, accordingly exploring its associated literature. This phase marks a pivotal point where theory meets practical application - allowing for comprehensive analysis and insights into specific contexts.

As this research goes through the intricacies of Thailand's implementation of CORS technology, the review discovered a multitude of scholarly papers that predominantly focused on technology, human resources, finance and policy. FIGURE 3.7 is a diagram that draws a conclusion of those pieces of literature with the essence encapsulated in the inner layer showing their linkage with the tangible happening of CORS technology in Thailand. The in-depth exploration of these interconnected aspects sheds light on the specific strides made in Thailand's CORS technology implementation. On the flip side, the outer layer includes elements in the broader context in which innovation management exists. Therefore, the picture emerges generally without intricate analysis of the practical application and significance of CORS technology specifically in Thailand.

TABLE 8 CORS management in the public sector in Thailand (Source: Author's own research, developed from TABLES 1, 2, 3, and 4)

Ownership and governance	Power asymmetries	Interaction processes and supporting technologies	Setting direction of collaboration
• Several Thai government organisations separately owned and managed their CORS technology. (Charoenkalunyuta <i>et al.</i>, 2012; DOL, 2017a; National Geo- Informatics Board, 2017; National Subcommittee on GNSS Network, 2017a; National Subcommittee on GNSS Network, 2017b; Rizos and Satirapod, 2011; RTSD, 2014)	• Thai government agencies had a different amount of budget for CORS development. • The organisations that had been assigned to lead the attempts to create cooperation on CORS between Thai government agencies were influenced by the dominant authority. (DOL, 2017a; National Geo- Informatics Board, 2017; RTSD, 2014)	• Each Thai government agency received some monetary support to build its CORS, but the allocated budgets were insufficient for fulfilling this technology throughout Thailand. • Thai CORS owners did not provide access to their systems and share their technology development plan with others. • The Thai government has encouraged attempts to create a co-working environment between CORS owners. (Charoenkalunyuta <i>et al.</i>, 2012; DOL, 2017a; National Geo- Informatics Board, 2017; National Subcommittee on GNSS Network, 2017a; National Subcommittee on GNSS Network, 2017b; Rizos and Satirapod, 2011; RTSD, 2014)	• The Thai government required practical guidance for CORS collaboration between government agencies. (National Geo-Informatics Board, 2017; National Subcommittee on GNSS Network, 2017a; National Subcommittee on GNSS Network, 2017b; Rizos and Satirapod, 2011)

3.5.1 Innovation Ecosystem

The innovation ecosystem is a notion in relation to the flow of idea-to-business that involves surrounding systems to deliver success (Adner, 2006; Odum, 1969). The review of innovation ecosystems in this study has been prepared based on the multiple aspects of evolving sets of players and resources and their relationships in growing innovation (Adner, 2006; Adner and Kapoor, 2010; Smith, 2006). A summary of the review, as shown in TABLE A – 4 in the Appendix, is featured in the context of multi-dimensional systems: component, structure, process, requirement, evaluation, and development. These categories were developed from the distinction between the main idea of the literature work on the innovation ecosystem. First, the system component concludes the ideas about the essential elements of a system. The review shows innovation, innovation process and complements, organisations and culture, and actors as the requisite parts of innovation development. The system structure is determined by the pattern of the innovation ecosystem, in which innovation networks and knowledge clusters are the keys. In comparison, the system process mentions the flows of inputs and outputs. In terms of system requirements, the literature highlights the business model, financial management, materials and resources, actors and human capital, and logistics as the necessities. Furthermore, the system evaluation is a group of concerns about business area, risk assessment, the position of a focal firm, bottleneck, and role and responsibility of personnel to the system. Lastly, system development draws the inference of innovation in the matter of ecological succession.

3.5.2 CORS Ecosystem

As described above, innovation ecosystems necessitate many features of the system to encourage the accomplishment of innovation activities. In light of GNSS CORS technology, several factors are stated as essential for implementation and arrangement. As in TABLE A – 5 in the Appendix, the CORS ecosystem summarised from the literature work presents the items that are considered relevant. This summarisation categorises the CORS ecosystem into six groups: infrastructure, human resources, policy, standards, financial resources, and business model. These items are substantial pieces of information extracted from the literature on GNSS CORS development (Abidin *et al.*, 2010; Strange and Weston, 1995; Supinajaroen and Van Loenen, 2019). The importance of infrastructure is the influence of communication links, data and facilities, and technology and infrastructure. On the other side, human resources lay interest in the human element consisting of staff, experts, and personnel training. Turning to policy, it has shed light on the governmental endorsement of infrastructure and professionals as well as an inauguration of policies and institutional framework. By the same token, the standards issue points out the need for authentic infrastructure and the quality and standard of products. Furthermore, for financial resources, revenue generation is aimed; however, monetary support is expected. Lastly, the business model indicates a high degree of business model, and a master plan is required.

3.5.3 CORS Business Model

According to the business model mentioned earlier in CORS Ecosystem, CORS necessitates a model and effective plan for devising the growth of this technology implementation. The key areas that appeared in the literature on the CORS establishment and build-up are presented in TABLE A – 6. These areas include technology, infrastructure, strategy, financial resources, benefits, human relations, policy-legal-standard, and business models. They are contained in the business models developed for different contexts. For instance, the CORS-TR System in Turkey is a model comprised of a business strategy, i.e. administrative structure, technical infrastructure, and financial structure (Bakici *et al.*, 2017). The section on technology and infrastructure concerns CORS technology in terms of communication, security, and technique. On the other hand, the financial resources term spotlights the installation and operation costs in equipment, software, maintenance, promotion, and communication. The model has the prospect of benefits based on revenues and service charges supervised by the Board and categorised by the service types. For this model, the human relations involved in the system is the user.

In addition to the CORS-TR System in Turkey, several models are described in the table. For example, PSGL web services, the National Positioning Infrastructure (NPI), the viability of GNSS infrastructure in emerging countries, the Network RTK Service Model in Nigeria, GNSS-RTK business models, Client-Server based model, GNSS CORS for agriculture businesses, Thailand's CORS collaboration model, and GSI's GEONET model (Bouwman *et al.*, 2008; Donker, 2009; Janssen *et al.*, 2016; Moegen *et al.*, 2018; Ojigi, 2015; Osterwalder and Pigneur, 2002; Rizos, 2013; Rizos and Cranenbroeck, 2006; Rizos and Satirapod, 2011; Roberts, 2009; Tsuji *et al.* 2017).

3.5.4 CORS System Through the Lens of Innovation Ecosystem

The summary of the literature review, as previously mentioned, described the categories of the system derived from the innovation ecosystem. Also, the review of the CORS ecosystem has resulted in six groups of significance: infrastructure, human resources, policy, standards, financial resources, and business model. In addition, the CORS business model illustrates the models and their components supporting CORS. As a result, this section will combine all ideas extracted from the review to demonstrate the relationship between the innovation ecosystem and the CORS system. A summary can be found in TABLE A – 7 and TABLE A – 8. Through the lens of the innovation ecosystem, regarding the earlier section, the CORS system can be assorted into six aspects: CORS system component, CORS system structure, CORS system process, CORS system requirement, CORS system evaluation, and CORS system development. Each feature presents the relevancy of the innovation ecosystem in the aspect of CORS and its relevant supplements. For instance, the CORS system component encompasses multiple constituents of CORS, from innovation, innovation process, organisation and organisational culture, and actors and human resources.

Besides, this discovery found that other aspects show the attributes of CORS related to the innovation ecosystem. For example, knowledge clusters in the CORS system structure, flow of inputs and outputs in the CORS system process, financial management in the CORS system requirement, risk assessment in the CORS system evaluation, and ecological succession in the CORS system development.

3.5.5 CORS Ecosystem in This Research

The innovation ecosystem offers high-impact features for strengthening competitive advantage and sustaining the business value to strive for the organisation's accomplishment. However, to obtain this fulfilment, the organisation demands a straightforward innovation process, appropriate organisational culture, and human capital improvement (Smith, 2006). Moreover, to gain success, the organisation necessitates attention to the movement and influence of upstream and downstream constituents in the innovation ecosystem (Adner and Kapoor, 2010). Also, technology settings and the financial and service mechanisms are inseparable parts of the innovation ecosystem to encourage organisational growth (Adner, 2006). In addition, inefficiency in management potentiality, business model, and supporting policy are weighted barriers to innovation formation attainment in the social innovation ecosystem (Terstriep *et al.*, 2020). Therefore, these components can be regarded as critical circumstances for value creation in innovation generation.

As summarised earlier, the ecosystems play essential roles in highlighting the desired environment of technology employment, including GNSS CORS implementation. The following table shows the connection between the innovation ecosystem, CORS system and CORS business model that concluded concerning the concepts, practical uses and relatedness. This inference uncovers and categorises the links between GNSS CORS technology and those core elements by narrowing the possible conditions into viable essences for CORS solely. As a result, the links demonstrate the overall requisites for growing and running the CORS system effectively on a literature basis.

The reviews of the general innovation ecosystem, the CORS ecosystem, the CORS business model, and the interrelationships among their key components informed the development of TABLES A-4, A-5, A-6, A-7, and A-8 in the Appendix. Building on these analyses, TABLE 9 was constructed to synthesise the linkages between the innovation ecosystem, the CORS system, and the CORS business model across four overarching dimensions: technology, finance, human resources, and policy. Each of these dimensions is further disaggregated into relevant sub-categories, enabling a structured comparison and clearer interpretation of how these factors interact to shape the development, operation, and sustainability of CORS-based services.

TABLE 9 presents the ecosystem of GNSS CORS implementation, which is the focal point of this study, in four main categories: technology, finance, human resources, and policy. These items are derived from the literature review in the associated areas (Abidin *et al.*, 2010; Adner, 2006; Adner and Kapoor, 2010; Bakici *et al.*, 2017; Bouwman *et al.*, 2008; Carayannis and Campbell, 2009; Donker, 2009; Jackson, 2011;

Janssen *et al.*, 2016; Jones *et al.*, 1994; Moegen *et al.*, 2018; Odum, 1969; Ojigi, 2015; Osterwalder and Pigneur, 2002; Rizos, 2007; 2008; 2013; Rizos and Cranenbroeck, 2006; Rizos and Satirapod, 2011; Roberts, 2009; Smith, 2006; Strange and Weston, 1995; Supinajaroen and Van, Loenen, 2019; Tsuji *et al.* 2017), as above-written, and hence formulated on its possible influence over this exploration. The first item, technology, refers to the technology and relevant technical components involved in the establishment and management of CORS. The components that are important for this research are infrastructure, tools, techniques, access, and delivery. An example of this category is the technique for identifying types of services to support a variety of user groups. Technology is an important matter that needs to be taken into account as it is the foundation of the CORS implementation programme. The next item is finance. It also entails investment and return on investment (ROI). Finance considers installation and operation costs, including equipment, software, maintenance, promotion, and communication. Likewise, it covers revenues, service charges, payment mechanisms, and market strategy. Thus, the finance matter is essential for CORS development, particularly monetary support.

Human resources are identified as one of the essential categories for the study of GNSS CORS implementation (Abidin *et al.*, 2010; Adner and Kapoor, 2010; Bakici *et al.*, 2017; Bouwman *et al.*, 2008; Carayannis and Campbell, 2009; Jackson, 2011; Jones *et al.*, 1994; Osterwalder and Pigneur, 2002; Rizos, 2013; Rizos and Cranenbroeck, 2006; Rizos and Satirapod, 2011; Roberts, 2009; Smith, 2006; Supinajaroen and Van, Loenen, 2019; Tsuji *et al.* 2017). This category takes account of professionals, including actors and their connections, as well as staff that comprises intermediaries. Additionally, this category considers organisational culture, such as a reward system and competent improvement, like personnel training. The players are imperative throughout the flow of the CORS ecosystem; therefore, this matter is placed as one of the four essences of this research. The last item is policy, which engages legal, standard, business model and plan. This group of ecosystems is crucial for administering public sector innovation as the action regarding CORS implementation would be effective by complying with laws and policies. For example, the policy for inter-organisational collaboration, service to the best practice, and the standard for multi-tier CORS stations. These policies and standards provide guidelines for the CORS implementation movement.

The initial conceptual framework was established based on ownership and governance, power asymmetry, interaction processes and supporting technologies, and setting direction of collaboration, as indicated in FIGURE 3.2 and evolved into the outer layer of FIGURE 3.7. Also, it is majorly taken to consider how the framework can be applied to Thailand's CORS technology implementation. When started finding literature on this topic, a number of recurring themes and concepts emerged. Specifically, technology, finance, human resources, and policy have been consistently mentioned. By organising literature in relation to CORS technology under these four main headings, along with subheadings such as infrastructure, tools, techniques, and more, a comprehensive understanding of the various aspects of implementing this technology can be achieved. This structured approach allows for a thorough

exploration of each key element involved in the successful implementation of CORS technology. As such, it provides a table that takes all relevant factors within this context.

TABLE 9 contains important components of the overall analysis, but it is not the summary of the whole searched information. The summary lies in the comprehensive diagram with circles of key senses, as shown in FIGURE 3.7. This diagram evolved from a broad view of innovation literature taken from one of the most general models in the textbook by Tidd and Bessant (2020). Considering that this research is driven by a particular interest in innovation creation, it looks at basically different ways in which organisations perform and work together to create innovation. Ultimately it encompasses various aspects of innovation creation, such as collaborative innovation, network innovation, innovation ecosystem, and business model innovation.

When assessing the feasibility of the application of this general model to CORS technology in Thailand, it is crucial to take into account both the key themes derived from written evidence shown in the outer layer and the subheadings in the inner layer of the diagram. TABLE 9 pertains to filling in the inner layer of this final diagram – it serves as a means to analyse and understand how these components relate to one another within the context of CORS technology. That is the specific areas such as technology, finance, human resources, policy, and other relevant subheadings are all-inclusive in TABLE 9.

In selecting topics and themes for exploration, the level of collaboration and cooperation among stakeholders substantively gave way to the logic of this design. The decision to focus on the lack of collaboration within the Thai government's efforts to bring together various parties stems from the observable disunity in their actions. Despite individual efforts such as the establishment of CORS stations, a collective approach was lacking, resulting in suboptimal societal benefits from technological advancements. The theme of inadequate collaboration not only highlights an issue within a specific context but also opens up discussions about the role of government in fostering cooperation. By delving into this theme, the research aims to shed light on the importance of working together towards common goals and examine potential strategies for enhancing collaborative efforts. This deliberate choice serves as a way to provoke critical thought and constructive ideas on how societal benefits can be maximised through effective collaboration.

The deliberation in team effort among people or stakeholders has returned results as in Chapter 2. This outcome got the researcher's interest and made the research carry on with the key to fostering collaboration, which are various forms of innovation, such as collaborative innovation, networked innovation, innovation ecosystem, and business model innovation. Subsequently, based on all that literature, there are four main themes emerged, including ownership and governance, power asymmetries, interaction processes and supporting technologies, and setting direction of collaboration. These themes were drawn with the more relevant working environment for all involved parties for a better understanding of the reasons behind

both successful and unsuccessful collaborations. This undertaking can explain how collaboration works in the public sector and why it does not work or does not work well. In essence, the selection of themes is rooted in an analytical framework that seeks to address pertinent issues while offering insights into the government's role in enhancing multiple parties' joint working improvement. Through this approach, it has endeavoured to contribute meaningfully to ongoing discussions about collaborative dynamics and governmental intervention in shaping cohesive endeavours for societal advancement. Therefore, in the previous stage, the centre of attention is on the outer layer of the diagram, which is from those four main themes.

However, at the moment, the focus is on the circles in the interior, like technology, human resources, finance, policy, and their subheadings. These circles are, in a way, more related to things like project management. They reflect on how the technology can be managed, the way to organise human resources, the manner of finance management and the procedure of policy inauguration.

TABLE 9 The links between the innovation ecosystem, CORS system and CORS business model (Source: Author's own research, developed from TABLES A-4, A-5, A-6, A-7, and A-8)

Technology					Finance		Human resources			Policy			
Infrastructure	Tools	Techniques	Access	Delivery	Investment	ROI	Professional	Staff	Training	Business model	Policy	Legal	Standard
CORS infrastructure, communication, technology update and installation method (Abidin <i>et al.</i> , 2010; Adner, 2006; Bakici <i>et al.</i> , 2017; Bouwman <i>et al.</i> , 2008; Carayannis and Campbell, 2009; Donker, 2009; Jackson, 2011; Moegen <i>et al.</i> , 2018; Ojigi, 2015; Rizos, 2007; Rizos, 2008; Rizos, 2013; Rizos and Cranenbroeck, 2006;	device and technology and IT support (Adner, 2006; Carayannis and Campbell, 2009; Jackson, 2011; Rizos, 2007; Rizos and Cranenbroeck, 2006)	technical design, service generation, types of services to support a variety of user groups (Bakici <i>et al.</i> , 2017; Carayannis and Campbell, 2009; Donker, 2009; Jackson, 2011; Rizos, 2007; Rizos, 2008; Rizos, 2013; Rizos and Cranenbroeck, 2006; Rizos and Satirapod, 2011; Roberts, 2009; Supinajaroen and Van, Loenen, 2019;	data access, web-based services (Adner and Kapoor, 2010; Bakici <i>et al.</i> , 2017; Bouwman <i>et al.</i> , 2008; Rizos, 2013; Cranenbroeck, 2006; Supinajaroen and Van, Loenen, 2019)	data flow, web-based services (Adner, 2006; Adner and Kapoor, 2010; Bakici <i>et al.</i> , 2017; Rizos, 2013; Cranenbroeck, 2006; Strange and Weston, 1995; Supinajaroen and Van, Loenen, 2019)	installation and operation costs, including equipment, software, maintenance, promotion, and communication (Abidin <i>et al.</i> , 2010; Adner, 2006; Bakici <i>et al.</i> , 2017; Bouwman <i>et al.</i> , 2008; Bakici <i>et al.</i> , 2017; Bouwman <i>et al.</i> , 2008; Carayannis and Campbell, 2009; Moegen <i>et al.</i> , 2018; Ojigi, 2015; Osterwalder and Pigneur, 2002; Rizos, 2013; Rizos and Cranenbroeck, 2006; Satirapod, 2011;	revenues, service charges and payment mechanisms, market strategy, free public service, preventable costs (Adner, 2006; Bakici <i>et al.</i> , 2017; Bouwman <i>et al.</i> , 2008; Donker, 2009; Janssen <i>et al.</i> , 2016; Moegen <i>et al.</i> , 2018; Ojigi, 2015; Osterwalder and Pigneur, 2002; Rizos, 2013; Rizos and Cranenbroeck, 2006; Rizos and Satirapod,	actors and their connections (Abidin <i>et al.</i> , 2010; Adner and Kapoor, 2010; Bouwman <i>et al.</i> , 2008; Carayannis and Campbell, 2009; Jackson, 2011; Jones <i>et al.</i> , 1994; Rizos and Satirapod, 2011; Smith, 2006; Supinajaroen and Van, Loenen, 2019)	operation, customer relationship, middleman (Abidin <i>et al.</i> , 2010; Adner and Kapoor, 2010; Bakici <i>et al.</i> , 2017; Carayannis and Campbell, 2009; Jackson, 2011; Jones <i>et al.</i> , 1994; Osterwalder and Pigneur, 2002; Rizos, 2013; Rizos and Cranenbroeck, 2006; Rizos and Satirapod, 2011; Roberts, 2009; Smith, 2006; Supinajaroen and Van,	human resource capability improvement (Abidin <i>et al.</i> , 2010; Adner and Kapoor, 2010; Carayannis and Campbell, 2009; Jones <i>et al.</i> , 1994; Smith, 2006; Supinajaroen and Van, Loenen, 2019)	GNSS-RTK business models, NPI, Client-Server based model, CORS-TR System in Turkey, Network RTK Service Model in Nigeria, PSGI web services, GNSS CORS for agriculture businesses, Thailand's CORS collaboration model, GSI's GEONET model (Abidin <i>et al.</i> , 2010; Adner, 2006; Adner and Kapoor, 2010; Bakici <i>et al.</i> , 2017; Bouwman <i>et</i>	encouragement of policy and announcement, inter-organisational collaboration, service to the best practice, (Abidin <i>et al.</i> , 2010; Donker, 2009; Janssen <i>et al.</i> , 2016; Odum, 1969; Rizos and Satirapod, 2011; Supinajaroen and Van, Loenen, 2019)	traceability regulations adoption (Moegen <i>et al.</i> , 2018)	system of systems concept, multi-tier CORS stations Rizos, 2007; Rizos, 2008; Rizos, 2013; Rizos and Cranenbroeck, 2006; Rizos and Satirapod, 2011; Strange and Weston, 1995; Supinajaroen and Van, Loenen, 2019)

Technology					Finance		Human resources			Policy			
Infrastructure	Tools	Techniques	Access	Delivery	Investment	ROI	Professional	Staff	Training	Business model	Policy	Legal	Standard
Rizos and Satirapod, 2011; Roberts, 2009; Strange and Weston, 1995; Supinajaroen and Van, Loenen, 2019)		Tsuji <i>et al.</i> 2017)			Roberts, 2009; Supinajaroen and Van, Loenen, 2019)	2011; Roberts, 2009; Tsuji <i>et al.</i> 2017		Loenen, 2019; Tsuji <i>et al.</i> 2017)		al., 2008; Donker, 2009; Janssen <i>et al.</i> , 2016; Moegen <i>et al.</i> , 2018; Ojigi, 2015; Osterwalder and Pigneur, 2002; Rizos, 2013; Rizos and Cranenbroeck, 2006; Rizos and Satirapod, 2011; Roberts, 2009; Supinajaroen and Van, Loenen, 2019; Tsuji <i>et al.</i> 2017)			

3.5.6 Core Theoretical Dimensions Underpinning This Study's Framework

The review of relevant literature was structured around four core themes: collaborative innovation, networked innovation, innovation ecosystem, and stakeholder theory. Together, these themes provide the primary analytical lens for examining innovation in the public sector. Across this literature, four recurring dimensions emerge as central to collaborative innovation initiatives: ownership and governance, power asymmetries, interaction processes and supporting technologies, and setting direction of collaboration. Foundational theoretical insights are drawn from Tidd and Bessant (2020), who conceptualise collaborative management as a mechanism for mobilising distributed capabilities and resources across organisational boundaries. The development of ideas concerning the management of public sector innovation is further informed by Sørensen and Torfing (2011), who demonstrate the applicability of open and collaborative innovation principles within public sector contexts. Additionally, the contributions of Nambisan (2008), Moore (2009), and Bommert (2010) underscore the pivotal role of resource sharing across public sector organisations in enabling collaborative innovation. Collectively, these perspectives provide a robust rationale for adopting the collaborative innovation model in the public sector as the conceptual backbone of this study.

Within the specific context of GNSS CORS management, key contributions include Abidin *et al.* (2010), Strange and Weston (1995), and Supinajaroen and Van Loenen (2019), who highlight the critical role of infrastructure — particularly communication links, data, facilities, and relevant technology — in enabling effective coordination and service delivery. However, this study largely concentrates on collaboration among Thai government agencies, with comparatively limited attention given to the sharing of ideas and technology across organisational and national boundaries. Building on this body of work, the present study extends the discussion by examining the interrelationships between technology, human resources, finance, and policy, as well as their associated sub-dimensions, thereby contributing to the development of a theoretical framework for inter-organisational and international collaboration in GNSS CORS systems.

3.5.7 Collaborative Innovation Theoretical Framework

The theories describing innovation exploration enable the realisation of innovation matters under the umbrella of a collaborative effort. FIGURE 3.3 and FIGURE 3.4 give the details of the interrelation between essential elements in the broad innovation ecosystem and the CORS ecosystem that appeared in the literature review, respectively. Both figures were developed by grouping the fundamental factors based on the relevancy of this observation in which the context of the reviewed works has some links to others. These diagrams present the review result in four primary categories according to the essential components previously summarised: technology, finance, human resources, and policy. In particular, FIGURE 3.3 shows the points that

the innovation ecosystem emphasises, as found in the pieces of literature. Additionally, the references identified in this figure demonstrate the relationship between communal interests in the literature. Hence, three references were found that their works relate to all categories: Adner, 2006; Jackson, 2011; and Smith, 2006. By the same token, 4 puts the lists of references associated with the four essential elements in the CORS ecosystem and their linkages between the elements.

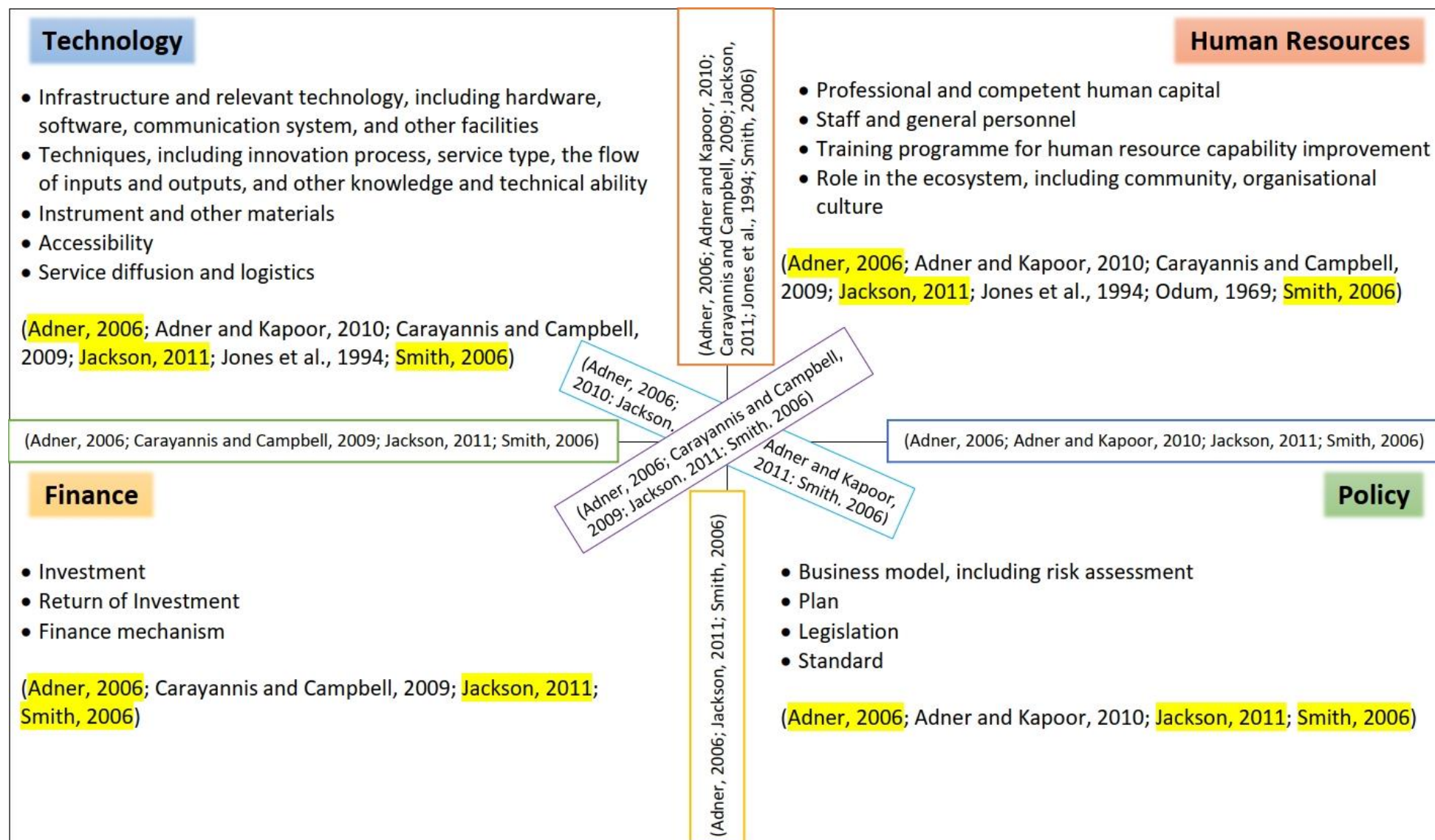


FIGURE 3.3 Interrelation between essential elements in the innovation ecosystem (Source: Author's own research)

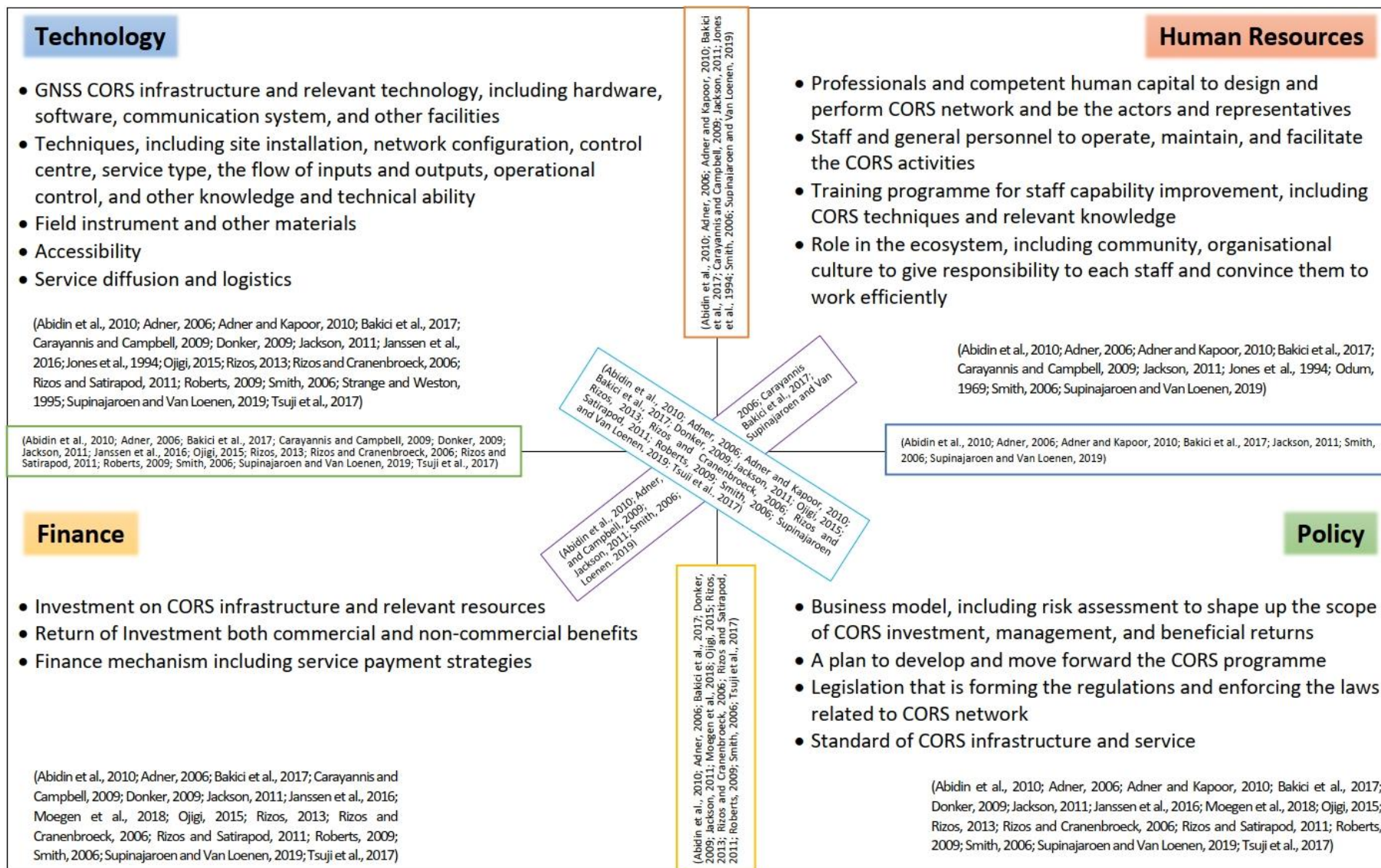


FIGURE 3.4 Interrelation between essential elements in the CORS ecosystem (Source: Author's own research)

The theoretical lens of the *Innovation Ecosystem* presents a framework of relevant elements concerning innovation. With the *Networked Innovation* approach and open innovation in the public sector, specifically *Collaborative Innovation*, the joint effort concept provides a better understanding of innovation management. In addition, the *Business Model* strategy helps shape the CORS management model associated with *Stakeholder theory*.

The figures below demonstrate an interrelation between each feature regarding CORS technology management. FIGURE 3.5 shows the foundation of the GNSS CORS ecosystem: technology, human resources, finance, and policy. These items have a mutual relationship that affects the development and sustainability of CORS. Details of each element are illustrated in FIGURE 3.6. The constituents of technology focus are infrastructure, techniques, tools, access, and delivery, while human resources' dimensions include professionals, general staff, and training programmes. The finance term consists of investment and the return, whereas the policy aspect combines multifaceted policy, legal, business model, plan, and standard. Resultantly, the combination of these pieces builds the ideal of collaborative innovation on GNSS CORS technology and states their interrelations and influences. Furthermore, the initial framework generated from various principles based on the literature review encompasses the entire range of innovation management determination in general; thus, the developed CORS collaborative innovation setup is under the umbrella of this initial design. These models eventually formed the collaborative innovation theoretical framework for GNSS CORS technology in this study by the integration of the initial framework and the CORS collaborative innovation framework, as shown in FIGURE 3.7.

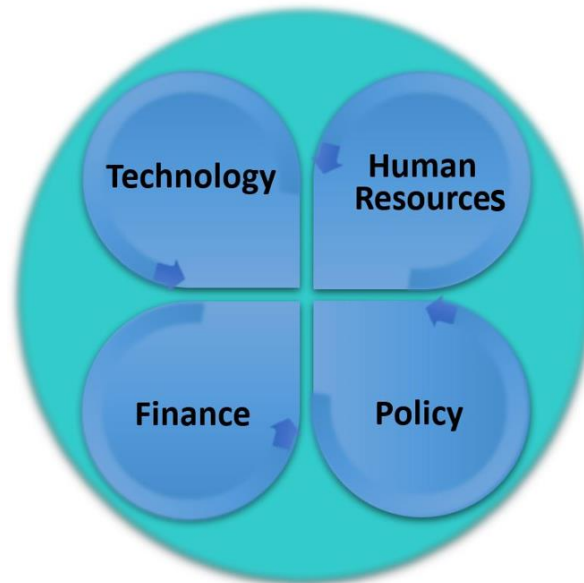


FIGURE 3.5 GNSS CORS ecosystems (Source: Author's own research)

The diagram in FIGURE 3.5 is a schematic summarisation of the major items that have an influence on CORS implementation. They are considered the major matters in technological innovation management in the public sector based on their impactfulness on the overall movement. These items are selected from a range of indicators obtained from the literature review associated with innovation ecosystems, with a particular emphasis on the GNSS CORS technology process, and determined based on their significance in relation to this study. As a result, technology, human resources, finance, and policy are considered the prime foundations of this research investigation.

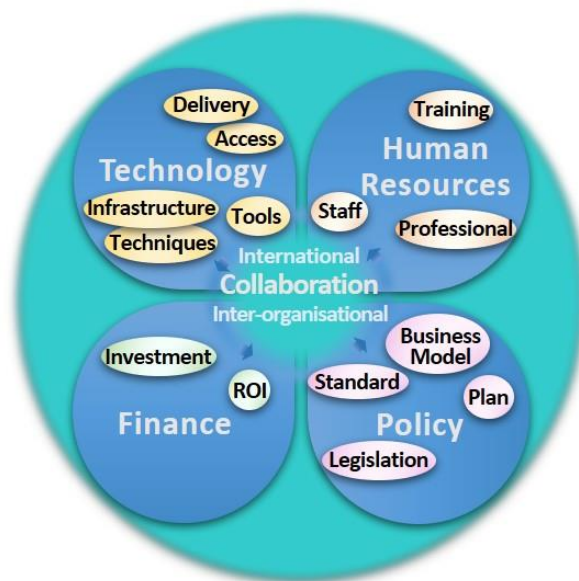


FIGURE 3.6 Collaborative innovation theoretical framework on GNSS CORS technology (Source: Author's own research)

In FIGURE 3.5, the diagram introduces key indicators that take critical positions in the GNSS CORS ecosystem and are considered the main themes in shaping the patterns of this investigation. The indicators were derived from the review of literature on the GNSS CORS manoeuvre; the model thus uses these four issues with the preeminent sense. Firstly, technology covers all relevant technical components and supporting systems. It does not only rest on instruments but also on services and other knowledge. Next, human resources are indispensable elements in handling all people relations at an organisation. This section considers many personnel matters, from defining each human capital group, their roles and responsibilities, and competency improvement. Besides, finance is counted as one of the markedly suited concerns in the CORS ecosystem. It positions an essential point in commencing and maintaining the project. Accordingly, the investments, returns, and financial mechanisms need to be thoroughly considered. Lastly, a policy is a crucial requisite for ensuring success. It stands on multiple aspects with reference to the CORS ecosystem undertaking. To accomplish these means, the model requires effective plans, regulations, laws, and other arrangements that underpin the headway of a project.

These vital elements are thus modelled as interlinking in the form of the diagrammatic representation in FIGURE 3.6. This modelling integrates them to fit into a collaborative innovation theoretical framework on GNSS CORS technology that will be a frame of reference for this study.

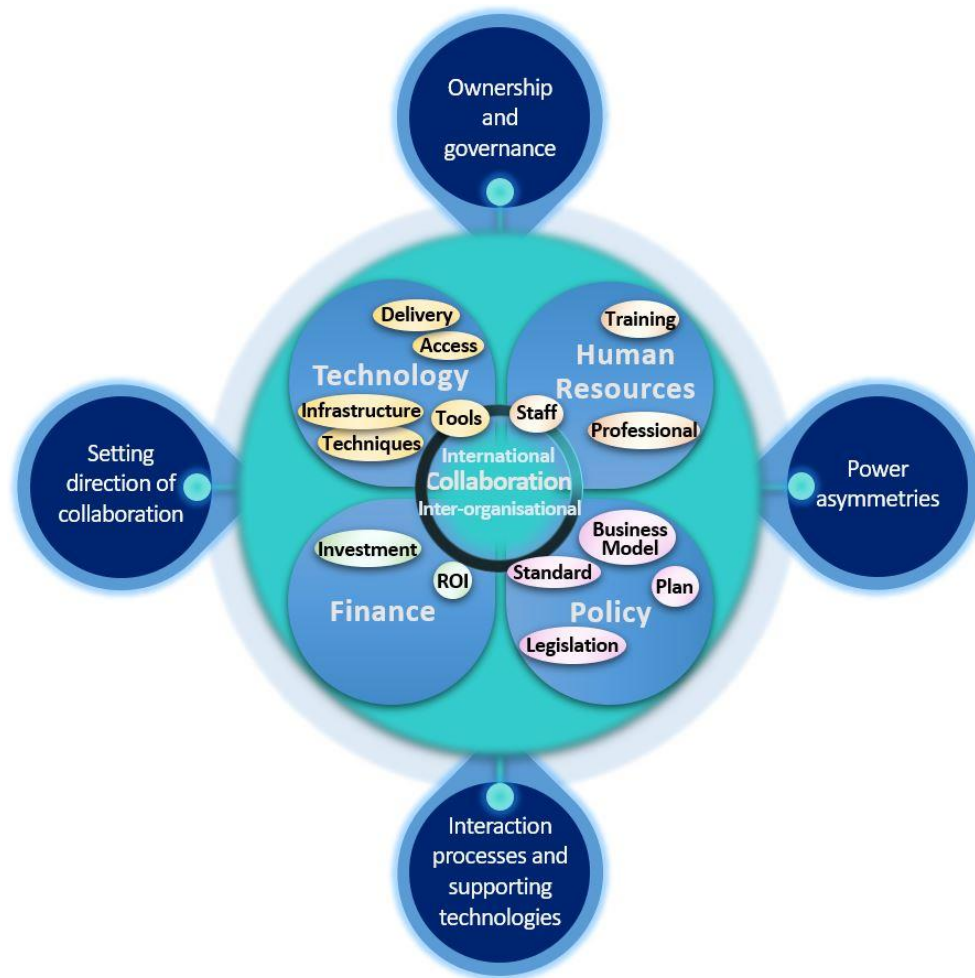


FIGURE 3.7 Collaborative innovation theoretical framework on GNSS CORS technology for this study (Source: Author's own research)

In conducting secondary research, this study has focused on the work of other authors to explore key areas such as technology management, project management, and infrastructure management. These aspects are crucial to understanding the broader context of collaborative innovation. The outer layer of the framework is drawn from the literature on collaborative innovation, which highlights the importance of various elements in driving successful collaboration. Specifically, for this technology, the research has been reviewing literature that addresses how technology intersects with human resources, policy, and finance, to better explain its implementation and integration into broader innovation systems. This approach helps provide a comprehensive understanding of the factors influencing the technology's success.

Nonetheless, the overall frame of this study is a combination of the previously developed structures: the initial conceptual framework (FIGURE 3.2) and the collaborative innovation theoretical framework on GNSS CORS technology (FIGURE 3.7). This framework interrelates the initial key factors for establishing the research design with core components for examining the research exploration. Finally, this model is represented diagrammatically in FIGURE 3.7 to conclude the relationship

between the features derived from the literature review for the whole research design.

The above-stated theories are influential in innovation governing; the constituents of the initiatives are insistent on thriving innovation success. Of particular relevance to this study, open innovation is a phrase that presents the concept of an aggregation of multi-player opinion sharing, which the operative condition of a solitary organisation has not complied. In addition, some publications insisted that innovation in the public sector has been progressively corroborated by open and collaborative forms of innovation, either in a quantitative or qualitative manner (Bommert, 2010; Nambisan, 2008). This study then confines collaborative innovation in the public sector, focusing on the vital elements that the CORS ecosystem uses.

3.6 CHAPTER CONCLUSION

To discover and understand the research gaps, answer the research questions regarding the objectives of this study and select the strategies to investigate the findings, reviews of the existing knowledge will help shape the process and demonstrate the uniqueness of the contribution.

According to Rizos and Satirapod (2011), Thailand's CORS contribution has proceeded inefficiently due to the variety of asset owners and a lack of joint practice procedures and appropriate frameworks. Also, with supporting information from Charoenkalunyuta *et al.* (2012), the CORS community in Thailand has separately manipulated this technology using different techniques. These secondary resources are the exploration of diverse aspects relevant to Thailand's CORS; however, this research has collected primary data to determine whether these studies are true and investigate the management of GNSS CORS in Thailand. This research consequently addresses this gap by studying the cross-boundary resource sharing between the Thai government organisations and examining the possibility of recommending a guideline to encourage the inauguration of the policy for managing the government-owned CORS and fostering their cooperation.

Based on the above-mentioned literature, this research identifies collaborative innovation management on GNSS CORS technology in Thailand and acquires a critical study on networked innovation in the public sector. GNSS CORS components are examined through the lens of innovation ecosystem theory, and the CORS business model analysis is highlighted. Furthermore, the stakeholder theory underpins the relationship between the organisations associated with this cooperation and the moderating role of this movement. Finally, an in-depth analysis of qualitative case studies is conducted to reinforce the validity of the research.

In considering the management of innovation, Tidd and Bessant's basic concept provides a foundational understanding that is significant for shaping the purposeful guideline for the literature review. However, the researcher has a special interest in delving deeper into how different stakeholders collaborate to manage innovation, which later on could lead the researcher the way to explore further and more specific matters concerning this study to

develop a theoretical framework as shown in the outer layer of the main diagram (FIGURE 3.7). Even so, the entire consideration is broadly general for innovation management. As the researcher sought more distinct information on how CORS technology is managed among stakeholders, the review then focused on papers as a result of the search, which particularly used CORS as a keyword and examined them for generating the inner layer in the diagram. Furthermore, the researcher narrowed the extent of focus to comprehend how this whole idea can be applied to CORS technology. This pursuit has been conducted alongside studying examples of CORS management in Australia for expanding experience in a similar context. Ultimately, the evolved framework will be a rigorous tool applicable to innovation management.

Through this chapter, the assessment of literary works reveals the realm of literature proposed by diverse scholarly aspects with knowledge and strategies that increase the realisation of innovation management. Although the existing literature provides a foundation for understanding the topic, there remains unexplored territory that requires a spotlight. Besides, this study necessitates drawing attention to the things that have not been previously discussed to identify the research gaps and formulate precise research questions. By acknowledging both the known and the missing literature on the successful manipulation of GNSS CORS in Thailand, the gaps in the scholars' writing regarding Thailand's CORS technology implementation have been underlined accordingly. In formulating research questions, careful consideration must be taken to ensure that they guide empirical research effectively. Based on the literature review, questions can be captured as to how and why Thailand has not successfully performed the CORS collaborative management between multiple stakeholders, which are government organisations. In addition to this, Chapter 3 also presents core themes derived from the literature that relate to methodological approaches for tackling innovation management issues. This is particularly important given to comprehend the nature of the methodology that will be employed, which leans towards abductive reasoning. On account of this, it becomes imperative to address areas where the literature lacks clarity and explore how these matters specifically pertain to CORS technology implementation in Thailand. Therefore, the coming chapter will engage information discovered within the current body of literature to direct the fieldwork and contribute meaningful insights to this study.

This research focuses on a case study of Thailand over time, following an abductive approach. Initial ideas were drawn from the literature on collaborative innovation, which guided the research process. The researcher devises to supplement these theoretical insights with original fieldwork, developing a preliminary model based on this combined analysis. This model, introduced in this chapter, serves as a foundational framework but may be further refined after additional fieldwork is conducted. The iterative nature of this approach allows for ongoing adjustments, ensuring that the model becomes more precise and aligned with real-world observations as the research progresses. Basically, abductive research involves an ongoing interaction between the researcher's initial theoretical framework and findings from practical research. This iterative process allows the model to evolve over time, as has been the case in this study. Abductive reasoning often begins with an incomplete set of observations, as was seen in Chapter Two, where the research presented partial data. Up to 2018, there is some historical context, but it remains incomplete, leaving gaps in

understanding. This lack of sufficient information calls for further investigation, allowing the researcher to refine and adjust the model as more insights are gained through continued analysis and fieldwork.

In Chapter 3, the theoretical model was developed to provide a framework for understanding the key elements related to the implementation of CORS technology. In the upcoming chapter, there will be attention with regard to determining how to apply it in this research by formulating specific research questions based on the established theoretical framework to investigate the issues surrounding CORS technology implementation in Thailand. These questions will encompass various aspects of the model concerning collaborative innovation, drawing from the essential components illustrated in

FIGURE 3.7, including ownership and governance, power asymmetries, interaction processes and supporting technologies, and setting direction of collaboration (outer layer), as well as technology, human resources, finance, and policy (inner layer). By addressing these dimensions, the model serves as a foundation for guiding the research questions and analysis of the challenges faced by the CORS project in Thailand, particularly the investigation of why the implementation did not work as effectively as expected. In doing so, the next chapter will shed light on the role of these matters to explore how these factors influenced the CORS project in Thailand to gain deeper insights into its challenges.

Chapter 4

RESEARCH METHODOLOGY

In previous chapters, a theoretical framework was established for understanding the complexities of GNSS CORS management in Thailand. In addition, an outline was developed for identifying (to identify) critical areas that require further attention and research. Building on these foundational insights, this chapter delves deeper into raising specific research questions and explores approaches for answering them. The focus here is on the formation of the methodology to systematically investigate the GNSS CORS administration challenges, providing a structured approach to uncovering significant understandings. By examining both the methods and rationale behind the research design, this chapter aims to lay the groundwork for a comprehensive analysis that will contribute to resolving the administration dilemma in Thailand's GNSS CORS network.

4.1 RESEARCH PROBLEMS

Concerning insight into the actions in advancing satellite positioning technology utilisation in Thailand, six problems have been addressed in this research derived from the literature review (Charoenkalunyuta *et al.*, 2012; DOL, 2017a; National Geo-Informatics Board, 2017; National Subcommittee on GNSS Network, 2017a; National Subcommittee on GNSS Network, 2017b; Rizos and Satirapod, 2011; RTSD, 2014). In order to undertake the investigation, adhering firmly to the facts in Thailand, this study will work towards these issues and address them as research problems.

1. The nature of the inter-organisational collaboration on GNSS CORS implementation between government organisations in Thailand (Charoenkalunyuta *et al.*, 2012; DOL, 2017a; National Geo-Informatics Board, 2017; National Subcommittee on GNSS Network, 2017a; National Subcommittee on GNSS Network, 2017b; Rizos and Satirapod, 2011; RTSD, 2014).
2. The nature of the international collaboration on GNSS CORS implementation between Thailand and foreign countries (National Geo-Informatics Board, 2017; National Subcommittee on GNSS Network, 2017a; National Subcommittee on GNSS Network, 2017b).
3. The nature of the data sharing and central network of GNSS CORS in Thailand (National Geo-Informatics Board, 2017; National Subcommittee on GNSS Network, 2017a; National Subcommittee on GNSS Network, 2017b).
4. The nature of the central unit for GNSS CORS management in Thailand (National Geo-Informatics Board, 2017; National Subcommittee on GNSS Network, 2017a; National Subcommittee on GNSS Network, 2017b).

5. The nature of the futuristic technology as an administration tool for GNSS CORS management in Thailand (National Geo-Informatics Board, 2017; National Subcommittee on GNSS Network, 2017a; National Subcommittee on GNSS Network, 2017b).
6. The nature of the policy framework for GNSS CORS management in Thailand (National Geo-Informatics Board, 2017; National Subcommittee on GNSS Network, 2017a; National Subcommittee on GNSS Network, 2017b).

The following table summarises the relationship between the research motivation, the purpose of the research, and the research problems for this study.

TABLE 10 The research motivation, the purpose of the research, and research problems for this study (Source: Author's own research)

Research Motivation	Purpose of Research	Research Problems
The lack of effective collaboration on the GNSS CORS network between government organisations in Thailand	1. Examine the critical factors of success in developing an innovative collaboration among the CORS owners and relevant organisations, inclusive of public agencies and academia, regarding facility sharing.	The nature of the inter-organisational collaboration on GNSS CORS implementation between government organisations in Thailand.
		The nature of the international collaboration on GNSS CORS implementation between Thailand and foreign countries.
		The nature of the data sharing and central network of GNSS CORS in Thailand.
		The nature of the central unit for GNSS CORS management in Thailand.
		The nature of the futuristic technology as an administration tool for GNSS CORS management in Thailand.
	2. Consider whether the Location-Based Services technology could be a key answer to sweep the lack of central management tool issue.	The nature of the policy framework for GNSS CORS management in Thailand.

4.2 RESEARCH QUESTIONS

In general, the study has been conducted in accordance with the interests, personalities, and areas of competence of the researchers. Hence, the research question is crucial for deciding the method used to investigate the research. Furthermore, researchers differ in correspondence to their unique ideas of developing and establishing the knowledge necessary to support a study argument in a meaningful and rigorous way (Altinay and Paraskevas, 2007). The research questions then frame the direction of the exploration. Throughout the initial literature review, several areas of interest appertain to innovation

management have been captured. However, this investigation has explicitly been carried out regarding the context of GNSS CORS management in Thailand. Besides, the research gaps are the particular concerns of duplication of CORS investment and the uncoordinated arrangement of CORS technology in Thailand. So, this study needs to optimise the strategies to overcome the absence of the CORS collaboration issue. On account of this, the research questions for this contribution have been allocated to five distinct subjects.

RQ 1. How can we evaluate the success of technology management?

The first research question foregrounds the typical collection of aspects for measuring innovation performance based on the literature. The inquiry explores a framework deliberately elaborated from the literature to assess the accomplishment or failure of GNSS CORS implementation. Innovation management has been taken on diversely on the subject of the technologies and the actors. It is also up to a variety of influences in each country. This question directs the initiative to scrutinise the evidence into the most weighty and pertinent criteria for judging the outcomes of technology management. As a result, it will closely examine the most appropriate way to evaluate the occurrence of CORS management in different countries. The adopted framework will be applied to determine the attainment of CORS throughout this research project.

This research question is intended to consider the developed evaluation framework. Therefore, this question will measure the framework's sensibility and see how the chosen theme is practical and functional in accordance with the study.

RQ 2. How has GNSS CORS technology management between government organisations in Australia been done?

The second research question has a bearing on the Australian government CORS managerial success. The question of how Australia organises the CORS technology tends to explore critical approaches and components needed for efficiently governing this technology. The review indicated the links between the research problems and the history of CORS development in countries other than Thailand. Especially in Australia, where the CORS funding duplication and the separate control and operation had once been problematic at the national level, the same as Thailand has been encountering. As the Thai situational problem is quite unique, learning from the Australian pathway to end those particular complexities, which is similar to the Thai context, could solve the decentralised CORS predicaments. In contrast, other countries' movements do not fit the Thai context; they are not a logical framework in harmony with the Thai approach.

The transpired induction of the national positioning scheme in Australia is a credible case for studying how they have performed, for what purposes, and who has been involved. Therefore, this question is purposive to understand the overall linkages between the elements in such a thriving national plan. It also aims to encapsulate the essential features of those collaborative undertakings of CORS.

The findings of this research question are predominantly about the Australian CORS management process, poring through the pieces of evidence. Yet, the coherence of

the actions and results needs to be identified. It is vital to understand why the Australian government managed to succeed. Therefore, it will give a rational explanation linking the exertions and their outputs. The attempts in Australia should be absorbed, examining every detail to answer why the activities that have been done met their expectations. These answers could provide a practical guideline for Thailand to follow.

RQ 3. How has GNSS CORS technology management between government organisations in Thailand been done?

The third research question is relevant to the Thai context. To perceive the CORS running status in Thailand, the question of how the Thai are organising GNSS reference bases would be applicable. This question has the intention to collect and compile the alignment and positioning of the CORS handling in Thailand. It takes stock of the GNSS CORS in Thailand, including the realisation of the technology, the owners of the system, the awareness of the issues, the relative influence of implementers, and the plans and resolutions threatening the problem. The question also puts stress on discovering the cooperation between the Thai government agencies and rapprochement between Thailand and foreign countries. It should engender a sense of the performing situation in terms of how the Thai have been doing, why they decided to do that, and who is counted. The study of the procedures for adopting the CORS network in Thailand will shed light on the cause of the difficulty and steer a direct course for making sense of the situation.

The present state of Thailand's CORS has been measured as not successful yet, according to the comparison with the critical concerns determining the program's success. It is crucial to discover why it has not been accomplished. So, it is decisive to realise the sources or factors preventing an accomplishment over the Thai GNSS reference stations administration. The question seeks tentative and generalised advocacy in pursuit of this goal that should be achieved. The answers in relation to this will give insight into the reason behind the unattainable ambitions and bring the expedition to prosecute the CORS proceedings in Thailand.

RQ 4. How does collaborative innovation alleviate the lack of GNSS CORS technology sharing between government organisations in Thailand problem?

This research question will examine the feasible solutions for addressing Thai's CORS matter. The question of how the collaborative innovation approach could solve the unavailability of resource-sharing disposition is set to scrutinise the disjointed networks and solo work. It is to explore whether the coordination of the GNSS network between the agencies in the public sector can eliminate the duplication of investment and facility-sharing problems. The assessment will pinpoint the fundamentally based cause of failures to underpin the collaborative GNSS CORS preparation. In addition, it is important to investigate whether the national CORS cooperation policy framework is achievable to form the overall CORS direction for Thailand.

The variety of moves and motivations brought about the decentralisation and is desperate for something to embody in the stakeholders orienting towards the same determination. Correspondingly, as an administration tool, the LBS technology will be selected to consider whether it is suitable for managing collaborative networks. As part of the question, LBS is designed to evaluate if this technology is a sought-after instrument for conducting the diverse layouts of CORS. If it is, can it be used as an adjunctive system to administer these affairs?

RQ 5. What guidance should have been recommended for managing the GNSS CORS technology in Thailand?

The final research question looks to provide advice suitable for the Thai context. The central part of this question is to find the appropriate recommendations for working optimally on GNSS CORS management in Thailand. Such suggestions can be held accountable for the improvement of CORS implementation in the future. In addition to this, the following question addresses the effectiveness of the issued guidelines. Assessments of CORS implementation guidance have been put in place to see how it could be realised when in operation. Furthermore, if the direction has been taken, how could it make things better for Thailand?

The research question that has been formulated is grounded on how they will contribute to resolving the technology management problems. It will take part in justifying the reasons why things have gone well or not so well. In so doing, RQ 4 and RQ 5 have mainly been framed to perform a particular action of collaborative innovation management on GNSS CORS in Thailand.

The correlation between the research motivation, the research aims, the research questions, and the research objectives for this study are shown in the table below.

TABLE 11 The research motivation, research aims, research questions, and research objectives for this study (Source: Author's own research)

Research Motivation	Research Aims	Research Objectives	Research Questions
The lack of effective collaboration on the GNSS CORS network between government organisations in Thailand	1. To obtain an understanding of how effectively GNSS CORS technology was managed between government organisations that involve this technology in Thailand.	1. To develop a sensible evaluation framework for this technology management based on the literature.	RQ1. How can we evaluate the success of technology management?
	2. To understand the role of the governments in supporting and encouraging the development of GNSS CORS operational partnership.	2. To evaluate Australia's experience based on the developed evaluation framework.	RQ2. How has GNSS CORS technology management between government organisations in Australia been done?
	3. To gain a comprehensive understanding of the complex and multifaceted aspects of using Location-Based Services as an administration tool for managing the GNSS CORS collaboration.	3. To evaluate Thailand's experience based on the developed evaluation framework.	RQ3. How has GNSS CORS technology management between government organisations in Thailand been done?
	4. To understand the effect of implementing the adopted GNSS CORS management policy framework.	4. To compare the different experiences between Thailand and Australia based on the developed evaluation framework.	RQ4. How does collaborative innovation alleviate the lack of GNSS CORS technology sharing between government organisations in Thailand problem?
		5. To issue guidance for fitter implementation on GNSS CORS in Thailand.	RQ5. What guidance should have been recommended for managing the GNSS CORS technology in Thailand?

4.3 RESEARCH METHODOLOGY

According to Babbie (2016), Blaikie (2013), Bryman (2016), Guba (1990), and Saunders *et al.* (2024), the research paradigm needs to individually consider reality in three elements, specifically ontology, epistemology, and methodology. With the basic argument of how the lack of technology sharing can be solved through inter-organisational association and how technology can be used for collaboration management, the study will concentrate on collaborative innovation management. As a consequence, Pragmatism will be tempered to designate a philosophical outlook for this research; this qualitative research design will be underpinned by objective ontology, pragmatist epistemology, abductive approach, case studies and interview techniques.

As Elo and Kyngäs (2008); Hsieh and Shannon (2005) and Mostyn (1985), analysing qualitative data typically involves some form of deriving meaning from data, where the research identifies key themes within the collected data. The primary focus is on understanding the themes that emerge from what people have discussed, and how these themes connect to the developed theoretical framework. Specifically, content analysis is a research analysis approach that examines the meanings and relationships of gathered information to explain features of the content. In addition, this tool organises research analysis by quantifying the data, either words, themes, or concepts. Furthermore, the methods used for analysing the data must be systematic and reproducible, ensuring consistency and reliability in the analysis process. As a result, content analysis would be suitable for this research.

4.3.1 Research Philosophy

To address those research questions effectively, it is vital to adopt a well-defined research philosophy that will guide this research approach and ensure consistency throughout the study (Creswell 2014; Crotty 1998; Saunders, *et. al*, 2024). This philosophy will shape the researcher's perspective on data collection, analysis, and interpretation, influencing every stage of the research process (Crotty, 1998; Scotland, 2012). Within this decided philosophy, the selection of suitable research methods that align with the research objectives and are capable of yielding meaningful insights was conducted thoughtfully (Creswell, 2014; Saunders, *et. al*, 2024). These methods will be explained in detail, providing a comprehensive account of why each method was chosen, how it was applied, and the specific steps taken to implement it (Flick, 2014). By establishing a clear methodology within a coherent philosophical framework, the intention is to make certain that the research findings are both reliable and relevant to the issues at hand (Bryman, 2016; Creswell and Creswell, 2018).

Research philosophy involves a knowledge-building process and a collection of viewpoints that support starting research (Saunders *et al.*, 2024). Although it is not necessary to provide a novel theory, it is nonetheless important to explore new areas of knowledge or specific problems. The philosophical approaches also exert influence on the generation of the research question and lead to the practical benchmark for assessing the research quality. These philosophical assumptions underline views on the beliefs to resolve an appropriate research paradigm of the social approval model

that covers data collection and analysis. Research paradigms, a significant part of research strategy that uses the philosophical perspective to define the research design, is composed of several concepts: ontology, epistemology and methodology. Thus, it broadens the perceived reality range from concept to practice (Guba, 1990; Saunders *et al.*, 2024).

The paradigms that underpin research philosophy vary substantially in their underlying perspectives, leading to distinct ontological positions, epistemological assumptions, and methodological approaches. Creswell and Plano Clark (2018), drawing on Creswell (2013), summarised four major research worldviews—postpositivism, constructivism, transformative, and pragmatism—as illustrated in FIGURE 4.1. This synthesis captures the core elements of worldviews and their implications for practice, providing the rationale for summarising the relevant perspectives examined in this study.

TABLE 2.4 ■ Elements of Worldviews and Implications for Practice				
Philosophical Question	Postpositivism	Constructivism	Transformative	Pragmatism
Ontology (What is the nature of reality?)	Singular reality (e.g., researchers reject or fail to reject hypotheses)	Multiple realities (e.g., researchers provide quotes to illustrate different perspectives)	Multifaceted and based on different social and cultural positions (e.g., researchers recognize different power positionalities in our society)	Singular and multiple realities (e.g., researchers test hypotheses and provide multiple perspectives)
Epistemology (What is the relationship between the researcher and that being researched?)	Distance and impartiality (e.g., researchers objectively collect data on instruments)	Closeness and subjectivity (e.g., researchers visit with participants at their sites to collect data)	Collaboration (e.g., researchers actively involve participants as collaborators, build trust, and honor participant standpoints)	Practicality (e.g., researchers collect data by “what works” to address research question)
Axiology (What is the role of values?)	Unbiased (e.g., researchers use checks to eliminate bias)	Biased (e.g., researchers actively talk about and use their personal biases and interpretations)	Based on human rights and social justice for all (e.g., researchers begin with and advocate for this premise)	Multiple stances (e.g., researchers include both biased and unbiased perspectives)
Methodology (What is the process of research?)	Deductive (e.g., researchers test an a priori theory)	Inductive (e.g., researchers start with participants’ views and build “up” to patterns, theories, and interpretations)	Participatory (e.g., researchers involve participants in all stages of the research and engage in cyclical reviews of results)	Combining (e.g., researchers collect both quantitative and qualitative data and mix them)
Rhetoric (What is the language of research?)	Formal style (e.g., researchers use agreed-upon definitions of variables)	Informal style (e.g., researchers write in a literary, informal style)	Advocacy, activist-oriented (e.g., researchers use language that will help bring about change and advocate for human rights and social justice)	Formal or informal (e.g., researchers may employ both formal and informal styles of writing)

Source: Adapted from Creswell (2013).

FIGURE 4.1 Elements of worldviews and implications for practice (Source: Creswell and Plano Clark, 2018)

Overview of Research Paradigms Relevant to the Study

Research paradigms provide the philosophical foundations that shape how phenomena are conceptualised, investigated, and interpreted in research (Guba and Lincoln, 1994; Creswell and Creswell, 2018). Among the dominant paradigms in social science research, positivism, critical realism, interpretivism, and pragmatism offer

contrasting assumptions regarding the nature of reality (ontology), the nature of knowledge (epistemology), and appropriate methodological approaches (Bhaskar, 1978; Crotty, 1998; Creswell, 2013).

Positivism adopts the view that reality is singular, objective, and measurable, and that scientific inquiry should aim to uncover generalisable causal relationships through empirical observation (Comte, 1853; Creswell and Creswell, 2018). This paradigm values objectivity, replicability, and quantitative measurement (Saunders *et al.*, 2024; Scotland, 2012).

However, critical realism, while similarly acknowledging the existence of an objective reality, argues that this reality is stratified and only partially observable, consisting of empirical events and the underlying causal mechanisms that produce them (Bhaskar, 1978; Danermark *et al.*, 2002). It integrates ontological realism with epistemological fallibilism and employs retrodution as a mode of reasoning to infer mechanisms that are not directly accessible through observation (Danermark *et al.*, 2019). As a result, critical realism advocates methodological pluralism to enable the investigation of both observable phenomena and the deeper structural conditions that shape them.

Interpretivism, by contrast, rejects the assumption of an objective, measurable social world, arguing instead that reality is socially constructed through shared meanings and interactions (Schwandt, 1994; Denzin and Lincoln, 2011; Scotland, 2012). As such, interpretive research emphasises qualitative inquiry aimed at understanding actors' intentions, experiences, and contextual meaning-making (Schwandt, 1994; Scotland, 2012). Pragmatism departs from these philosophical debates by treating truth as what works in practice; it focuses on solving real-world problems through flexible methodological choices rather than committing to any single ontological or epistemological position (Morgan, 2007; Biesta, 2010; Saunders *et al.*, 2019). Pragmatism thus supports the integration of quantitative and qualitative approaches based on the needs of the research question.

These perspectives are synthesised and presented in the table below to consolidate their overarching elements, including respective strengths and limitations, as well as the roles assumed by researchers in applying them within their studies.

TABLE 12 Comparative overview of positivism, critical realism, interpretivism, and pragmatism (Source: Author's own research)

Paradigm	Ontology	Epistemology	Methodological	Role of Researcher	Strengths	Weaknesses
Positivism	A single, objective, measurable reality exists independently of human perception. Comte (1853); Creswell & Creswell (2018); Scotland (2012)	Knowledge is objective, quantifiable, and derived from empirical observation and measurement. Creswell & Creswell (2018); Scotland (2012)	Quantitative methods <i>Data collection:</i> surveys, experiments, statistical modelling <i>Analysis strategies:</i> Deductive <i>Methodological caveats:</i> over-simplification, context blind, stats used carefully Creswell and Plano Clark (2018); Scotland (2012); Saunders <i>et al.</i> (2024)	Researcher is neutral, detached, and value-free. Scotland (2012); Saunders <i>et al.</i> (2024)	Offers clear, measurable, generalisable findings Scotland (2012)	Oversimplifies complex social phenomena Scotland (2012)
Critical Realism	Reality exists independently but is stratified into empirical events, actual events, and underlying causal mechanisms.	Knowledge seeks to understand causal powers and structures; knowledge is fallible and theory-laden.	Mixed methods <i>Data collection:</i> quantitative data and qualitative data <i>Analysis strategies:</i> case studies; explanatory	Researcher aims for objectivity while recognising influence of theoretical perspectives. Danermark <i>et al.</i> (2019);	Explains both observable events and hidden mechanisms Danermark <i>et al.</i> (2019);	Conceptually demanding; harder to operationalise Bhaskar (1978); Danermark <i>et al.</i> (2019);

Paradigm	Ontology	Epistemology	Methodological	Role of Researcher	Strengths	Weaknesses
	Bhaskar (1978, 1998)	Bhaskar (1998); Danermark <i>et al.</i> (2002)	analysis of mechanisms. <i>Methodological caveats:</i> align ontology and methods, claims are fallible; theory-based Danermark <i>et al.</i> (2019); Scotland (2012)	Scotland (2012)		
Interpretivism	Reality is socially constructed, multiple, and shaped by human interactions and meanings. Schwandt (1994); Saunders <i>et al.</i> (2024)	Knowledge is co-constructed through interpretation and engagement with participants. Denzin & Lincoln (2011)	Qualitative methods <i>Data collection:</i> interviews, focus groups, ethnography <i>Analysis strategies:</i> inductive thematic analysis <i>Methodological caveats:</i> reflexivity required, low generalisability, trustworthiness Schwandt (1994); Scotland (2012); Saunders <i>et al.</i> (2024)	Researcher is part of the research process; reflexivity is central. Scotland (2012)	Deep understanding of human experiences Schwandt (1994)	Limited generalisation; risk of subjectivity Schwandt (1994)

Paradigm	Ontology	Epistemology	Methodological	Role of Researcher	Strengths	Weaknesses
Pragmatism	Reality is dynamic and dependent on what works in practice; rejects commitment to a single ontology. Morgan (2007); Biesta (2010)	Knowledge is judged by practical usefulness in solving problems; accepts multiple forms of knowledge. Morgan (2007)	Mixed methods, method choice based on practical problem-solving needs. <i>Data collection:</i> quantitative data and qualitative data – surveys, experiments, interviews, observations, document analysis <i>Analysis strategies:</i> induction, deduction and abduction <i>Methodological caveats:</i> methods chosen, ontological priority, rationale and values, reflexive about consequences Morgan (2007); Creswell and Plano Clark (2018); Saunders <i>et al.</i> (2024)	Researcher acts as a problem-solver, selecting approaches pragmatically. Morgan (2007); Creswell (2014);	Flexible, practical, problem-centred Morgan (2007)	May lack philosophical consistency Morgan (2007)

Linking Research Paradigms to the Study of GNSS CORS Collaboration in Thailand

The study of GNSS CORS collaboration in Thailand necessitates recognition of the complexity arising from multi-stakeholder interactions, fragmented investment structures, and uneven technological development across institutions. Different research paradigms offer distinct lenses through which this phenomenon may be examined (Guba and Lincoln, 1994; Creswell and Creswell, 2018). A positivist approach would prioritise the measurement of objective indicators of CORS deployment, such as the number of reference stations, spatial service coverage, duplication of investment, and system performance metrics. While such an approach is valuable for assessing operational efficiency and technical outcomes, positivism alone is insufficient for explaining organisational behaviour, institutional dynamics, and the structural barriers that impede effective collaboration (Crotty, 1998; Creswell, 2013).

In contrast, a critical realist perspective is more closely aligned with the research problem, as it seeks to identify and explain the underlying causal mechanisms that generate observable outcomes. These mechanisms may include governance arrangements, asymmetries in resources and authority, bureaucratic boundaries, and policy or regulatory constraints that contribute to fragmented CORS implementation. Critical realism emphasises the distinction between empirical observations and the deeper structures that give rise to them, and it supports the use of mixed methods to investigate both observable patterns and underlying institutional conditions (Bhaskar, 1978; Danermark et al., 2002). An interpretivist perspective further complements this analysis by enabling an in-depth understanding of how public sector organisations perceive collaboration, how institutional cultures influence attitudes toward resource sharing, and why past coordination efforts have been limited or unsuccessful. Interpretive approaches are particularly valuable for capturing stakeholder meanings, experiences, and interpretations that cannot be adequately represented through quantitative indicators alone (Schwandt, 1994; Crotty, 1998).

Among these paradigms, pragmatism is ultimately the most appropriate philosophical stance for this study, as it integrates the strengths of both quantitative and qualitative approaches within a problem-centred framework. Pragmatism prioritises research questions and practical outcomes over strict adherence to any single philosophical tradition, thereby enabling the simultaneous examination of technical data, organisational processes, governance challenges, and stakeholder perspectives (Creswell and Plano Clark, 2018; Morgan, 2014). This approach aligns with the overarching research aim of developing a practical and actionable policy framework to enhance GNSS CORS collaboration within the Thai public sector. The flexibility inherent in pragmatism is especially pertinent in a context characterised by fragmented institutional responsibilities, diverse organisational mandates, and the need to generate evidence-based recommendations that can inform policy and practice.

1. *Ontology* - objective ontology

Ontology concerns the nature of reality in existing knowledge objectively or subjectively (Blaikie, 2013; Guba, 1990). An objective ontological viewpoint in the social system focuses on individual players as a priority, while subjective ontology explores the social movement's context as social actor achievement (Saunders *et al.*, 2024; Bryman, 2016). Though this study examines the collaboration between multiple parties, the position and perspective of the participants who are the stakeholders in this project are influential to the study. Further, the subjectivist assumption is improbable to view reality by investigating empirically; the ontological position of this research will be objective; the scientific method can be applied in empirical testing.

2. *Epistemology* - pragmatist epistemology

Epistemology will find out the nature of the relationship between the researcher and the things being studied to clarify the frameworks of knowledge (Blaikie, 2013; Guba, 1990). It is associated with a variety of methods for figuring out reality. Based on this assumption, the pragmatic perspective can be used to underpin both quantitative and qualitative research due to its capability to offer the best realisation of a research problem (Creswell, 2014). Pragmatism as a research paradigm provides the essence for research procedures in an action-oriented style that applies practical strategy in gaining knowledge. Therefore, this study will subscribe to the pragmatic assumptions of manipulating qualitative data and understanding the research characteristics.

Guided by a pragmatist epistemology (Butler and Murphy, 2007; Ochs, 1998; Peirce, 1905; Vangen and Huxham, 2003), this research relies on a qualitative approach that aligns closely with the developed theoretical framework. Pragmatism emphasises the practical application of ideas and the value of research outcomes, making it well-suited to address real-world issues in GNSS CORS implementation in Thailand. This perspective highlights the connection between the researcher and the challenges encountered in Thailand's GNSS CORS undertakings, positioning these challenges within the context of the theoretical model crafted for this study. By adopting this approach, the focal point is attended to explore the difficulties of GNSS CORS management with an emphasis on practical insights and solutions, reflecting the dynamic and problem-solving nature of pragmatism.

According to the philosophical perspective, the methodology aims at how the researcher should go about researching to describe systematic procedures for acquiring knowledge (Blaikie, 2013; Guba, 1990). Typically, abductive reasoning is a critical method referred to as the best explanatory inference that can be applied in various fields with a variety of phenomena (Hobbs, *et al.*, 1993). To answer the research questions of this study, an abductive approach was determined to underpin the exploration due to its flexibility in addressing complex issues surrounding innovation management science. With reference to Bendassolli, 2013; Brinkmann, 2014; Burks, 1946; Douven, 2011; Eiter and Gottlob, 1995; Ezzy, 2013; Graneheim *et al.*, 2017; Haig and Haig, 2005; Hobbs *et al.*, 1993; Josephson and Josephson, 1996;

Kennedy and Thornberg, 2018; Kovács and Spens, 2005; Magnani, 2011; Mantere and Ketokivi, 2013; Mitchell and Education, 2018; Reichertz, 2004; 2007; 2014; Rennie, 2012; Richardson and Kramer, 2006; Schurz, 2008; Tavory and Timmermans, 2014; Thagard and Shelley, 1997; Thompson, 2022; Timmermans and Tavory, 2012; 2022, abduction involves generating hypotheses in qualitative research with the expansion of the theoretical model based on real-world insights. It bridges the gap between theory and empirical observations by moving iteratively between existing frameworks and new data, distinguishing it from deduction and induction.

By leveraging both deductive reasoning to test hypotheses and inductive reasoning to generate new ideas, the abductive approach provides comprehensive frameworks for understanding challenges through the identification of underlying causal mechanisms and the generation of plausible hypotheses, making it a powerful tool for theory development and evaluation where existing theories fail to account for new or surprising data. Thus, the qualitative abductive approach will benefit this exploration to encourage in-depth value creation of the cases.

GNSS CORS management has become problematic at the national level in some countries because of their inefficacious settings in governing multiple owners' assets. This problem was also found in Australia and Thailand (Hausler, 2014; Rizos and Satirapod, 2011). According to Babbie (2016) and Altinay and Paraskevas (2007), research is a systematic process of describing, clarifying, examining, and manipulating in order to establish facts or actions associated with unrevealed individual realities and backgrounds to generate progressive ideas. In addition to this, Babbie (2016), Bryman (2016), and Merton (1967) stated that a theory that is an angle drawn from personal experience in explaining a systematic justification would give researchers guidance in their data collection procedures. Consequently, this study will be undertaken in response to earlier described theories and collect data from Australia and Thailand for investigation.

4.3.2 Data Collection

According to Stake (2006), a variety of data collection techniques can be merged to exploit complementary capacities of awareness in research. Therefore, this study will capture research data using two methods: case studies and interviews.

Yin (2014) pointed out that case studies research concerns the minimisation of the researcher's feelings in deriving the case replication to confirm hypotheses. Case studies research is generally broken down into three components: description, evaluation, and investigation. The second method is interview research, which underlines data acquisition through conversations. This research approach, in which the relationship between the researcher and the participants is a question deliverer and responder, can be performed using a structured, semi-structured, unstructured or in-depth format (Saunders *et al.*, 2024).

The research design adopted for this study is grounded in qualitative research methods, particularly focusing on the interviewees who participated in expert

interviews and focus groups, and the collection of relevant documents or data that have been applied. The research approach aims to return to the developed basic framework, as outlined in FIGURE 3.7, which highlights several key areas of importance from a theoretical perspective. The researcher seeks to determine the extent to which these elements and factors have influenced the implementation of CORS in Thailand. Key factors in this framework include *Ownership and governance*, *Power Asymmetries*, *Interaction processes and supporting technologies*, *Setting direction of collaboration* in the outer layer, and *Technology*, *Human Resources*, *Finance*, and *Policy* in the inner layer. The study relies on qualitatively in-depth data collection and the conduction of qualitative analysis, rather than employing statistical methods, to explore how these factors have impacted the implementation process.

Generally, one of the key challenges in qualitative research is the potential for bias in the data. If the research places reliance on the perspective of only one person regarding a particular technology project, that viewpoint may be biased by the individual's position or personal experience. To mitigate this, it's important to gather insights from multiple individuals to ensure a broader, more balanced understanding of the topic. This research follows that approach by interviewing several people and organising focus groups involving multiple stakeholders who are relevant to the GNSS CORS implementation project. This method allows the researcher to capture a diverse range of perspectives and reduces the likelihood of individual bias affecting the results. This study does not depend solely on individual views to understand what really happened and why it happened that way. Instead, the researcher has conducted qualitative research through expert interviews, focus groups, and document analysis, all with an awareness of the potential biases that may arise when people report not necessarily what truly happened, but what they believe happened. One effective approach to address this issue is to gather information from a diverse range of individuals, ensuring that different perspectives are considered. Additionally, the insights from experts play a crucial role in minimising biases, as these individuals typically do not have a personal stake in the success or failure of the technology management, making their input more objective and valuable.

4.3.2.1 Data Collection Method

This section delineates the transparency surrounding the data collection methods employed in this research. The study extensively utilised focus groups comprising participants drawn from a diverse array of organisations, with a deliberate effort to maintain anonymity by referencing only their roles and positions rather than their names. This approach not only mitigates personal and professional biases but also enhances the credibility of the findings by incorporating a broader spectrum of viewpoints. Furthermore, the inclusion of academic participants—who typically possess no vested interest in the organisations being studied—adds an essential layer of objectivity to the research. To address the research questions effectively, multiple data collection methods were utilised, including structured focus groups and expert interviews. This diverse methodological framework aims to overcome inherent biases

by engaging a wide range of respondents, thus enriching the data set and ensuring a more comprehensive understanding of the subject matter.

1. Transparency of Data Collection

As this research aims to assess how effectively Thailand manages the implementation of CORS, the data collection focuses on gathering an assortment of opinions from diverse groups connected to GNSS CORS technology. The inclusion of various perspectives is crucial to capturing a holistic understanding of the project's progress and challenges. The interviews are designed to engage participants who can impart significant information and valuable insights, making certain that the data reflects both the technical and managerial aspects of CORS implementation from multiple angles. More importantly, the collection of individuals from predominant organisations, who are the major stakeholders in this project, can supply insightful information about the actual situation that cannot be acquired from unaffiliated sources.

Although the researcher initially designed the target groups of interviewees, the final selection was made by their respective organisations, assigning participants based on their background and involvement in the research context. This procedure made sure the most pertinent participants were included in the study. Ultimately, the finalised list of interviewees and the details of the data collection process are presented in TABLE A – 1, TABLE A – 2, and TABLE A – 3, assuring a transparent approach to obtaining the necessary information for the research.

2. Choice of Participants

The participants selected for data collection were chosen based on their association with the GNSS CORS endeavour in Thailand. These individuals play an active role in the Thai government's efforts to ensure the successful implementation of CORS technology. As key stakeholders in the project, their contributions are pivotal to the effective management and deployment of this technology, making their insights and experiences highly valuable for understanding the project's progress and challenges.

The participants consist of both leaders and operators from various organisations who partake in the GNSS CORS endeavour. Their roles are decisive in supporting the development and arrangement of this technology. With their mixed backgrounds in terms of discipline, position, and levels of seniority hinged on knowledge and years of experience, they can bring an expansive range of perspectives and skills. The participants come from educational backgrounds primarily in engineering and geography, fields that are closely aligned with the technical and spatial features of GNSS CORS technology. Their work experience spans a wide range, from junior professionals to senior specialists, offering a broad spectrum of viewpoints. This diversity convinces that the data collection process addresses all relevant aspects of the project, covering the necessary technical, operational, and strategic requirements for the accomplished management of CORS technology. The favoured participants work in government organisations and universities and specialise in GNSS technology,

with specific expertise in GNSS CORS. The details of the selected participants are presented in TABLE A – 2 in the Appendix. This table highlights the variation in participants' attributes and their involvement in the project. Their in-depth knowledge and hands-on experience in this field make them well-equipped to offer important enlightenment on the deployment and oversight of CORS technology. Their backgrounds provide a strong foundation for understanding the technical challenges, policy implications, and research developments related to GNSS systems, ensuring that the data collected reflects both practical and academic perspectives on the project. Although the intended participants were initially selected in connection with their educational background and work experience, the actual participants in the data collection process, particularly the focus group interviews, were assigned by their agencies, which are key organisations that are the primary stakeholders in Thailand's CORS implementation. However, these people play a vital role in the project and ascertain that the views gathered are in straight with the core interests of those directly and point to the priorities and challenges faced by the main actors in the initiative.

The methodology used in this research focused on qualitative data collection, acknowledging the possibility of bias. Addressing it by including participants from numerous types of roles and personal histories could logically reduce this issue. Relying solely on information from a single group of people may result in a biased view of the situation. In connection to that, for this research, the interviewed participants are from varied backgrounds, including key stakeholders and academics involved in the CORS technology implementation in Thailand. The interviewees were specially designated for partaking in the focus group interviews by their respective agencies, confirming that they had relevant experience and engaged with the project. This method assisted in lowering possible bias by incorporating a variety of viewpoints from various communities, such as government officials both technical experts and executives, and academic professors. The inclusion of academics was especially significant, as they provided a more objective standpoint, given that they did not have a direct stake in the technology's success or failure. General interviewees may not necessarily deliver an unbiased response due to their engagement in the technology, whether hoping it succeeds or fails, while professors are more likely to offer an objective perspective. On the grounds of this, the methods for answering the research questions include conducting focus group interviews to gather a range of views from within an organisation and other stakeholder groups, along with individual interviews with experts from differing universities.

Furthermore, according to the theoretical framework, governance is a crucial qualitative concept. As its function and ideal structure can vary in perception; thus, it is critical to get several kinds of positions on how the governance system operates for this specific technology. Therefore, it is indispensable to enquire into the issues with a series of questions and employ the theoretical framework in FIGURE 3.7 to gain a more comprehensive understanding of what truly transpired in Thailand regarding the implementation of CORS technology. This methodology primarily addresses questions

formulated with the help of the literature review, while taking into account people's views and judgments to support the execution of this qualitative research. By gathering diverse opinions from varying stakeholders, it aimed to capture a balanced comprehension of the factors influencing the CORS project, as reflected in the theoretical framework developed in Chapter 3. The bias possibility due to this qualitative research design should then be minimised by ranges of beliefs that reveal what actually happened in this particular situation.

3. Method of Data Collection

Stake (2006) concluded that the combination of data collection methods would significantly affect the research. For this reason, with regard to the research design, data collection methods for this study comprise case studies, focus group interviews, expert interviews, and follow-up interviews. Since multiple techniques are employed for this research, numerous sources of evidence were collected.

3.1. Document

A variety of data formats, such as letters, newspapers, announcements, and interviews, will be gathered in case studies research. These could cause complications in defining and confining the case (Harrison *et al.*, 2017). Nevertheless, proper planning, designing and preparation for data collection, both data sources from individuals and organisations, and existing archives and new observations will strengthen the reliability of findings (Yin, 2014).

With reference to this study, two cases are put to research: the CORS management in Australia and the CORS management in Thailand. The exploration of these cases requires evidence regarding the endeavours of the GNSS CORS administration of both countries. Such materials are the official announcement, meeting minutes, report, letter, thesis, news, and other documents relating to the CORS project.

3.2. Interviews

The interview is one of the most widely used qualitative research techniques for data collection. It relies on the collection of data through the use of questions. The interview consists of two or more individuals participating, with one as the interviewer who asks the questions. There are various interview kinds, which are frequently distinguished by their degree of structure. In a structured interview, questions are asked in a prearranged sequence. A semi-structured interview is between a structured interview and an unstructured interview, which is a free-form interview.

This study will employ an interview strategy to gather data for the investigation. Three interview techniques will be applied to collect data in a semi-structured format using the same major questions:

1. How do you feel about the GNSS CORS collaboration between government organisations in Thailand?

2. How do you feel about the GNSS CORS collaboration between the Thai government and foreign organisations?
3. How do you feel about creating the central network of GNSS CORS?
4. How do you feel about establishing a government agency for the central network of GNSS CORS?
5. How do you feel about using LBS as an administration tool for the central network of GNSS CORS?
6. How do you feel about adopting the policy frameworks for future GNSS CORS management?

The conduction of research data gathering utilising an interview approach will be as follows:

3.2.1. Focus Group Interviews

As a qualitative data collection technique, a focus group interview is designed to explore the reality from people's views (Fraenkel *et al.*, 2011; Kvale, 1996). Multiple standpoints and expressions on a given subject matter will be collected simultaneously during the activity, in which participants of a range of ages, knowledge, and socio-characteristics related to the research area are selected and invited to join (Burrows and Kendall, 1997; Rabiee, 2004; Richardson and Rabiee, 2001). This technique necessitates a moderator's skill in managing and facilitating the group dynamic in order to engage participants with the topic in a relaxed environment while verbal and nonverbal feelings are recorded (Kitzinger, 1994, 1995).

This study highlights the separate ownership of GNSS CORS technology of the Thai government agencies; as a consequence, the research data collection targets these organisations as a priority. Focus group data collection was undertaken in the discussion sessions of six government agencies that own CORS technology: the Royal Thai Survey Department (RTSD), the Department of Lands (DOL), the Department of Public Works and Town & Country Planning (DPT), Hydro and Agro Informatics Institute (HAII), and the National Metrology Institute (Thailand) (NIMT). Each session contains four to six members of one organisation to talk about their standpoints regarding those six questions, as seen in TABLE A - 1 in the Appendix. As a moderator, the researcher gave the main six questions, added some points, and then noted their quotes and nonverbal reactions during the session, which varied between one and three hours in length. These activities were held during June – July 2018 at the organisations where the research subjects work. They were organised in a closed environment in order to minimise disruption.

3.2.2. Expert Interviews

The expert interview is a session of queries and responses on a particular subject between an observer and a participant who is proficient in the subject. Many superior strengths of the expert interview technique make this technique more effective than

participatory observation, systematic quantitative surveys, or other methods. Firstly, the expert interview technique requires a short period to collect data. In addition, the experts might be the key figure in the research topic movement and the important connection to relevant subjects. On this account, it can be conducted to collect data where other techniques are unfeasible or problematic, such as interviews with forbidden participants.

Moreover, experts are usually in institutes that are easier to reach (Bogner *et al.*, 2009). In a qualitative study, an expert interview is an approach in need of respondents with expertise and attentiveness of a particular setting to give skilful responses to the research questions. However, the number of interviews required to saturate the study cannot be designed. Presuming that the conditions upon this qualitative technique become relevant, the limitations on the prospective proficient and their availabilities still exist (Baker *et al.*, 2012; Muskat *et al.*, 2012).

Expert interview data collection is designed to focus on the lecturers in the government universities in Thailand who are skilful in GNSS technology and involved in the CORS implementation project. The study selected three lecturers from three universities: Chulalongkorn University (CU), King Mongkut's Institute of Technology Ladkrabang (KMUTL), and Kasetsart University (KU). The interviews took place at their workplace, one-on-one between the researcher and the expert. This semi-structured interview took at least one hour per session for six questions, the same as the focus group interview questions. The expert interviews were held alongside the focus groups in June – July 2018 to gain the diverse aspects of the situation from different circles.

3.2.3. Follow up Interviews

Lastly, the follow-up interview is a valuable technique for building on initial responses and acquiring further information from the participants. It offers the researcher extensive insight into the data that the contributors replied to earlier. In addition, this method will benefit the research in light of the more keenly priced data obtained. It can be arranged either directly or indirectly through face-to-face meetings or online. Furthermore, it can be an open-ended interview that is shorter than the initial interview (Roxburgh, 2021; Saunders *et al.*, 2024; Thumm, 2005).

A follow-up interview has been devised to track the update of the CORS implementation project in Thailand by asking some focus group interview participants the same questions. Five interviewees from RTSD, DOL, HII, GISTDA, and NIMT who participated in the focus group interview gave their points of view on those six questions per their situations. Details can be seen in TABLE A - 3 in the Appendix. An interviewee is a representative of the organisation to be personally connected via an online basis. Up-to-date information on the situation regarding GNSS CORS management in Thailand was obtained through their views. The interviews were done in short sessions, either through calls or informal chats. However, the interview with the representative from the GISTDA was repeated at her convenience in updating data.

4.3.2.2 Stakeholders

The problem of CORS duplication is prominent in Thai government organisations, inclusive of the Royal Thai Survey Department (RTSD), the Department of Lands (DOL), the Department of Public Works and Town & Country Planning (DPT), Hydro and Agro Informatics Institute (Public Organization) (HAII), Geo-Informatics and Space Technology Development Agency (Public Organization) (GISTDA), National Institute of Metrology (Thailand)(Public Agency) (NIMT), Chulalongkorn University (CU), King Mongkut's Institute of Technology Ladkrabang (KMITL), and other organisations.

In analysing the CORS collaborative management strategies, nine public organisations consisting of six government agencies and three universities have been considered for the research sampling. These samplings, including RTSD, DOL, DPT, HAII, GISTDA, CU, KMITL, and Kasetsart University (KU), are the main sources of research data.

4.3.2.3 Scope

The investigation of GNSS CORS collaboration between public organisations in Thailand will focus on the points of view of the prime GNSS service provider about facility sharing and interoperability with the LBS administration tool.

This study will engage in focus groups of Thailand GNSS CORS key dominants over two periods of the interview. The first primary data collection was conducted during June and July 2018, and the second data collection was held from 2020 to 2021. The focus group interviews were structured in a meeting room at the CORS collaborative involvement organisations. The participants are the government officers who involve the CORS in terms of investment, management, operation and policy. At least four, with a maximum of seven volunteers from the same agency, were invited to the interview session at the same time to share personal perspectives regarding the interview questions with other interviewees. The researcher was a moderator and observer who explored the respondent's verbal and nonverbal activity without interference. The interviewees were asked six interview questions, and the interviews continued for no longer than three hours. On the grounds of this, six government agencies relating to GNSS reference stations were invited to the investigation.

Besides, the expert interviews that were encouraged by professionals from three universities in Thailand were organised formally in the same periods as focus groups. An expert interview is a highly controllable technique that allows individual meetings with GNSS specialists in Thailand to be conducted to gain particularly high-quality content. However, university lecturer experts were unable to devote much time to interrogation; therefore, the researcher needed to be well-prepared.

Moreover, a case study of Australia's GNSS CORS management was put forward for comparison. With reference to the study on CORS collaboration management in Australia (ANZLIC, 2014; Hausler, 2014; Higgins, 2008; Janssen, 2011; Rizos, 2002; Roberts, 2009), the Australian government encountered complications concerning inter-organisational collaboration on CORS technology which is interchangeable with

Thailand's context. The inter-state endeavour to adopt a GNSS network policy framework in Australia could then be a very useful case study for Thailand. Thus, the doctoral theses, research project reports, scholarly papers, journal articles, pronouncements, and a variety of resources related to GNSS reference network collaboration in Australia were collected.

The scope of this study includes an inclusive description of the research methodology, particularly the data collection process. This section details when and how data collections were conducted, along with information about the participants involved. A table is provided below, summarising the timeline of data collection and specifying attributes about the participants, including whom the researcher interviewed and the dates of each interview. Data collections were carried out using two distinct methods, each involving multiple participants interviewed over a specific period to gather comprehensive insights. This study gathered data with a focus on addressing specific comprehension related to research questions. The table below outlines the data collected and identifies the participants involved. The primary data collection occurred from June to July 2018, with a second phase taking place between 2020 and 2022. By giving a summary of the timing and nature of these data collection phases, the study clarifies how they align with the research questions. The data collected covers all research questions, though certain aspects are more relevant to specific questions. This comprehensive approach allowed the study to address each question either fully or partially through relevant portions of the data. The summary of data collection within this scope of work is shown in TABLE 13 below.

TABLE 13 Data collection methods and interview questions in relation to research questions (Source: Author's own research)

Research Questions	Interview Questions	Other Resource	Methods
RQ 1. How can we evaluate the success of technology management?	-	Literature	Literature review
RQ 2. How has GNSS CORS technology management between government organisations in Australia been done?	-	Documents	Documents
RQ 3. How has GNSS CORS technology management between government organisations in Thailand been done?	IQ 1. How do you feel about the GNSS CORS collaboration between government organisations in Thailand? IQ 2. How do you feel about the GNSS CORS collaboration between the Thai government and foreign organisations?	Documents	Interviews + Documents
RQ 4. How does collaborative innovation alleviate the lack of GNSS CORS technology sharing between government organisations in Thailand problem?	IQ 3. How do you feel about creating the central network of GNSS CORS? IQ 4. How do you feel about establishing a government agency for the central network of GNSS CORS? IQ 5. How do you feel about using LBS as an administration tool for the central network of GNSS CORS?	Documents	Interviews + Documents
RQ 5. What guidance should have been recommended for managing the GNSS CORS technology in Thailand?	IQ 6. How do you feel about adopting the policy frameworks for future GNSS CORS management?	Documents	Interviews + Documents

TABLE 14 Summarisation of the data collection within the scope of work for this study (Source: Author's own research)

This table has been removed by the author of this thesis for data protection reasons.

4.3.2.4 Expected Limitations

As mentioned above, this study gathered data in Thailand by observing native Thai language speakers expressing their ideas in person or in a group discussion. Some limitations in using interviews as a data collection method were confronted and are detailed as follows;

Data Collection

1. The study does not include all organisations that are closely connected to this partnership. This is because of the restricted extent of the research design. Nevertheless, many of them have been indirectly involved. This investigation draws attention to the agencies with superior power to Thailand's CORS project and the pre-eminent experts on GNSS technology. Focus group interviews and expert interviews require considerable time and can be costly. So, the assemblage of study resources can be performed within a limited expanse.
2. The key dominant of some organisations refused to participate in the focus group interview or spent a short time interviewing.
3. At some points, the contributors might not clearly understand the topic discussed; they might miss the discussion point or provide only vague opinions. This misunderstanding could happen on account of their backgrounds or interests. They also borrowed ideas or followed the others' thoughts, which did not concern the conferring argument.
4. Although the discussion party had provided information cordially and welcomingly, the researcher cannot re-visit the organisations for added data collection due to time constraints and external factors.

Data Transcription and Translation

1. The meaning of the participators' intent could be misunderstood due to the distinct backgrounds of the researcher and the speakers. Since the interviews were conducted with nine divergent parties with contrasting personalities and expertise, each of the possible terms could be a disparateness of use. The researcher could proceed with the transcriptions by misinterpretation.
2. Infrequently, the respondents provide some particulars that can be altered in the interpretation. They might have given unclear ideas or feelings that can be inferred from a differing understanding.
3. The data transcription and translation is a critical stage that is connected to the data analysis stage. Therefore, it requires slow, deliberate and careful intention. In addition, there is considerable content from multiple providers. Consequently, it was a hard-working stage that required a significant time commitment.

Case Studies Research

Case analysis design could be problematic in light of the number carried out. Using multiple cases would produce robustness of results. However, it is difficult to determine how many would be considered adequate. This study drew plans for two cases that are relevant to the research aims.

4.4 INTENDED VALIDATION

The confidence of the study is well represented in the validity and reliability of the investigation. Thus, a measure of quality to ascertain confidence in findings from case studies and other empirical studies customarily uses construct validity, internal validity, external validity, and reliability (Edmonds and Kennedy, 2016; Yin, 2009). These four tests for case study design acceptability have an impact on the deployment of research design, as seen in TABLE 15 below and TABLE A - 29 in the Appendix. In addressing the validity and reliability of case study research, these tests have been given for preparing and organising the data for analysis and are inherent throughout the study.

Construct validity, the concept of operationalisation, has a significant role in identifying the variables for measuring the empirical works by using multiple sources of evidence, having key informants review the draft case study reports, and establishing a chain of evidence (Yin, 2009). In light of this research, accurate measures are generated through theories and data gathered using interviews and documentation methods. Likewise, internal validity, the causal relationships justification, has been placed in explanatory investigations rather than descriptive or exploratory case studies. Internal validity can be improved by combining data triangulation and methodological triangulation, additionally, through a cross-analysis of cases. With pattern-matching logic, the empirical results have been compared with theoretical propositions. The replication strategy, either literal replication or theoretical replication, then brings greater robustness and presents the identical results of the multiple cases inquisition. Consequently, the causal inference developed within this study reflects both the rich theoretical framework and validity of gaining an insightful understanding of this phenomenon.

In terms of external validity, which focuses on the generalisable findings, generalisability to other cases examination should be considered in relation to its outcomes. This test has confirmed the causal relationship with several terms, including units, treatment variations, outcomes, and settings. It also has an interaction in context-dependent intervention. In response to this test, the research has been formulated with extensive cases and methodological literature. The theories applied in the single-case studies also have been replicated in the multiple-case studies. Finally, reliability, the data collection repetition process, has attentively occupied with iterating the procedures for data assemblages. This test has pinpointed the creation of traceable principles that lead to obtaining the same results. It is strengthened by using the case study protocol to follow the study guidelines and developing a case study database from appropriate documents such as the project summary, field plans, guiding inquiries, and a report outline. The reliability extant in this research has

been proved by data collection methods that gathered all necessary resources for case studies and cross-case studies.

As mentioned earlier, triangulation is an approach that gives a confident assurance of the study results. It improves research validity by mixing multiple methods in one study to ensure that an investigator has learned from their experience (Dootson, 1995). Therefore, it is the employment of multiple ways to understand phenomena in qualitative research comprehensively. The research triangulation is inclusive of five techniques: theoretical triangulation, data triangulation, methodological triangulation, investigator triangulation, and analytical triangulation. These techniques facilitate data validation by cross-testing two or more sources. In addition, Murray (1999) concluded that the cross-method triangulation supports exploration in terms of variable correlation comparison, in-depth dimension comparison, and insight instrument comparison. Moreover, methodological triangulation, which refers to the use of multiple methods in collecting data to view different attitudes, can be advantageous to a researcher in understanding reality (Denscombe, 2010). This research strategy supports the research findings by providing the fulfilment of each research method requirement and improving the relevance of the results (Dootson, 1995). As summarised by Murray (1999) and Thurmond (2001), the strengths of triangulation are significant for research exploration. For example, it presents a more comprehensive view of the research area, enables the researcher to verify the validity of the research methodology, and increases confidence in the findings. Nonetheless, some disadvantages are outlined that study expenditure and timing would be very significant when conducting the triangulation in research.

Regarding the above advantages and drawbacks, triangulation techniques are being carried out to contribute to understanding the phenomenon. Applying methodological triangulation in an investigation will underpin the theoretical schemes in the study of a phenomenon. In accordance with this research project, three data collection techniques have been selected to comply with the methodological triangulation: focus group interview, expert interview, and document analysis. Methodological triangulation would be beneficial in this study in terms of broadening and deepening this qualitative research, which a solitary research approach cannot complement the satisfactory explanation. Methods triangulation involves not only data-gathering techniques but also research design (Lincoln and Guba, 1985). This type of triangulation is achieved in both quantitative and qualitative studies through data collection, data analysis, and explanation methods (Goodwin and Goodwin, 1984). So, methodological triangulation has been introduced as a measurement technique for the analysis of the relationships between the data collection methods in the validation process of this qualitative research project.

With this in mind, the consistency of research outcomes can be verified using different scrutinisation methods. This study employs a variety of theories, various data sources, several data collection techniques, and multiple data analytic strategies. Therefore, they can be evaluated for reliability using triangulation. As a result, according to Yin (2009), the approaches adopted for dealing with this exploration can be described as per an evaluation of research quality criteria (TABLE A - 25 in the Appendix). The findings of this research will be validated using theoretical triangulation, which are collaborative innovation, networked

innovation, innovation ecosystem, and stakeholder theory. Also, data triangulation and methodological triangulation by exploiting primary data sources and secondary data sources from focus groups, experts, and follow-up interviews and documents will be applied to this study. Thus, analytical triangulation with pattern-matching, content analysis and comparative analysis will be employed, too.

TABLE 15 Validity and reliability of case study research tests (Yin, 2009)

Test	Description	Purpose	Case Study Tactic	Phase of Research
Construct Validity	Identifying correct operational measures	To create a sufficiently operational set of measures	Use multiple sources of evidence	Data collection
			Establish a chain of evidence	Data collection
Internal Validity	Seeking to establish a causal relationship as distinguished from spurious relationships	To create causal relationships	Do pattern matching	Data analysis
			Address rival explanations	Data analysis
External Validity	Defining the domain to which a study's findings can be generalised	To create the extent of a study's findings generalisability	Use theory in single-case studies	Research design
			Use replication logic in multiple-case studies	Research design
Reliability	Demonstrating that the operations of a study can be repeated with the same results	To present the precision of the outcomes and minimise errors and biases	Use case study protocol	Data collection
			Develop case study database	Data collection

4.5 DATA ANALYSIS

4.5.1 Data Analysis

Analysing data in qualitative research involves the repeated and persistent procedure of comparing the information collected from observations, interviews, and focus groups. Furthermore, the coding technique will be used for decreasing and rectifying the raw data, both texts and pictures (Fraenkel *et al.*, 2011). Both verbal and nonverbal communication, namely kinesics, proxemics, paralinguistics, and chronemics, that the participants responded to the questions are key data for the focus group data analysis (Krueger and Casey, 2000; Rabiee, 2004). Regarding the above data collection techniques, two methods that will be used for data analysis in this study are *Content Analysis* and *Comparative Analysis*.

As Mostyn (1985) noted, content analysis is a method widely utilised to analyse a number of unlimited boundary resources systematically. It is suitable for quantifying qualitative data that can investigate a variety of data formats—for example, newspapers, audio and video records, and live streams. This technique was accordingly taken for sample selection, coding unit identification, and coding frame construction for this study. On the grounds of this, the statistical data analysis was performed to find the recurrence or other conditions under a pragmatist paradigm.

In reference to Elo and Kyngäs, 2008; Graneheim *et al.*, 2017; Krueger and Casey, 2000; Onwuegbuzie *et al.*, 2009; Rabiee, 2004; Stewart *et al.*, 1990, though the research papers mostly proposed the trustworthiness of quantitative content analysis, the content analysis approach is broadly applied to examine the quantitative data as well as qualitative data. The use of a qualitative content analysis performed in either inductive, deductive or abductive content analysis strategies can be found in various studies, including written material and open-ended questions analysis. However, qualitative content analysis is an extremely flexible technique that does not provide elementary instructions. It requires an essential nature of the researchers like self-criticism, knowledge and particular skills in order to execute the content analytics with validity and reliability of findings. Still, the process of data analysis could have biases in the outcomes. However, the risk of subjective views of data selection and assessment can be diminished by systematically, successively, continuously, and verifiably undertaking an in-depth analysis. Abductive content analysis, with the inspiration of inductive and deductive approaches, characterises the content of qualitative data and reveals patterns of empirical data structures. Accordingly, this technique is used to analyse focus group interview data and expert interview data.

The codes in this study were developed based on the theoretical framework derived from Collaborative Innovation, Networked Innovation, Innovation Ecosystem, and Stakeholder Theory. The codes were started from the list of CORS innovation ecosystems, which contained scores of factors related to GNSS CORS technology. Subsequently, collaborative innovation and networked innovation theories were applied to filter the relevant codes. With the supportive idea of stakeholder theory,

the final set of codes was ready for the categorising of collected data. Throughout this step, the code selection is formulated on the basis of the key needs for present and future work for CORS technology management on the ground of the literature in this field.

Although this analytical technique is applicable to this study because it can logically convert evidence into quantitative form, there are several points of concern. For instance, the fundamental theories used for assumption are not significant and unclear, the selected words or phrases are subjective, and some data might not be selected. These concerns are focused on the misunderstanding of context due to the exclusive substances. Besides, the unavailable material is a factor that needs to be considered; the different purposes of collected data could infer the different phenomena (Silverman, 2013).

Pattern-matching is a qualitative analysis technique that compares the theoretical pattern, which is on the basis of prediction, with an empirical pattern, which is an observed one (Hammond, 1966). Using the pattern-matching technique in case study analysis to underpin internal validity and relate to data variables is a preferred approach (Yin, 2014). In qualitative research, this algorithm has thus been recommended for strengthening rigour and lessening subjectivity as a whole (Johnson and Onwuegbuzie, 2004). As a result, it is sensible to apply this logic to this research's case analysis.

After investigating the interview data and case study data process, a comparative analysis was conducted to compare and contrast data interpretation results from those approaches. The interpretative results of those materials that used the focus group interview technique to collect data from government agencies in Thailand, the expert interview technique to gather data from universities, and the case study technique to capture evidence in the Australian and Thai context can be compared in terms of similarities and differences.

4.5.2 Case Studies

According to Yin (2009), case study research involves the use of a logic model for analysis that links a theoretical framework with empirical data from observed events, either quantitatively or qualitatively. This notion states the case study's beneficial role in supporting the explanation of research outcomes and its appropriateness in arranging evaluation. A case study is a method that is widely applied in qualitative research in a variety of disciplines. One such example is the analysis of innovation in call and contact centres. The case studies technique was the qualitative approach taken to investigate these difficulties. Both separate and cross-case examinations of the data from various enterprises have successfully been conducted (Smith, 2009).

This study employs a case studies strategy to analyse GNSS CORS management data in two countries with similar difficulties in organising this technology: Australia and Thailand. In-depth qualitative data analysis of these cases examines the collected data using within-case and cross-case approaches. As a consequence, multifaceted

explorations of the cases reveal the correlation between the theoretical framework's core items and the research data's elements.

4.5.3 Methodology of the Coding

A coding methodology design is a systematic plan for the entire analytical process that engages a series of sequential steps to perform the fundamental data analysis. The loop of the coding process is illustrated in FIGURE 4.2.

The *Theoretical Framework* derived from the literature review offers the core components in the context of CORS collaborative innovation. The *Code Identification* then specifies the codes based on these components. Then, the contents that have a connection with the nodes are selected into those codes in the *Coding* stage. The *Re-coding* step may be repeated in order to obtain more precise results. The coded outcomes can be explored and presented in terms of their connectivity and attributes at the next level, *Linking & Mapping*. Consequently, the findings are taken into consideration in the *Interpretation* process. Finally, the out-turn is collated with the *Theoretical Framework* to consider consistency.

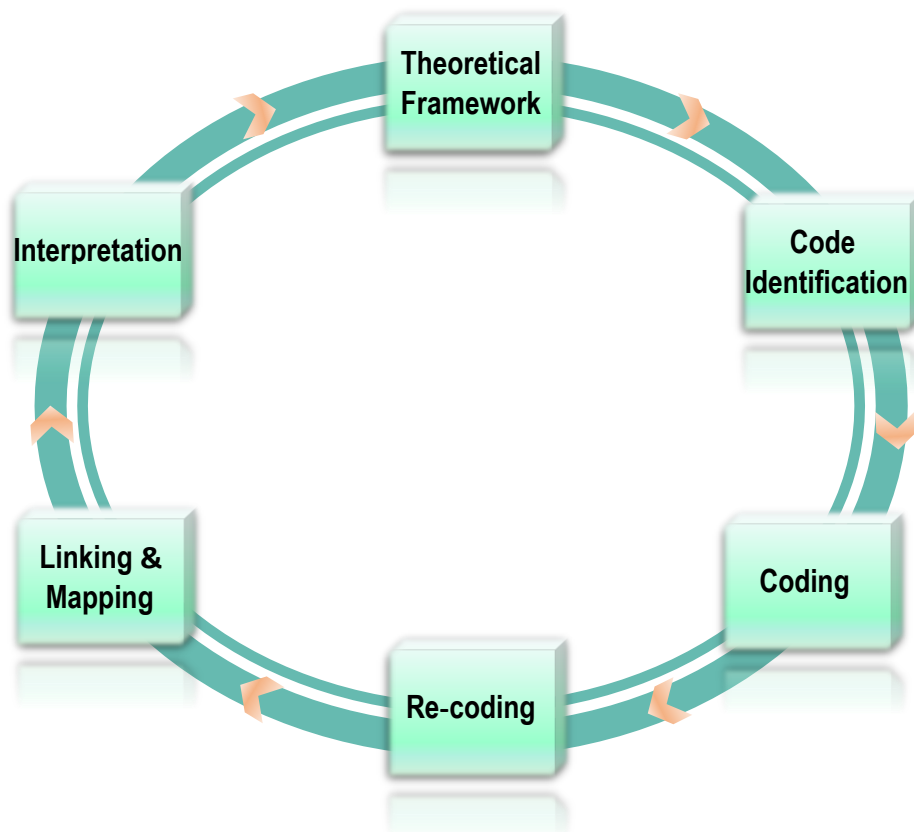


FIGURE 4.2 Content analysis methodological model

The levels of coding in this study were defined from the theoretical framework. The first level listed prime factors of this study: Collaboration, Finance, Human Resources and Responsibilities, Plan and Policy, and Technology. Multiple subordinate nodes were created as children to categorise more specific details. The procedure of interview data analysis complied with the guidelines introduced by Attard and Muir

(2021). The study followed these processing steps: data analysis technique selection, literature review and researcher's personal viewpoints arrangement, theoretical framework generation, data collection, coding, findings interpretation, and conclusion.

Both parent and child codes were predetermined in line with the theoretical framework, as can be seen in the diagram below, which shows the relationship between prime codes and their subordinates selected for this study analysis.

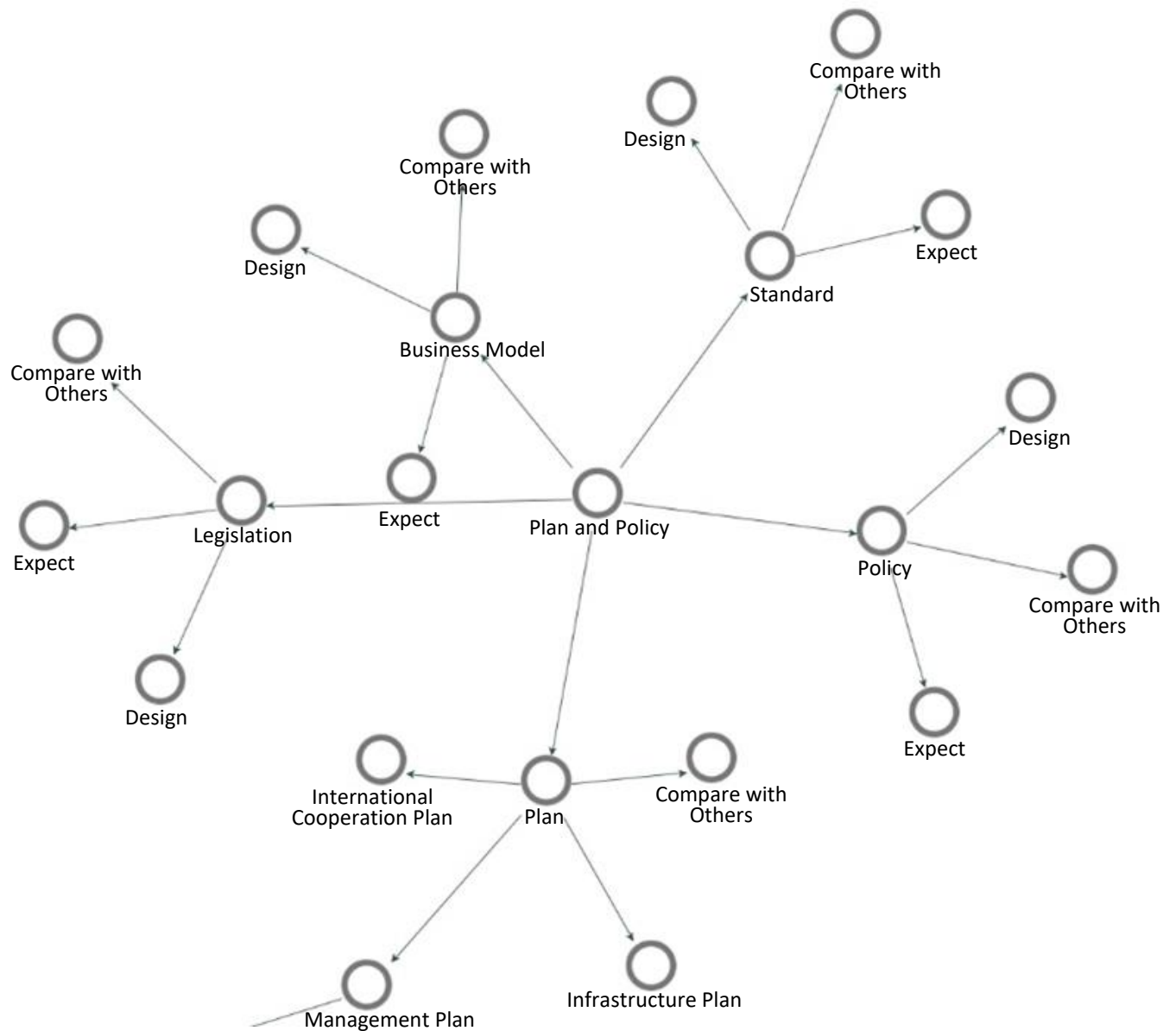


FIGURE 4.3 Example of the node map and relationship

4.5.4 Initial Data Analysis

Initial data analysis is a study at an early stage to inspect the collected data and filter the input data for the subsequent research process step. This analytical technique is conducted separately from the research analysis programme to ensure the efficiency

of the research in the next part and reduce the risk of mistakes or misleading outcomes.

Data for Analysis

Data employed during the initial data analysis is from the first data assemblage. In pursuing the matter of CORS, semi-formal engagements were hosted to collect viewpoints from organisations that partake in these activities. This data combines gestures and voice expressions. Thereby, the initial exploration was performed on the interview data to address the interconnection between them.

4.5.5 Interview Data Analysis

Interview data analysis is the main procedure to perform an investigation of primary data collected in Thailand.

Explanation of the findings congruency

Qualitative data analysis using a pattern-matching strategy to compare theoretical models and empirical data needs to develop the conceptual framework before the scoring stage. This study predefined the codes based on the factors influencing collaborative innovation in the public sector. Those conditions were generated from the literature review and used for data grouping. Within the scope of this study, the analysis is purposive to examine how and why Thailand has not successfully alleviated the uncoordinated circumstance on CORS between government organisations. As a result, the following initial conceptual framework is introduced to justify the consistency of the outcomes from this analysis, which will lead to the reasoning explanation.

1. Ownership and governance: This element looks at the responses related to the ownership of CORS assets and the manipulation of those assets. It is to determine overall perspectives on "*Whether or not the separate ownership and management of CORS is a barrier to CORS collaboration in Thailand.*".
2. Power asymmetries: This topic aims at the balance of the exertion of authority. The attitudes to the exercise of power associated with the CORS will be examined to determine "*Whether or not the unequal power influences the CORS collaboration in Thailand.*".
3. Interaction processes and supporting technologies: This point concerns the procedures in relation to CORS implementation and CORS-related technologies. It will use the individual's orientations to measure "*Whether or not the lack of proper procedures, resources, and relevant technologies affect the CORS collaboration in Thailand.*".
4. Setting direction of collaboration: This constituent lays stress on the establishment of the collaboration settlement. The person's worldviews will be captured to assess "*Whether or not the unavailability of effective guidelines and legislation impact the CORS collaboration in Thailand.*".

This examination thoroughly perused verbal and non-verbal cues by the exchange attendants and the professionals. Further, the content analysis technique was taken to perceive the respondents' positions.

Data for Analysis

Data used in a detailed examination of the elements of Thailand's CORS originated from the first data collection. Primary data gathered from the scholars and staff working for the government and participating in the stipulation of CORS are the inputs of the insight. This data is verbal and nonverbal communication forms transcribed from the interviews in June – July 2018.

1. **Focus group interview data** was acquired from separately organised discussions of six government agencies involved with Thailand's CORS.
2. **Expert interview data** was obtained from three academics who specialised in GNSS technology from three universities in Thailand.

4.5.6 Timeline Data Analysis

Timeline data analysis is in the follow-up stage to examine primary data gathered in Thailand after the analysis of interview data collected earlier has been completed.

Data for Analysis

The second research data assembly was delayed as a consequence of the global pandemic of coronavirus disease 2019 (COVID-19), which restricted face-to-face interaction. This meant that, for both the researcher and the participants, a meeting was not possible. In that event, this exploration exploited data accumulated from the representatives of the organisations that participated in the first data collection. The comments from five representatives out of six organisations were gradually aggregated via online chats from 2020 to 2021.

4.5.7 Comparative Data Analysis

Comparative data analysis is the cross-analysis of the scrutinisation of Australia and Thailand.

Data for Analysis

The comparative data analysis deliberately looks at contrasting outcomes from the syntheses of a number of theories explaining the phenomenon through diverse aspects of the partakers. The study has persevered by making use of the out-turns from the earlier stages. In so doing, the sources from case studies and interview data analysis results are inputs for comparison.

4.5.8 Analysis Support Tool

Case study analysis is a technique that does not have structural formulas or specific rules for analytic protocol, as opposed to quantitative study. An analysis of the considerable size of written resources in processing case studies could then have faced the complexities in handling the materials. To this point, the use of computer-assisted tools would be helpful in arranging codes and themes of qualitative data (Yin, 2009).

Computer Assisted/Aided Qualitative Data Analysis Software (CAQDAS) is a tool assigned for research data analysis to achieve a retrieval of diverse research data types with both primary and secondary data. NVivo is a client-based software package that supports qualitative and mixed-methods research. It can store and organise qualitative open-ended questions and interviews, categorise and analyse data attributes, and visualise and discover further exploration (QSR International, 2018). As a result, NVivo is an appropriate CAQDAS tool to assist with the data analysis in this research. Therefore, NVivo software was used to collect content related to themes in the data under the identified codes. Also, several functions were employed to explore the links between them.

4.5.9 Language Use in Data Analysis

In some types of qualitative research, namely discourse analysis, the language that is used to impart information and share feelings is significant due to its relation to ideological or societal impacts (Thorne, 2000).

In response to the GNSS reference station technology study based on the range of evidence and interviews assembled in Thailand, it is important to decide the language of input materials to use for the analysis. Since the language of communication and documentation is Thai, all research data sources from Thailand are in Thai. As a native language, Thai people use the Thai language daily to communicate with other Thai people. It is not only the nature of the human exchange of ideas that is genetically inherited but also the straightforward way to express their actual thoughts. Some terms may have an identically established background that shows the experience or unique history of the speaker. Language translation could lose those signs hidden behind the words spoken. As a result, the researcher decided to use Thai in the analysis without translating them into English. All research data, both the documents and narrative text transcribed from the interviews, were written in Thai. However, the theme coding was labelled in English to categorise the Thai language data sources into English themes. The brief data materials from note-taking were translated into English for initial data analysis.

On the whole, the relationship between research questions, resources, and analytical approach for this study can be seen in TABLE 16 below.

TABLE 16 The relationship between research questions, resources, and analytical approaches for this study (Source: Author's own research)

Research Question	Resource	Analytical Approach
RQ1. How can we evaluate the success of technology management?	Literature	Literature review
RQ2. How has GNSS CORS technology management between government organisations in Australia been done?	Document	Case study: Within-case analysis Content analysis: Pattern matching
RQ3. How has GNSS CORS technology management between government organisations in Thailand been done?	Document Interview data	Case study: Within-case analysis Content analysis: Pattern matching
RQ4. How does collaborative innovation alleviate the lack of GNSS CORS technology sharing between government organisations in Thailand problem?	Interview data	Comparative analysis
RQ5. What guidance should have been recommended for managing the GNSS CORS technology in Thailand?	Interview data	Comparative analysis

Summarisation of the research design

Based on the above-described research methodology, this study's overall components and process flow can be illustrated as shown in FIGURE 4.4. This diagram concludes the activities in growing this research project, starting from the list of theories used in developing the theoretical framework of this study. The set of research questions is displayed afterwards, followed by the data collection details and data analysis techniques that were employed in this study. After that, the diagram shows the research findings that are the output of the analytical work. Then, the findings' themes are listed to summarise the relational outcome of the study. Finally, it produces a collaborative innovation framework as the ultimate result of this study.

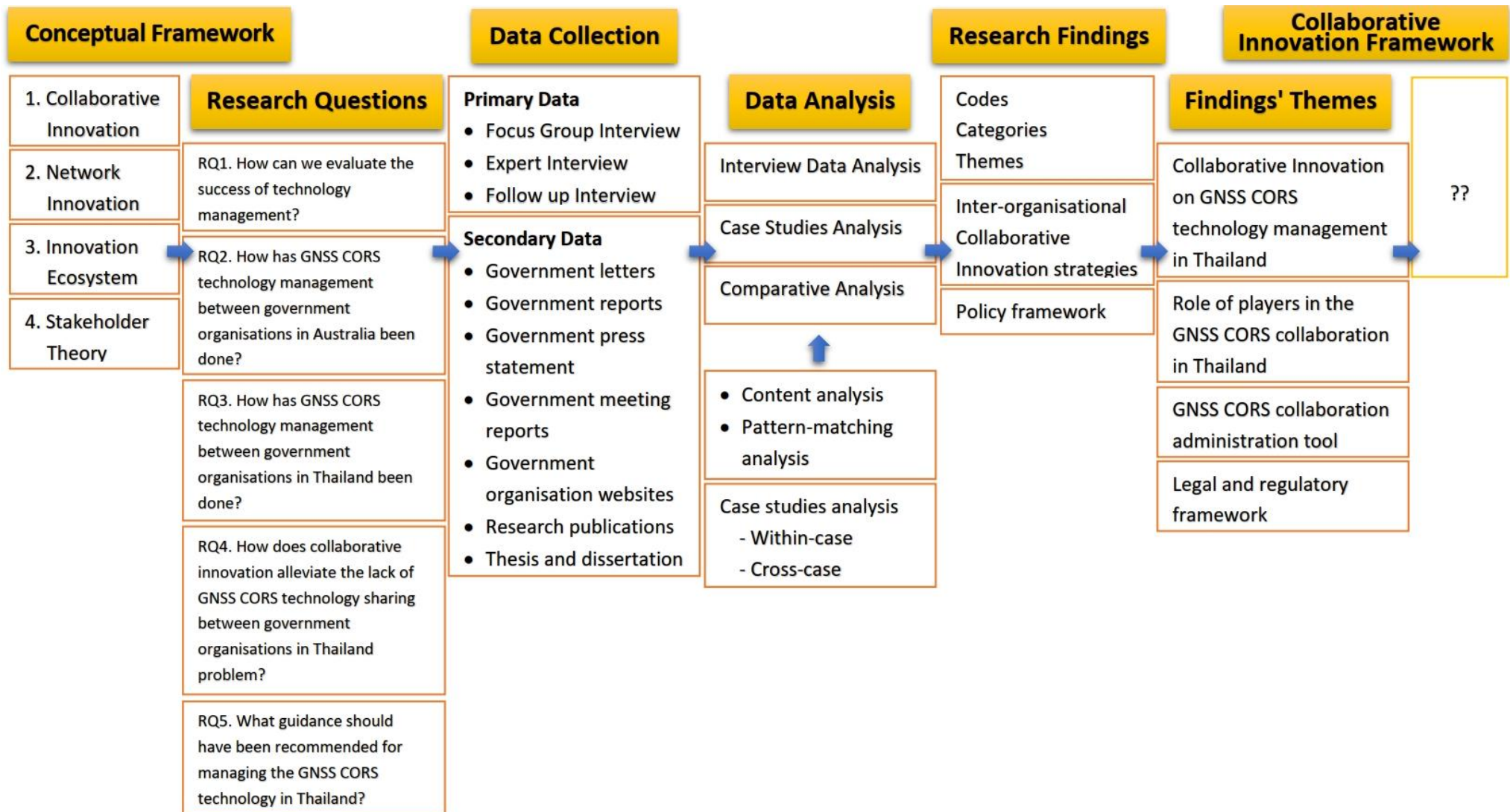


FIGURE 4.4 Process flow of research study (Source: Author's own research)

4.6 ETHICAL STATEMENT

Denscombe (2010) stated that research ethics are the important apprehensions to the pragmatic direction, which considers the rights and risks of participants as a priority. Akhavan *et al.* (2014) introduced ethics in management to enhance the performance of decision-making, together with morality and responsibility. This investigation is certain to minimise the possibility of harm to the research subjects. Therefore, the ethical theory could be used to augment the fundamental structure of decision analysis to handle ethical issues. The investigation maintains the anonymity of the participants and assumes aliases to identify their names. It is ensured that all viewpoints from each of the group members remain confidential. The moderator did not ask a question that was vulnerable and asserted that the investigation did not use the discussed views, which were likely to be sensitive. Some questions might cause discomfort to participants during a discussion session; however, the research design allowed them to refuse to answer or delete their opinions should they wish to. The questions were asked clearly to avoid misunderstandings and vague feelings. Members continued the discussion without the moderator's interference to guarantee that the subject's perspectives were not affected by the researcher. Moreover, the transcriptions were arranged carefully to prevent misinterpretations.

4.7 CHAPTER CONCLUSION

Collaborative innovation is a set of theories and methodologies to enable the capacity enhancement of a particular phenomenon (Rösler, 2015). A model for managing collaborative innovation is composed of three levels: prepare, partner and pioneer. According to the research design, the perspectives of related people in nine organisations were collected through interviews, and Australia's coordination and infrastructure deployment evidence will be gathered as a case study. The synthesis of interviews and case studies was consequently organised and compared to resolve the collaborative innovation in GNSS CORS management issues to foster the national plan development in Thailand.

In the next chapter, the developed framework will be applied to analyse the collected data in line with the research design. The success evaluation framework will be adopted to assess the accomplishment of the GNSS CORS implementation project. Following this, a within-case analysis of case studies in both Australia and Thailand will be conducted. Through this approach, the data analysis will highlight the performance of the technology management, the implications of how it was carried out, and the underlying sources of its success or failure. This analysis will be guided by the principles outlined in the research design and supported by the data gathered throughout the study.

Chapter 5

WITHIN-CASE ANALYSIS

As a research method, case studies are commonly applied in various disciplines, both in natural science and social science. According to Yin (2009), a researcher should devise a case study research design, including data collection, handling, and analysis in response to the research questions and with a comprehensive understanding of its strengths and constraints. Moreover, case studies are often used to investigate "how" and "why" questions of contemporary events without access to or control over the behaviours. As previously mentioned, the complications in CORS management in Thailand share some similarities with those observed in Australia, making both countries central to this research. Data collection was carried out for both countries using different methods, with a particular emphasis on Thailand, complemented by revealing explorations from Australia, where the management of CORS challenges appears to be successful as supported by insightful studies conducted by numerous researchers. Additionally, further research on GNSS and other geospatial technologies was gathered from Australian publications, contributing significant data relevant to this study. An investigation of the management of GNSS CORS technology in Australia and Thailand is underpinned by a case studies approach; therefore, these explanatory questions can be adopted to examine this study as follows:

"How has the GNSS CORS technology management between government organisations in Australia been done?" and "Why has the GNSS CORS technology management in Australia been done successfully?"

"How has the GNSS CORS technology management between government organisations in Thailand been done?" and "Why has the GNSS CORS technology management in Thailand not been done successfully?"

This chapter presents the case studies analysis findings for the Australian and Thailand cases. Throughout this study, data for Australia is primarily sourced from existing research conducted by other scholars, whereas the Thailand case study relies mainly on primary data collected specifically for this research by the researcher. The study explains what has happened or is happening in Australia and Thailand. The timeline of their occurrence is included. Also, this chapter describes how they developed over time. The justification for the completion of each case has been determined according to the developed success evaluation framework. Accordingly, the findings from the analysis of data collected through focus groups, expert interviews, and follow-up interviews will be presented.

5.1 SUCCESS EVALUATION FRAMEWORK

Based on the success measurement concepts (Cooper and Kleinschmidt, 1987; De Wit, 1988; Pinto, 2004), in regard to this study, the success evaluation framework is an outline adopted for measuring the outcome of the technology implementation. It is applicable within the context of any technology management assessment, particularly in positioning-related efforts. The evaluation has taken both qualitative measures and quantitative measures into account to avoid bias and omission of evidence and provide a more precise and reliable model. As stated in an investigation of qualitative evaluation of the successfulness of the best practices in the business process (Reijers and Mansar, 2005), the designed model was used to consider the influence of the best practices over four elements: flexibility, quality, time, and cost. A link between the qualitative and quantitative measures was formed.

The literature on GNSS technology utilisation is systematically surveyed. The reviews have been taken on the extent of GNSS technology focus, either the applications exploiting navigation satellite information or ground augmentation networks. This academic analysis of substance has searched for materials that specifically have a bearing on the final result of implementing such positioning technology in multiple countries. Both favourable outcomes and disappointment have been brought into consideration to capture the outline of the measuring scale. In particular, the historical exploration of the national positioning scheme in Australia presented the attainment of the endeavour in handling GNSS and relevant positioning technology. Thus, it is a valuable resource for learning and capturing the main idea. With this in mind, the evaluation framework of success initiated for qualitative assessments of this research settled on four prime constituents: technology, human resources, finance, and policy. In connection with this, profit and other benefits have been valued quantitatively.

Below are the criteria for assessing the Australian GNSS CORS collaborative management achievement (ANZLIC, 2014a; 2014b; 2018; 2020a; ASC, 2012; Bastrakova *et al.*, 2019; Box *et al.*, 2015; Cranenbroek *et al.*, 2006; Denham *et al.*, 2006; Geoscience Australia, 1992 in Hausler, 2014; Hale, 2007; Hale *et al.*, 2005; Hausler, 2014; Hausler and Collier, 2013b; Higgins, 2008; ICSM, 2007; 2014; Janssen *et al.*, 2011a; Rizos *et al.*, 2004; Roberts, 2009; Roberts and Stanaway, 2009; Roberts *et al.*, 2004). The study will use the same measures to evaluate Thailand's ongoing GNSS CORS endeavour.

Qualitative measures

1. No data centre
2. No central tool for data centre
3. No role and responsibility description
4. No central unit for CORS management
5. No co-planning on CORS investment
6. No maintenance, renewal, or expansion budget
7. No resource sharing
8. No legal procedure
9. No strategic plan

10. No business model
11. No policy
12. No CORS standard (infrastructure, data, technique)

Quantitative measures

1. Non-profit
2. For-profit

Success evaluation framework

According to GNSS CORS elements in FIGURE 3.7, various points of concern are suggestive of CORS technology involvement. The evaluation framework for measuring the achievement of technology management in a general background can also be adopted from these critical indications, particularly those within the inner circle. In addition, the outcomes of a study in GNSS CORS and related technology organising in Australia and other positioning technology management in many countries have a matching correspondence with such CORS elements. As a result, the success evaluation framework, either qualitative or quantitative models, will be composed of technology, human resources, finance, and policy, akin to CORS components in FIGURE 5.1.

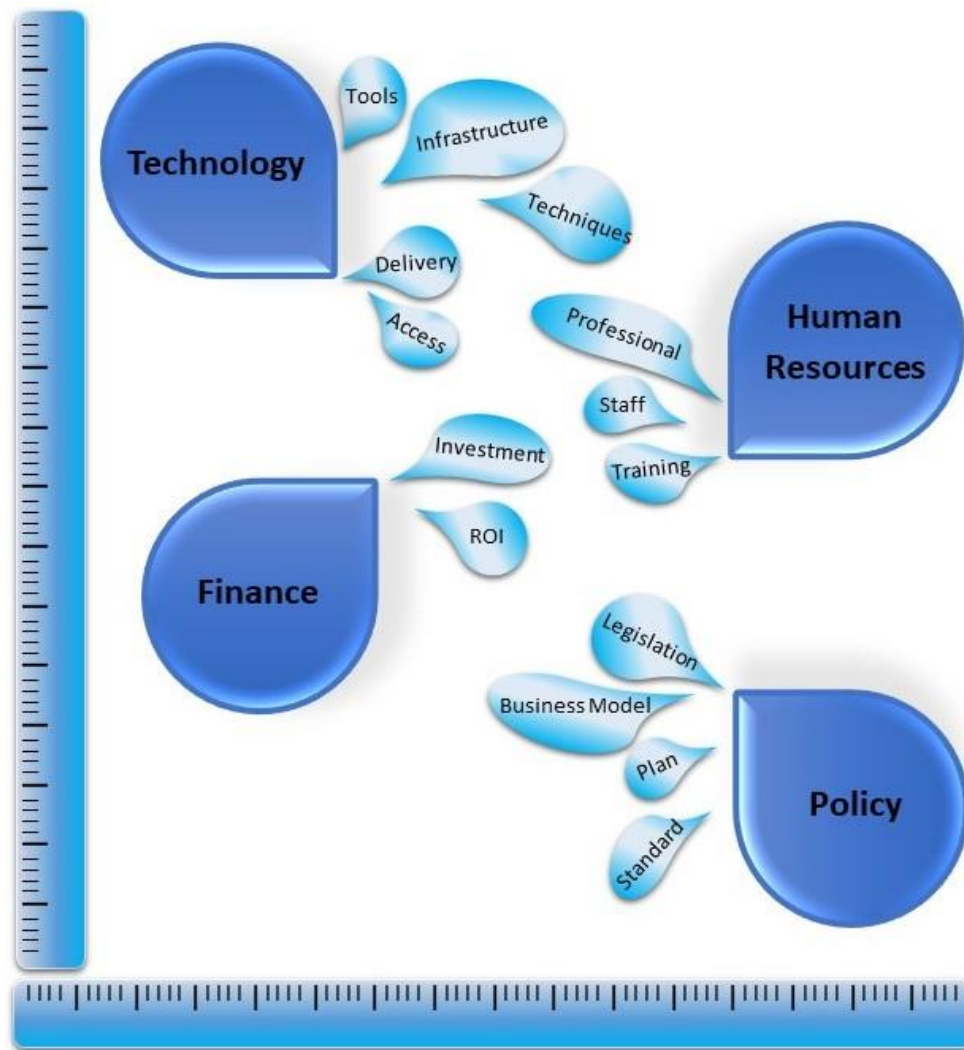


FIGURE 5.1 Success evaluation framework (Source: Author's own research)

Furthermore, a more in-depth analysis will be conducted later in this study, following the factors outlined in the outer layer of the theoretical framework. This will ensure a comprehensive evaluation of the key elements influencing CORS implementation and provide deeper insights into the challenges and successes observed.

5.2 OVERVIEW OF AUSTRALIA CASE STUDY

The advent of Global Navigation Satellite Systems (GNSS) technology in 1978 (GPS.GOV, 2020) has made positioning applications and new creative possibilities far more advanced. Even though the early operating system provided low-quality location data, supplement technology like the augmentation systems can alleviate this problem. Australia installed the first Continuously Operating Reference Stations (CORS), which is a ground augmentation system, to improve satellite data efficiency in 1992 in Bathurst (Janssen *et al.*, 2011a). After that, multiple government and private operators established CORS networks for their internal use (Geoscience Australia, 1992 in Hausler, 2014; Roberts, 2009; Roberts and Stanaway, 2009; Roberts *et al.*, 2004). The heterogeneity of CORS owners has led to a complexity of duplicated

infrastructure, over-investment, and a lack of service standards (Hausler, 2014). Consequently, duplicate infrastructure components, non-homogenous systems, and the lack of nationwide access to CORS networks problems were brought to review in 2005 (Cranenbroek *et al.*, 2006; Denham *et al.*, 2006; Hale, 2007; Hale *et al.*, 2005). The unified CORS network then became the primarily evaluative thought through collaborative efforts (Higgins, 2008). Since the research methodology for the Australian case study is based on secondary data analysis, the data were fundamentally collected by other researchers; however, for this study, they have been re-analysed by the researcher. The findings from the Australian case are summarised in the following sections.

5.2.1 About Australia

Australia is a large island that has a predominately flat, desert coast terrain. This extensive land has excellent topographical stability and is situated in the southern hemisphere, inevitably deriving tremendous data from the navigation satellites. It lies within the GNSS "hot spot" extent. Taken up with the political environment, Australia has been reflected that it is apt for ground reference station placing (ASC, 2012). Conversely, the broad geographical areas have challenged the CORS networks' closeness in Australia (Hale, 2007). In the same way, the crowdedness of the population fluctuates with geographical distribution. Resultantly, the communications infrastructure deficiency is a striking barrier to CORS service propagation in the city zone (Feng *et al.*, 2007). Empirically, geography was one of the facets compulsory for multivariate statistical analysis inclusive of social, environmental, and economic factors. This assessment has been conducted within the Administrative Boundaries theme (ANZLIC, 2014a; 2014b). Contemplating the topography has considerable influence on the activeness of the country. Furthermore, spatial information is a semantic essentiality for this. The GNSS network is, therefore, expected to continue its operation.

As of August 2013, there were approximately 325 GNSS base stations, excluding shared sites, that various government agencies owned throughout Australia. Each jurisdiction contains both state-owned sites, which had been funded by Geoscience Australia (GA) and AuScope and other Responsible Authorities (RAs) sites that several government organisations had independently funded. Contrarily, there were, at a minimum, forty-nine CORS stations in the Australian Capital Territory (ACT), New South Wales (NSW), Queensland (QLD), and Victoria (VIC) that private organisations owned. These privately owned CORS are located in the same area but have not joined government-owned reference networks (Hausler, 2014).

Many types of distributors individually marketed the GNSS network services, termed Service Providers (SP), Data Service Providers (DSP) and Value-Added Resellers (VAR). These commercial strategies varied according to each operator's conditions and jurisdiction requisitions (Hausler, 2014). In the Australian positioning service, SPs are the governmental or private CORS owners that vend real-time GNSS data services. At one point, all government SPs streamed their services processed by the same commercial software, while industry SPs offered services generated from varying

sources. The private DSPs – agricultural dealers in particular – delivered original data from CORS operators without any improvement. Still, they continued to sell them, along with turnkey products such as tractors. Whereas the VARs, the private companies that licensed data from either CORS owners or third-party SPs, can modify data and resell them as their own solutions.

The independent operation and commercialisation of CORS had been taken into account for years by multidiscipline experts, variegated background players, and multitudinous organisations. Rizos *et al.* (2004) demonstrated that the difficulty of integrating CORS networks from multifarious owners and technologies was another challenge that needed to be evaluated. As the united systems were necessary for seamless service supply, this issue was initially considered "network research", and the Cooperative Research Centre for Spatial Information (CRCSI) was eventually taken forward.

5.2.2 Conclusion

Attempts to eliminate the GNSS reference network duplication problem and provide a borderless unified service in Australia have been underway for years. This ambitious project has now begun to prove itself.

In 2010, Australia permitted the official acceptance of the National Positioning Infrastructure (NPI) policy on the national scale and made public by ANZLIC (ANZLIC, 2010; Hausler, 2014). Later, in 2012, the Australian Spatial Consortium (ASC) published the Australian Strategic Plan for GNSS (ASC, 2012; Hausler, 2014). Later, in 2013, the National Positioning Infrastructure (NPI) Plan was adopted under the deliberation of cross-section stakeholders (Geoscience Australia, 2015a) and contributed an essential guide to Australia's Satellite Utilisation Policy (2013). The NPI Plan then developed a National Positioning Infrastructure Advisory Board (NPI-AB) in 2014 to prepare the strategic guidance and recommendation for NPI implementation to Geoscience Australia. The Board consists of Geoscience Australia as the Chair & Secretariat and ten professionals from PNT-related organisations in Australia and New Zealand, both in the public and private sectors. Such organisations are Austroads, Land Information New Zealand, RMIT University, Intergovernmental Committee on Surveying & Mapping, International GNSS Society; QLD Department of Natural Resources & Mines, Australian Maritime Safety Authority, NovAtel Inc., Civil Aviation Safety Authority, Precision Agriculture, and Position Partners.

The Multi-Tiers strategy was finalised in 2014 by the ICSM. This intensified effort was made to cope with guidelines, proper practices and standards for the CORS establishment and operation (Hausler, 2014). That was conducive to the clarity of the ICSM Standard for the Australian Survey Control Network Special Publication 1 (SP 1) Version 2.1 (ICSM, 2014), and the GNSS CORS accuracy and integrity standards were created respectably (Burns and Sarib, 2010). The SP 1 scheme was published by ICSM and the Permanent Committee on Geodesy (PCG) – a Geodesy Working Group within ICSM that comprises technical specialists from each jurisdiction to coordinate geodetic

projects in Australia and New Zealand. It came up with six guidelines, including Guideline for Adjustment and Evaluation of Survey Control v2.1., Guideline for Continuously Operating Reference Stations v2.1., Guideline for Control Surveys by GNSS v2.1., Guideline for Control Surveys by Differential Levelling v2.1., Guideline for Conventional Traverse Surveys v2.1., and Guideline for Installation and Documentation of Survey Control Marks v2.1. As the previous version of SP1 in 2007 (ICSM, 2007) was abolished, the 2014 version has remained active since then.

The National GNSS CORS Infrastructure (NGCI) web map was launched to support CORS sites' metadata centralisation. This interactive online portal is an aggregate source of location and relevant data of government-owned and industry CORS systems. Whilst the others, such as the APREF (Geoscience Australia, 2020a) and the NGRS web map (Geoscience, 2020c), which had preceded the equivalent spatial online service, are likely to expose data of the CORS operated by governments solely (Hausler and Collier, 2013b). Nevertheless, the prototype NGCI web map was developed by a private company, which is the CRCSI ally, and hosted on their server. The NGCI database was also created to classify third-party SPs that license data from governments and non-government operators using the metadata at a definite node (Hausler, 2014).

The Foundation Spatial Data Framework's Location Information Knowledge Platform (the FSDF-LINK) is a governed, online, dynamic, cloud-based analysis and discovery tool (ANZLIC, 2018; 2020a) implemented from the findings conclusively settled in the ANZLIC and ICSM meetings in October 2016. The FSDF-LINK digitally displays the national datasets combined from each jurisdiction and their out-turns. It shows FSDF's relevant information, from traditional metadata to marketing data, to benefit policy development and supply chain work planning. The FSDF represents spatial data in the company with economies across Australia and New Zealand to the National Spatial Data Infrastructure (SDI). This activity was held following the ANZLIC (2014a) plan to make a "common asset" of spatial information to decrease infrastructure duplication, fulfil potentials, and increase supply chain performance (Bastrakova *et al.*, 2019; Box *et al.*, 2015).

Above and beyond those positioning enablements, Australia has continued forward. A new web portal for the GNSS data centre was available in June 2020 (Geoscience Australia, 2020d). Under the administration of Geoscience Australia, this international data centre is purposed to support the GNSS CORS products over the Asia-Pacific region for IGS and APREF projects. One new access point was announced in September 2020: the GNSS Data Repository website, a hub for multi-GNSS data; it can be retrieved via two accessible interfaces: FTP and a website. Likewise, a continuum of additional GNSS base station instalments to satisfy Australia's accurate positioning eagerness has been well underway (Geoscience Australia, 2020f).

The next target for enhancing positioning future in Australia, as well as international collaboration, is the regional Satellite-Based Augmentation System (SBAS). A new partnership development between Australia and Asia was announced in February

2020; this relationship has been made to jointly create the Southern Positioning Augmentation Network (SPAN) in the South Hemisphere (Geoscience Australia, 2020e).

5.3 MORE IN-DEPH AUSTRALIA CASE STUDIES ANALYSIS

The within-case analysis in qualitative research is an approach that can be used at the initial stage to emphasise an individual description of each case primarily. The attention on the case will be steered toward definite phenomena and processes inwards (Ayres *et al.*, 2003). This section presents an examination of the cases in Australia and Thailand, respectively.

5.3.1 Australian Case Study

Australia has made significant progress in developing CORS and positioning-related technologies through cooperative efforts both domestically and internationally. Since the Melbourne 2006 Commonwealth Games, where CORS technology was applied for counter-terrorism purposes, numerous collaborative initiatives have been established. These include the National Collaborative Research Infrastructure Strategy (NCRIS), the AuScope project, the National Geospatial Reference Framework (NGRF), and the Asia-Pacific Reference Frame (APREF). These initiatives have involved activities such as technical studies, research partnerships, strategic agreements, international standard setting, policy development, and business management. The cooperative nature of these efforts, which are detailed further in TABLE A – 10 and item C.1 in the Appendix, has been essential in advancing GNSS CORS technology in Australia and fostering knowledge sharing across organisations and countries.

The success of these cooperative activities is evident in the continuity of actions and investments in CORS implementation and applications. Following the initial success at the Melbourne Commonwealth Games, multiple organisations, both independent and collaborative, funded additional CORS infrastructure and research initiatives. These efforts focused not only on expanding the CORS network but also on addressing challenges related to positioning technology. In addition to domestic collaborations, Australia has worked with other countries on GNSS CORS advancements, such as data processing development with Singapore, natural hazard mitigation research with Japan, and geodetic datum projects with APREF. These international projects highlight Australia's commitment to leveraging partnerships for technological growth and problem-solving in positioning systems.

In the foundation of Global Spatial Data Infrastructure (GSDI), which is worldwide and openly performing the cooperative undertaking and knowledge transfer regarding spatial data management, the elements in relation to technology, data, delivery procedure, human resources, organisational activity, finance, policy, and standard are essential (Van Loenen and Kok, 2004).

Australia's GNSS reference network development engaged diverse arrangements and an assortment of stakeholders, making it imperative to evaluate whether these initiatives were effective. The success evaluation framework will be applied to analyse the effectiveness of these initiatives, as summarised in TABLE A-11 and detailed in item C.1 in the Appendix, which highlights Australia's activities and their alignment with theoretical frameworks. Besides, under the terms of policy and business model, some points also need to be considered: plan, standard, and legal. For instance, the National Positioning Infrastructure (NPI) Policy (ANZLIC, 2010), the service provider (SP) licensing strategy (Lim and Rizos, 2007), and the state and territory government CORS (Higgins, 2008). One of the theories that these applied to is that legal and policy issues are parts of the Spatial Data Infrastructure settings (Van Loenen and Kok, 2004).

Australia has made significant advancements in CORS technology through several techniques, tools and infrastructures, including the thick infrastructure model, NGCI database, TCAR approach, server-based and thin-client platforms, and FSDF services. These developments reflect the belief that innovation ecosystems are intertwined with technology platforms and socio-economic conditions (Gobble, 2014). In human resources, initiatives like ICSM's support for standards and information modelling, GA's provision of leadership for the NPI-AB, and the emphasis on engaging competent actors highlight the importance of skilled personnel (Diener, 2014). Financially, considerations of cost and return on investment are crucial, with estimates indicating over \$70M for CORS sites nationwide (AuScope Geospatial Team, 2008), \$152–206 million for agriculture in 2008 (Roberts, 2009), and an \$8.4 million over-investment in AuScope and ARGN sites (Hausler and Collier, 2013a). These financial aspects align with the understanding that economic factors significantly influence the enhancement of spatial data infrastructures (Van Loenen and Kok, 2004). Additionally, policy and business model considerations, such as the National Positioning Infrastructure (NPI) Policy (ANZLIC, 2010) and service provider licensing strategies (Lim and Rizos, 2007), underscore the value of legal and policy frameworks within Spatial Data Infrastructure settings (Van Loenen and Kok, 2004).

As discussed, the history of the moves in Australia shows the development of the attainment in GNSS CORS management they gained corresponds to the theories. In so doing, the theming of interrelation between key elements regarding theoretical proposition and the actual occurrence in Australia has been laid down. This conclusion could be considered alongside the following summaries.

TABLE 17 The qualitative measure considering an achievement in GNSS CORS development in Australia (Source: Author's own research, summarised from Section C.1 and TABLE A-11)

Issue	Resolution
No resource sharing	They have shared now.
No strategic plan	They have the Australian strategic plan for GNSS, which proposed NPI for providing services for PNT applications.
No policy	They have a positioning policy with the CORS network included (NPI Policy Framework)
No legal	They exert a force through the relevant ACT.
No role and responsibility	They created roles and responsibilities for each organisation through the NPI Policy Framework, for example, ICSM and ICSM Working Groups.
No CORS standard (infrastructure, data, technique)	They have now, e.g. Multi-Tiers, System of Systems, Client-Server
No central unit for CORS management	The established NPI Advisory Board (NPI-AB) consists of representatives from multiple organisations.
No data centre	They have now, e.g. NGCI database, SDI (FSDF)
No central tool for data centre	They built the data centre web portal, e.g. FSDF.
No business model	They have now, e.g., a licensing strategy.
No co-planning on CORS investment	They have now, through the NPI-AB.
No maintenance, renewal, and expansion budget	They have now, through the NPI-AB.

In explaining some kinds of studies, such as learning achievement and personal stipend, quantitative data could be noticeably supportive for qualitative case studies research. These statistical data may be of relevance to the conduct of the upshot from the evaluative case study or the analysis unit established within the more generous case study. As a result, the analysed numerical data should situationally be combined with the qualitative data to provide a better explanation of the case study (Yin, 2009). To obviously affirm the successfulness of CORS network preparation in Australia, some figures have been taken into account. The table below illustrates the statistics of the outcomes from the GNSS base station implementation in Australia.

TABLE 18 The quantitative measure considering an achievement in GNSS CORS development in Australia (Source: Author's own research)

Strategy	Outcome
Preventable costs	Focus on keeping expenses incurred in the chosen scenario less than other options rather than generating a financial advantage
	Queensland (Higgins, 2007; 2008) • Increase 30% mining operations productiveness • Decrease 40% physical harm idle time • Decrease 30% construction time span • Decrease 10-20% in agricultural expenditure • Decrease 10% in transportation economising
Profit	Financial gain allocation for the network overheads (Janssen <i>et al.</i> , 2010; 2011b)
	• \$58B from GNSS CORS in Australia's gross benefit (ASC, 2012) • \$800M to \$1.5B per year in construction, farming, and mining (Allen Consulting, 2008; Geoscience Australia, 2018b) • AUD\$73B to AUD\$134B by 2030 in the precise positioning industry (ASC, 2012) • \$32B to \$58B in agriculture, mining, and civil solely (Allen Consulting, 2008; Geoscience Australia, 2018b)

Conclusion

The outcomes of the Australian case study, as demonstrated above, show that Australia is successful in terminating the CORS manoeuvre complication. Both the simultaneity and sequentiality of the moves that led to the optimum conclusion are major strengths of the Australian schemes. Further, the cooperativeness of the stakeholders and the research communities is crucial to Australian CORS management's success.

5.3.2 Success Evaluation Result

This study examines the implementation of CORS technology in Australia through a success evaluation framework. The evaluation considers both qualitative measures—such as the absence of a data centre, a central tool, and clearly defined roles and responsibilities—and quantitative measures, including preventable costs and profit margins. Secondary data from previous research was incorporated into this evaluation. The results demonstrate the success of CORS implementation in Australia, with all measures indicating positive outcomes (as shown in TABLE 19).

TABLE 19 Evaluation results of CORS implementation success in Australia (Source: Author's own research, developed from TABLES A-10, A-11, and A-13)

Type of measurement	Issue	Evaluation Result
Qualitative	Resource sharing	Successful
	Strategic plan	Successful
	Policy	Successful
	Legal	Successful
	Role and responsibility	Successful
	CORS standard (infrastructure, data, technique)	Successful
	Central unit for CORS management	Successful
	Data centre	Successful
	Central tool for data centre	Successful
	Business model	Successful
	Co-planning on CORS investment	Successful
	Maintenance, renewal, and expansion budget	Successful
Quantitative	Preventable costs	Successful
	Profit	Successful

5.4 OVERVIEW OF THAILAND CASE STUDY

Navigation satellite signals have profited since the 1980s, mainly in the geodesy and surveying fields (Rizos and Satirapod, 2011; Stone, 2006). The appearance of GNSS CORS technology in 1994 pressed on and tried to fill in gaps among high-precision positioning products (Stone, 2006; 2020). In Thailand, the first reference station was established in 1996 by the Department of Public Works and Town & Country Planning (DPT). Over time, dozens of government and non-government organisations have sited their CORS stations (Charoenkalunyuta *et al.*, 2012; Rizos and Satirapod, 2011). The CORS has been set up for diversified purposes by disparate organisations, with the restricted conditions of cross-boundary shareability consent. Correspondingly, the independent ownership and internal-based utilisation adversely affected the void of inter-organisation data sharing and the duplication of expenditure. To resolve these issues, the Thai government brought the integration of CORS operators to account (National Geo-Informatics Board, 2017; Rizos and Satirapod, 2011). This study highlights the developments in CORS technology in Thailand, with the research methodology for the Thai case study centred on the analysis of primary data collected by the researcher. Various data types and collection methods were employed, including focus groups, expert interviews, follow-up interviews, and document analysis. The overview of findings from the Thai case is summarised in the following sections.

5.4.1 About Thailand

Thailand is a country in Southeast Asia that has mixed ecosystems. It features high mountains in the north and west, where it shares a border with Myanmar. There is a

fertile plain in the central and a dry upland plateau in the northeast, along with a great river in the east, where the country's borders with Laos and Cambodia lie. The stalky and hilly southern sits between the Gulf of Thailand and the Andaman Sea; it connects with Malaysia at the southernmost. Thailand can reach omnifarious GNSS satellite information as it is slightly north of the Equator. However, topographically, a forested terrain in the northern, western, and southern is obstructive to the GNSS network infrastructure. The elemental troubles of the CORS sites in the mountainous tree-covered area are signal obtainability and internet connection. The wood is an obstruction to signal spread; moreover, it cannot depend on landline internet in such a region where mobile internet is unaccommodating.

In 2020, Thailand had 235 CORS stations from four authorities. Details are updated as follows: the Department of Public Works and Town & Country Planning (DPT) has 15 stations, the Department of Lands (DOL) has 134 stations, Hydro and Agro Informatics Institute (HAII) has six stations – one of them has been activated by National Metrology Institute (Thailand) (NIMT), and the Royal Thai Survey Department (RTSD) has 80 stations. In addition, many organisations in the academic, public, and private domains have extended GNSS networks. The last set of additional DOL CORS was installed in 2021, an utterly comprehensive fulfilment of the DOL GNSS network. Aside from this, no other reference station has been sketched out to add to the present system (Charoenkalunyuta *et al.*, 2012; Rizos and Satirapod, 2011; Srichai *et al.*, 2018; 2019).

The perspectives spanned by the CORS operators, scholars, users, and relevant clusters are the same way that the number of base sites is considered adequate. Still, it is unsatisfactory in across-boundary service allocation. The continuation of discussions about the permanent GNSS station unity has affected the forming of the CORS state commission. Furthermore, various aspects of CORS components have been assessed in Thailand.

5.4.2 Conclusion

As concluded by Ansell and Gash (2008), the pivotal factors that have critical impacts on collaborative endeavour achievable outcome are related to face-to-face communication, trust development, and commitment and sharing relationship building. These variables are important for stakeholder participation and engagement. While power asymmetry and resource imbalance are significant in conjoining different levels of the potential of each stakeholder, leadership is crucial for manoeuvring mutual interaction. Moreover, the institutional design, which is a series of apt stratagems for transpiring the actual procedure, is important for setting in motion the legitimacy of the collaboration protocols and rules. These relevancies are rational to "collaborative governance", which includes both public and private sectors' co-creation.

Taking note of the Thai collaborative movement on CORS networking, the balance of power and resources has been considered. Nonetheless, the RTSD has a vital role-play

in this joint work; they have been vying for a place in the national data centre. As a result of their dominance over others, either their resource readiness, service promptness, or abilities in commanding and controlling, they are accepted to be the leader of the collaboration. In the sight of technology capability, the current equipment, facilities, and techniques are in satisfactory condition. Still, the partners of these pooled activities are concerned about their existing infrastructure becoming obsolete in the near future and the recommencement of those instruments. They then expect the success of the National CORS Data Center to support the technology exaggerating, reviving, and exalting. Concomitantly, a web interface has been introduced as a portal for governing the CORS network and distributing services. This tool was suggested for the manipulation of data, analytics, and user control.

The National Subcommittee on GNSS Network is a consensus-oriented decision-making partnership towards the CORS station management that the National Geo-Informatics Board instituted in 2017. The Subcommittee held the meetings to share ideas about the GNSS CORS implementation between the Thai government organisations and international coordination. Nevertheless, encouragement from abroad has been underway between authorities and foreign countries rather than between the Subcommittee and those countries. One of the concrete examples of cooperation is the commitment between Thailand and Japan, which had already signed for the MOC on the Establishment of the Integrated Data Centre in 2017. However, the sponsoring of finance and adepts has not happened yet because of the recent Coronavirus pandemic.

5.5 INITIAL ANALYSIS OF PRIMARY DATA

This study focuses on the development and management of CORS technology in both Australia and Thailand; however, it primarily relies on secondary data for the Australian case study. Consequently, primary data is used exclusively for the Thai case. In the early stages of the research design, understanding the nature and consistency of observational data is crucial. The initial preparatory measures play a key role in shaping the planning and data collection process. Therefore, conducting this preliminary analysis of primary data is essential for guiding further analysis and refining the second data collection phase.

The procedure of analysis regarding the seven criteria of Krueger (1994) and Rabiee (2004) has been taken for data interpretation. It is to comprehend the connections between the quotations from the texts or speeches and capture relatedness between data. The primary data from focus group interviews and expert interviews, specifically gathered for this research to examine CORS implementation in Thailand, can be analysed based on the following criteria:

1. Consider the actual words used and their meaning

The term "business model" was used to indicate a framework for collaboration, setting rules and guiding intergovernmental activities, including policy and law.

2. Consider the context

Although not raised by the researcher, participants highlighted the importance of CORS technology and its potential to foster collaboration and expand the GNSS network.

3. Consider internal consistency

Most participants maintained their initial views unless new insights from experts or leaders shifted their opinions, showing consistency and occasional adaptability.

4. Consider the frequency and extensiveness of comments

The term "who" frequently appeared in discussions, reflecting the need to clarify leadership and responsibilities in CORS collaboration, with many organisations eager to participate.

5. Consider the intensity of the comments

Prominent organisations strongly supported collaboration but could reconsider if it lost relevance, while smaller units valued participation for its shared benefits despite limited resources.

6. Consider the specificity of responses

Participants' experiences shaped their input, with some referencing Japanese strategies or suggesting alternatives like cell-based technology while collaborating toward shared goals.

7. Find the big ideas

Breaks in discussions allowed participants to step back, evaluate the broader picture, and craft well-considered, effective plans of action.

The result of the interview data capturing shows that the respondents were concerned with some identical directionalities concurrently with some controversial issues raised to discuss. Analytically, the overall discussion placed great emphasis on the following:

1. Whether public collaborative innovation relating to GNSS technology will come into effect?

Cross-agency collaboration focus will be not only on convening but also on engaging the multiple stakeholders in making the decision to solve the problem creatively (Crosby *et al.*, 2017). Collaboration among Thai government agencies is challenging due to differing views, unclear policies, and volatile government changes. Respondents stressed the need for laws, a policy framework, and clear plans to ensure effective cooperation for CORS management.

2. Which government agency (between the one that has the maximum number of assets and the one that has core responsibility for state surveying) should be the project leader?

According to Crosby *et al.* (2017), using a collaborative innovation lens to foster public value creation needs four particular leadership roles: sponsors (political authority), champions (informal authority), catalysts (informal or formal authority), and implementers (uncertain processes). Two options are debated: DOL, with the most GNSS base stations, or RTSD, which has strong political connections and national positioning authority. Most interviewees favoured RTSD for its influence and ability to drive project success.

3. Which organisation should be the national data centre?

The interchange of resources strategy should be applied together with the pluricentric network cooperation to improve quality and escalate into a full-scale efficacy of the state policing and service distribution. The centrality and accessibility of resources and connections among actors are correspondingly principal to public value creation (Sørensen and Torfing, 2017). The choice is between a government body with authority to manage CORS commercially or RTSD, which is already seen as a central partner. However, doubts remain about RTSD's ability to generate financial returns from public assets.

4. What should be the shape of the cooperation design?

Public administration theory draws attention to a competent administration, reasonable judgement with predictability, certain regulations, and hierarchical authority over public governance (Sørensen and Torfing, 2011). Effective collaboration requires legal agreements and formal resource-sharing frameworks, like MoUs. A binding inter-agency plan is essential for managing GNSS reference stations and ensuring coordination.

5. Which business model should be selected?

The business model implementation is a challenge for the actors, especially fresh entrants, who want to use new directives to control the way to convey things (Tidd, 2006). The Japanese model, praised for its tech and financial efficiency, is a top choice, though the Australian model of multi-agency collaboration is also considered. Despite the Japanese approach currently seems most viable, the study may continue for years.

6. What technology should be installed for the overall network configuration?

The Australian CORS combination came to grips with the diversity of GNSS receiver complications many years ago, and numerous determinants in processing ground infrastructure connection, technical particularly, have been justified to pursue the quality and reliability of this system (Rizos, 2008a). Thailand must standardise software for network management to unify GNSS systems. Hardware is already entirely set up, but the software must be carefully chosen to ensure seamless data streaming and system reliability.

The interviewees, some are representatives of the organisations in the collaborative project, encompassed the needs for inter-agency cooperation on GNSS CORS management as follows:

1. Regulations or policies

Policymaking in public value governance is crucial in goal setting to determine where appropriate decisions should be based (Bryson *et al.*, 2014). Adopting policy to a narrow extent of exertion is a proactive approach to reducing unpredictable processes. Additionally, the legislation passed by the governments will enable a steady flow of action. Each of the Thai agencies has an internal policy of GNSS CORS management; nevertheless, the regulation pattern of technology-sharing with other bodies is not explicitly stated. The CORS technology was brought to exaggerate the capability of positioning and time applications for a variety of targets; achieving the proposals emanated from a collaboration then requires the definite design of arrangement that implies further formulated methods of teamwork.

2. Authority

Authority is one of the strategies in the public values governance triangle (Bryson *et al.*, 2017). A formal authorising environment involves public value management, and stakeholders are the strategic triangle framework adaptable in a multi-actor project to diminish the limits of joint governance forms of the Thai government. Many hesitations in the interaction between different agencies were caused by unsettled authorities; the respondents consequently felt that the shape of co-working would be more comfortable if public authority was created before exploiting complementarities. The stipulation on the scope of responsibilities, powers, rights, and legal protection not only declares the roles and tasks of each partner but also keeps them safe from allegations that might occur due to the practice.

FIGURE 5.2 and FIGURE 5.3 below illustrate the initial analysis results as the above concluded.

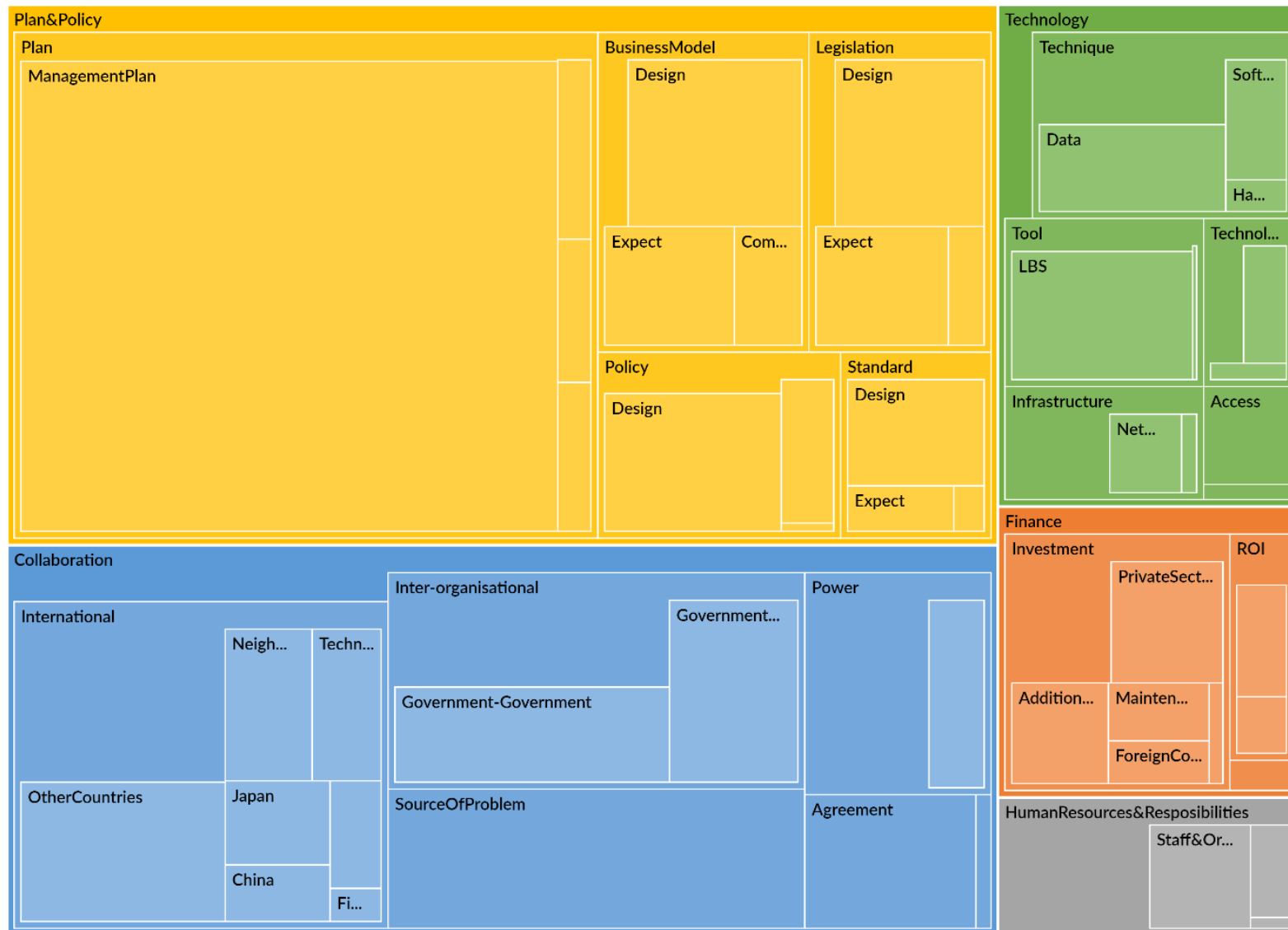


FIGURE 5.2 Hierarchy chart of the initial analysis result of focus group data (Source: Author's own research)



FIGURE 5.3 Word Frequency Query result of focus group data (Source: Author's own research)

5.6 INTERVIEW DATA ANALYSIS RESULT

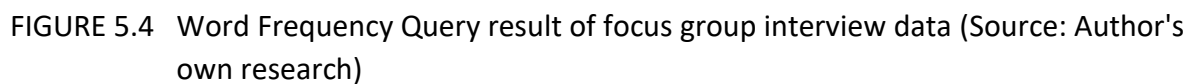
The entire interpretation of primary data was arranged after the first round stage. It considered interview data from the expert and focus group strategy. The discovery was initiated by matching the theoretical framework and data.

5.6.1 Focus Group Interview Data Analysis Result

Qualitative research is often seen as imperfect due to the subjective influence of the researcher, whose experience may affect data transparency. This study interpreted focus group data from Thai government organisations qualitatively, using a pattern-matching algorithm to analyse verbal and nonverbal content. Key findings were collated with literature considerations to highlight diverse aspects.

Word Frequency

According to the word count, the most repeated word in the discussion was "CORS," central to this research. Other frequent terms were "network," "GNSS," "data," "service(s)," and "centre," reflecting core study themes. CORS enhances GNSS technology's quality and accessibility, working independently or as a network connected to a central service platform. Word repetition trends are illustrated in the accompanying visual.



The research topics were gathered separately for each participant group, but interactions within and across organisations were analysed together. Responses were classified into codes, with "***Plan and Policy***" being the most common, accounting for seven references. "***Collaboration***," especially under the "***International***" code, followed closely with 25 references, highlighting its significance among stakeholders. Furthermore, the code with the highest reference count was "***LBS***" (Location-Based Services) at 13, under the "***Technology and Tool***" category. While technology was less concerning than plans and policies, it was frequently mentioned due to the need for a sustainable CORS system. Another notable code, "***Central Unit***" under "***Plan and Policy***," had eight references, reflecting supplementary requirements to the ongoing actions. The accompanying image illustrates the overall structure of these findings.

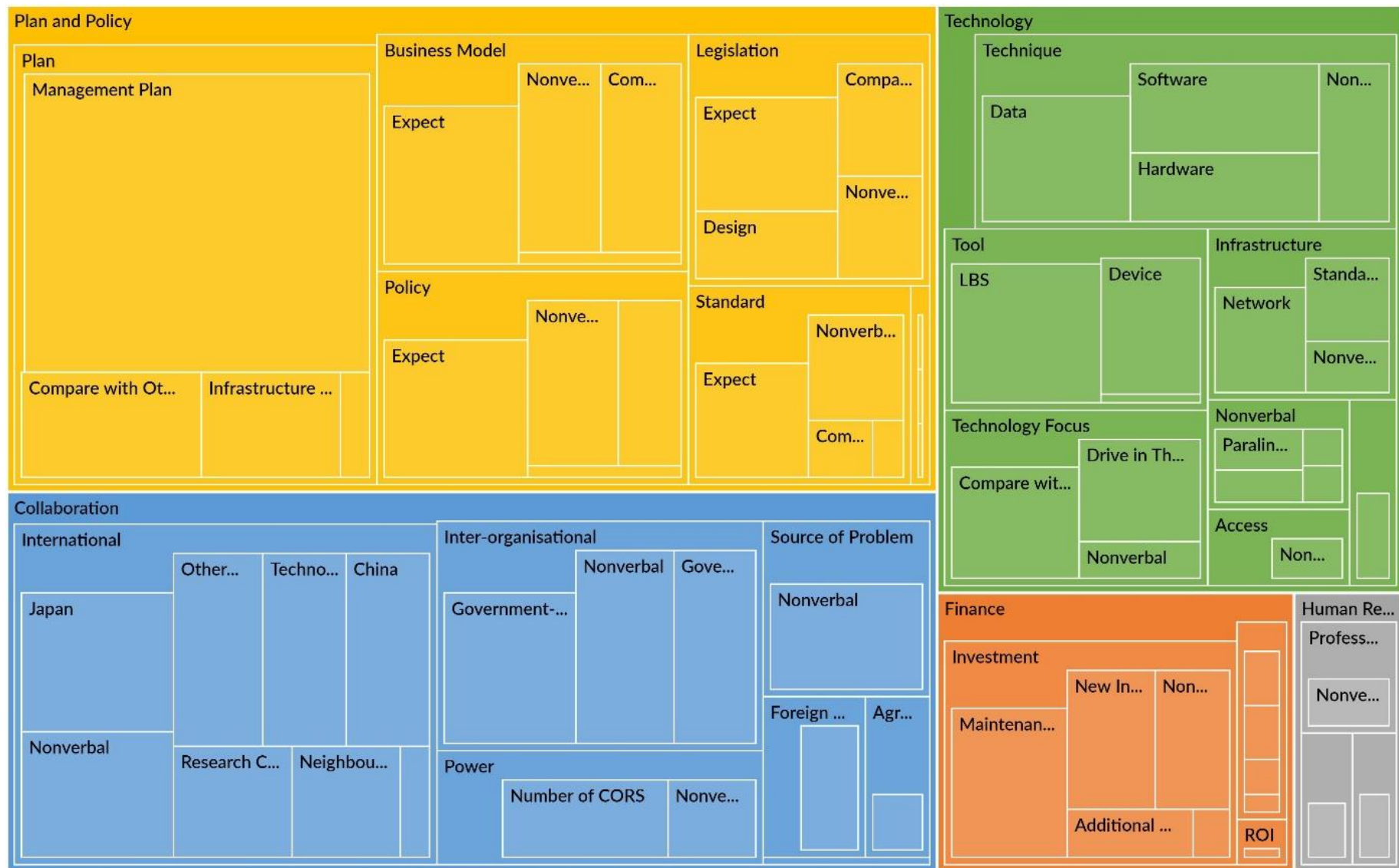


FIGURE 5.5 Hierarchy Chart result of focus group interview data (Source: Author's own research)

Theoretical - Empirical matching

The coding and recoding stage outcomes show statistical numbers that summarise the ideas expressed by the partakers from six parties. The following are the contents within each code that were categorised.

Collaboration

The Collaboration code focuses on personal views about CORS partnerships. Across five focus groups, 31 comments supported collaboration on GNSS CORS, such as, *"I agree to have cooperation."* Joint efforts in foreign countries were mentioned eight times, with examples like, *"Australia and New Zealand integrated into one structure and set up an agency to take care of it."* International collaboration, particularly with countries like China and Japan, was discussed 165 times, emphasizing partnerships for information exchange, technology, and support. Collaboration with neighbouring countries and others was raised 129 times, focusing on knowledge sharing and tailored support. Inter-organizational collaboration, including government-private sector partnerships, emerged 189 times, highlighting the need for committees and balanced cooperation. Power dynamics, including CORS numbers and authority, were discussed 66 times. The most common issue, mentioned 154 times, was the challenge of integrating CORS networks due to funding and operational constraints. These findings summarise participants' views and reveal key themes of collaboration through qualitative analysis.

Finance

The coding focused on CORS investment, ROI, and financial support. Speakers from six organisations shared views on new investment, additional funding, private sector involvement, foreign investment, and maintenance. Regarding investment, 26 views emphasised government dependency, such as, *"I think the investment capital in establishing CORS stations is considerable. So no company would take the risk of investing in it. I think we have to depend on the government anyway."* The new investment received 26 comments, focusing on expanding GNSS stations based on user needs. Additional investment had 32 responses, highlighting funding challenges, e.g., *"For the adding matter, firstly, is there the fund? Secondly, is there a user? That's all."* Private sector investment, discussed six times, noted limited large-scale involvement due to high costs. Foreign investment, raised 12 times, focused on external investors like China, with questions on integration into Thailand's CORS.

Maintenance and renewal received 30 comments stressing the need for upkeep and replacement, such as, *"Because, for CORS, when it is time, if there is no way to take care of it, even if it is useful, it is nothing."* ROI discussions captured six ideas about government and national benefits, e.g., *"The overall frame of investment in developing the country is that the government benefits, the private sector benefits, the country benefits in terms of income return and increased productivity."*

International financial support, mentioned 22 times, included countries like Japan and China, depending on mutual benefits. These views highlight the financial priorities and challenges for implementing the GNSS CORS system.

Human Resources and Responsibilities

Theming on human capital and roles focused on skills, general abilities, and improvement. It addressed individuals and organisations. For professionals, participants from four organisations emphasised expertise 27 times, e.g., *“If the matter is of money, need to find a financial professional.”* Matching skills to tasks was a key concern. For non-specialised staff, three organisations shared 10 comments, stressing task-person alignment, e.g., *“To use a man, dispatch jobs, assign people to work on tasks, should consider whether a person and a task would be a match.”* They also highlighted training and development for unfamiliar roles, with 10 mentions from two groups, such as, *“Before starting, we should have some knowledge. Such knowledge is about the actual meaning of that matter and who will get involved.”* Most emphasised understanding tasks through study. System operation relies on professionals and general staff, defined as individuals, groups, or organisations. Specialised organisations are “professionals,” while others with secondary roles are “staff.” Human capital impacts productivity and quality, making training and education essential for system improvement.

Plan and Policy

Representatives from six organisations extensively discussed the development of a Thai GNSS CORS. Their deliberations focused on five crucial aspects: a comprehensive plan addressing infrastructure, management (central or individual networks), and international collaboration; a viable business model, drawing comparisons with accomplished international examples; robust policies aligning with global best practices; clearly defined standards ensuring interoperability and meeting international benchmarks; and essential legislation providing legal authority and mirroring dominant international models. Numerous comments highlighted the need for phased implementation, centralised control, and the importance of considering both domestic and international precedents.

The discussions extensively examined the practical aspects of implementing the CORS, frequently referencing international examples to guide their recommendations. Participants emphasised the necessity of a phased integration approach, debating the merits of centralised versus decentralised networks. The business model consultations explored various revenue generation strategies, benchmarking against other successful systems. With regard to policy, the stakeholders underscored the importance of user requirements and long-term sustainability, referencing policies in developed countries. Standard-setting discussions stressed compliance with international best practices, and legislative considerations prioritised creating legitimate and authoritative frameworks for the CORS. The consensus across all participating organisations was that optimistic

CORS implementation hinges on careful planning and coordination across these five interconnected areas.

Technology

Discussions among representatives from six Thai government organisations revealed key perspectives on technology interest for a national CORS system. Participants centred on several technology-related aspects: the overarching technological focus (including examples from autonomous vehicles and agricultural applications), infrastructure requirements (standalone bases and network connectivity), necessary tools and equipment (GPS devices and software), technical challenges (hardware, software, and data issues), access and data delivery considerations. The conversations discovered a range of viewpoints, reflecting both support for and concerns about technological advancements and their integration within the CORS system.

The data collected comprised 71 viewpoints on technological concentration, with recurring themes emphasising existing technology adoption in Thailand (e.g., use in agriculture and drones), comparisons to international examples (e.g., Japan's agricultural use of CORS), the importance of robust infrastructure, and the need for reliable hardware and software solutions. Concerns also emerged regarding data transmission, access to the system, and potential delivery delays. This data, gathered from separate meetings within each organisation to encourage open exchange, will inform further research into the optimal approach to developing the Thai CORS.

Theoretical - Empirical congruency

This analysis compares a pre-defined theoretical framework with empirical data from interviews on Thailand's CORS implementation. High agreement between the framework and the data strengthens the study's validity.

- Ownership and governance: Significant obstacles include fragmented ownership and management, stemming from insufficient infrastructure planning and funding, lack of common goals, unequal expertise among agencies, and others.
- Power Asymmetries: Unequal power dynamics significantly affect CORS implementation, evident in disparities in decision-making, external support, control and inspection capabilities, etc.
- Interaction processes and supporting technologies: The success of CORS hinges on effective interaction and appropriate technology. Challenges include limited awareness of CORS's importance and technological obsolescence, a mismatch between work culture and technological capabilities, and more.
- Setting direction of collaboration: Several barriers hinder infrastructure completion and central administration. Successfully establishing inter-

organisational collaboration requires addressing security, technical handling of a central network, a comprehensive marketing plan and so on.

Conclusion

The links between the coding results of the focus group interview data and the codes developed based on the predicted keys demonstrate the alignment between theories and empirical work. These consistencies show interactions between the ideas and the tests and prove the quality of the research design.

The nonverbal data analysis result

The reactions agreeing to or opposing the perspective expressions were categorised into five groups: Facial Expressions, Gestures, Humour, Paralinguistics, and Posture. Those reactions were captured according to the responses to the topics predefined for coding: Collaboration, Finance, Human Resources and Responsibilities, Plan and Policy, Technology, and their child nodes. The outcomes are summarised below.

Collaboration

The discussion on collaboration had been sided with two paralinguistic communication feedbacks from one party. One of the comments was, *"Because of Thailand's design, it has CORS set up by many agencies."* This kind of response reached a maximum of 57 times by all organisations when talking about the Source of the Problem. For instance, *"The RTSD will set up their own system. So if there is an integration, we don't know whether CORS can be extended to a large scale extent."* The second top repeated nonverbal expression is the gestures that had been counted up to 27 times from the replies of five organisations. For example, *"The problem is that it hasn't been integrated, but they had the budget to do it. But the actor who took this action hasn't been able to use the budget yet. So the ones who had the budgets can set it up first."* Next, posture emerged 25 times from three agencies in response to international collaboration. An example of this expression is, *"I think that if there is cooperation between various agencies, it is good. But, personally, I think that each agency should show their sincerity in working here. So this cooperation could succeed."* In terms of facial expressions, its maximum count is 22 times expressed by five parties. One of these counts happened when they discussed the Source of the Problem. It is *"As far as I've ever seen, the budget for integration resulted in unsuccessful integration because the owners' agencies spent this money on something else."* The least counted nonverbal communication happening during the conversations is humour. It reacted three times to the international collaboration with Japan comments by one agency. An instance of these viewpoints is, *"Ah, Japan is like that."*

Finance

There were infrequent expressions in response to the financial evaluation situations. The topmost one is paralinguistics, in which five parties responded ten

times to the topic of Maintenance and Renewal. The reaction is seen in *"CORS needs MA. For now, it's still under warranty. After the contract expires, there will be an MA, and MA is per year. Hahaha!"*. The subsequent rank is the posture of three parties that interacted nine times with both New Investment and Finance. Examples include *"Then some organisations don't have it and want to set it up. Two weeks ago, there was the AEROTHAI that will set up its own CORS station."*. The third level of nonverbal response frequency is facial expressions, in which four organisations made six interactions with Investment. Next, two groups of participants made five gestures of reaction toward New Investment. Such actions included *"There are two models: the model that an agency can have its own budget, then invest and connect to the data centre later to become part of the network that covers all. The second model is to send a request to the main unit or the data centre about where it is still missing. If it's indispensable, they have to request a budget to set up."*. The last one expressed humour; however, there was no response like this to the conversation.

Human Resources and Responsibilities

Body language and voice characteristics supported conveyed feelings about the personnel and their roles. Paralinguistics were used most frequently during the view sharing, particularly in Staff and Organisation issues; the attendants from two teams reacted six times to highlight ideas. For instance, *"Regarding the personnel, people are like, eh, the data centre doesn't have personnel like this or people that, ah, I don't know what to say, well, don't judge them, it's not good."*. The following majority of feedback repetition is the posture that two groups were responsive to Professional and Representative five times. An example of them is, *"So this one; we might be able to get from the experts who came to help us gain knowledge of that part. But, the point to argue is that the benefits must be returned."*. The next frequently repeating gestures correspond to Professional and Representative four times by two organisations. For example, *"There are only the experts in this area gathering? What is this? It's biased."*. The subsequent one is facial expressions that one agency responded to three times on Training and Development, such as *"This knowledge requires equipment A, B and C. Let's see in Thailand where A is, where B is. Who and where is the one who really knows how A, B, C, and D work together? There might be; it's not that it doesn't exist at all, but because they don't know each other."*. Nonetheless, there was no humour when reacting to this subject.

Plan and Policy

There were numerous points of view and nonverbal reactions regarding plans and policies. The greatest number of reactions was paralinguistics related to the Central Unit; all parties expressed 100 times spontaneity. One of them was, *"Only one agency is more flexible to fix the problem in some aspects. That kind of situation has two sides."*. Secondly, the three parties reflected 31 times on the Management Plan through their posture. One of the instances was, *"Try to accommodate everyone and make them have no more excuses to say that they*

need to do this.”. In terms of gestures, there were 26 reflexes from four teams toward the Central Unit, such as *“The central unit can retrieve data and then dispense services.”*. The other spontaneous effect on the Central Unit was facial expressions that all organisations expressed 18 times, like *“I think the central unit is good as well, same as everyone.”*. The least frequent reaction was humour, which occurred only once to Policy/ Compare with Others. It was that *“It's like a road; they built it, but it depends on the user to use it. When you misuse it and blame the road builder for why they made it wrong? It can't be like that. They have to finish building the road. And when the road was built, it was misused; they must arrest the person who misused it.”*.

Technology

The simultaneous reply towards the standpoint sharing with reference to technology matters is mostly concerned with the topic of LBS. Their top rank is paralinguistics; five clusters reacted 64 times about it. One of those is, *“It still can't see that much. That is, these things will be considered in accordance with the installation contract rather than the expiration of the warranty period.”*. The second top is facial expressions; five organisations reflected 20 times when they talked about it. An example can be seen in *“Actually, this one by itself is already like that.”*. Besides, four groups of participants showed gestures in response to LBS 17 times. The instance is as seen in *“Suppose we already have a data centre. Do you think this data centre should have a 24-hour watchman? If there is a 24-hour watchman, why do we need a mobile?”*. In light of posture, there were 16 responses from three parties, such as *“To me, it's not necessary. One day, there might be software. What I'm trying to figure out is the user. The user should probably be the one who will use it. Once you approach the area, if there are some network failures, you should know it immediately.”*. Finally, there was no humour reaction in these discussions.

Nonverbal communication, as encapsulated above, was used as a complement to the verbal communication data to analyse the congruency between theory and field works.

5.6.2 Expert Interview Data Analysis Result

Qualitative research involves evaluating data that cannot be appropriately explained by numbers. As it is one of the powerful approaches in the social sciences, research data could be peoples' expressions collected from diverse fields of work. Within this analytical part, the input is the observation data specifically gathered from academics with particular expertise in GNSS technology. The analysis exerting the pattern-matching algorithm relied on oral interviews and turned out the exploration results in word frequency and correlation of contents. The connections between the input data, coded data, and conceptual model are demonstrated, and the relevancy, similarities, and discrepancies are described below.

Word Frequency

In the semi-structured interview with the academic experts in GNSS technology from three public universities in Thailand, the most common phrase was “**CORS**”. This word is found in the majority of the comments in regard to the topic of the conversation, so it was referred to repeatedly. Other expressions that were frequently remarked on are “**data**”, “**network**”, “**GNSS**”, “**central**”, and “**service(s)**”, respectively. Their correlation, as stated above, is formed by the research target and interview questions. These terms are about the GNSS CORS technology and its support. Therefore, they were present in almost every part of the conversation. The picture below demonstrates the continual recurrence of expression in the interview sessions.



FIGURE 5.6 Word Frequency Query result of expert interview data (Source: Author's own research)

Items coded

The discourses between the researcher and the professionals covered all the concerns of this discovery. The process of assigning the phrases to each code requires a read-through of all dialogues repeatedly. Thus, the themes can be summarised in this process. Considering the quantity of conversation related to each code, the most significant part of the aggregate number of coding references is the code “*Plan and Policy*”, with 399 coding references. Also, this code and its children have the optimum total number of aggregated references at 1,300. Particularly, the “*Management Plan*” came up with 154 aggregated counts. However, the second greatest part is the code “*Collaboration*”, with a slightly

smaller aggregated number of 395. Within this code, several child codes also contain many of the aggregate numbers of coding references, which, accumulated, amount to 942. The partition of this result can be seen in the picture below.

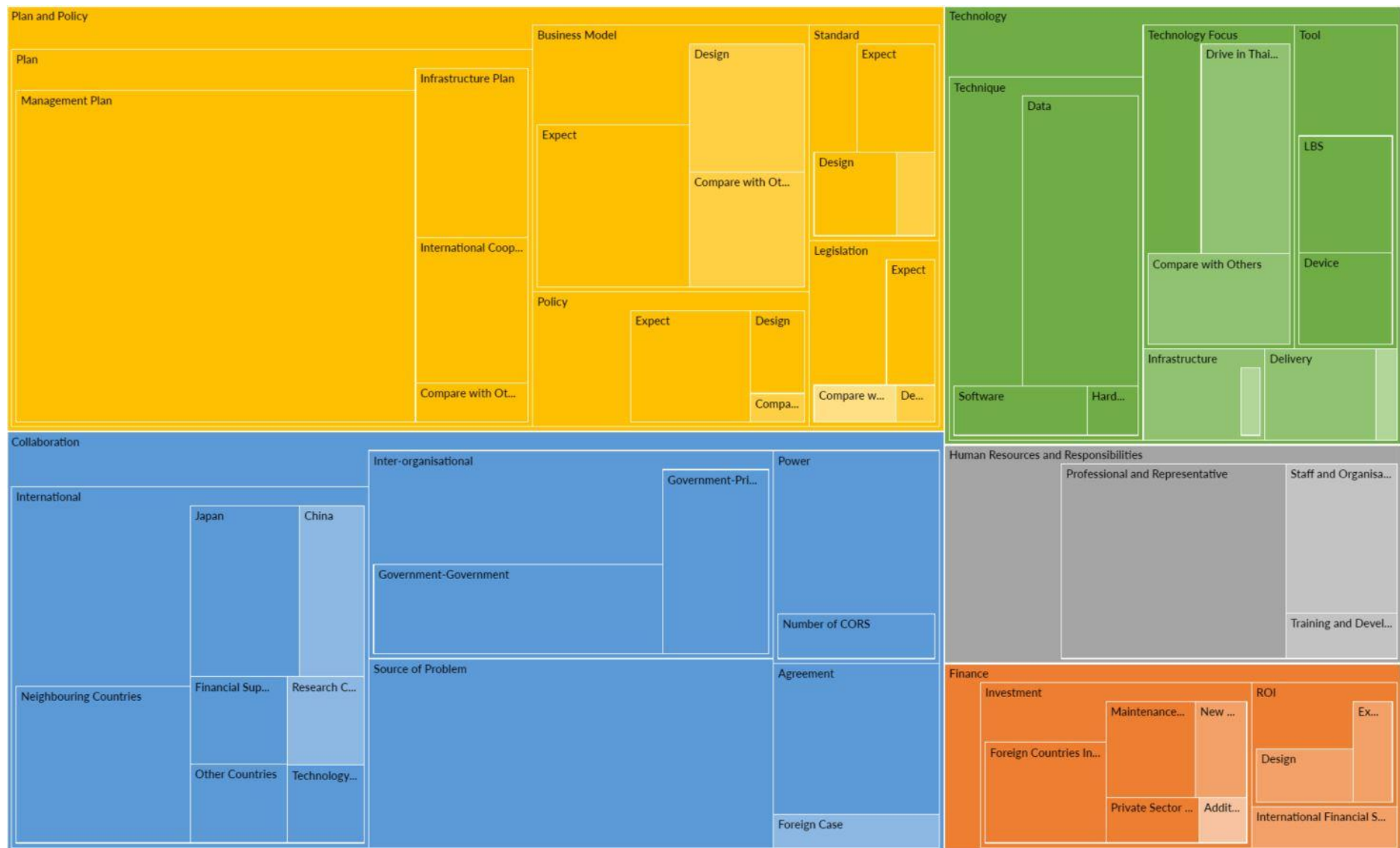


FIGURE 5.7 Hierarchy Chart result of expert interview data (Source: Author's own research)

Theoretical - Empirical matching

The interviews with the scholars specialising in GNSS technology results reflected their personal feelings about the CORS collaboration in Thailand. The experts from the three academies had a particular way of thinking that could be themed corresponding to the research framework. Below are the findings from the coding process based on the developed framework.

Collaboration

Experts largely agreed on the need for collaboration in Thailand's CORS development, citing both domestic and international examples (47 comments). International collaboration was discussed extensively (37 comments), focusing on relationships with China, Japan, neighbouring countries, and other nations, with varying levels of engagement and perspectives on possibilities for partnerships (13, 22, 32, and 9 comments respectively). Further exchanges indicated the significance of research, financial, and technological collaborations (25 comments), revealing varied viewpoints on data sharing, funding needs, and technology selection. Concerns were raised regarding differing motivations and approaches among potential collaborators.

Domestic collaboration also received significant attention (90 comments), with discussions concerning integration between government agencies and between government and private sectors. The consideration also pointed to the essential nature of gradual, bottom-up integration and collaboration between government and private sectors (38 comments). Experts highlighted the importance of overcoming possible obstacles (82 comments) such as unequal power dynamics, lack of expertise, and the necessity of improved communication and coordination to avoid redundancy and resource waste. The overall consensus emphasised the crucial role of collaboration in successfully implementing the Thai CORS system.

Finance

Financial considerations are central to Thailand's CORS development, with government funding being the primary source. Discussions centred on investment (40 comments), return on investment (ROI) (21 comments), and international financial support (7 comments). Concerns were raised about the possibility of private sector investment and foreign investment, highlighting challenges related to budget allocation, compliance with standards, and possible risks.

Regarding investment, perspectives varied on new installations, upgrades, private sector involvement, and foreign investment. Thoughts about budget constraints and the need to meet standards were expressed. The contributions of the CORS were seen as uncertain due to the perceived risk in the project. Foreign investment prospects were discussed, notably with regard to China's potential participation. The experts emphasised that ROI should not be the sole focus, but rather the quantifiable societal benefits of CORS. The potentiality of tax revenue

from private sector profits and the significance of promoting the use of CORS to spur economic activity were discussed in relation to ROI. International financial support was considered, but existing government funding and self-sufficiency were highlighted as priorities.

Human Resources and Responsibilities

The discovery of multi-stakeholder co-creation on GNSS reference station technology leads to key notices that collaboration requires diverse components, particularly human capital and organisational skills. The personnel and organisation management are established within a range of responsibilities, including functions of the players, labour control, and roles of each organisation. In addition, it is essential to develop their competency and improve their administrative capability. According to the interviews, the experts had 25 responsive answers to the question about human resources and responsibilities, such as *"Now we have the one to take care of it. As you know, it's the RTSD."*. Specifically, they shared 50 viewpoints concerning professional and representative, for example, *"We must not think that it is beneficial to the private sector. If they specialise in marketing, they will make it possible."*. Also, 19 comments were made regarding staff and organisation, for instance, *"There may be a GNSS unit that is responsible for this. Don't put other tasks on them."*. On top of that, they left some perspectives on training and development *"It's their habits. That is, if any matters they understand, they will instruct. They will be ready to get to know."*.

Plan and Policy

Experts offered varied perspectives on CORS planning and policy (14 comments), emphasising the need for a customer service centre and referencing Japan's outsourcing model for maintenance. Infrastructure planning (22 comments) highlighted the importance of reliable repair services. Management planning (45 comments) included talks about centralised versus decentralised networks (20 comments), with a strong preference for a central network, and leadership roles (31 comments), underscoring the imperative of having a clear authority. International cooperation plans (19 comments) stressed the need for mutual benefit.

Business model considerations (79 comments) comprised remarks concerning pricing strategies and referencing Japan's successful model, emphasising the need for widespread adoption to ensure viability. The experts advocated for government management initially, followed by potential private sector involvement. Conversation about policies (40 comments) noted the importance of long-term planning, referencing other successful multi-party collaborations. Recommendations included using brainstorming sessions to foster collaboration and establishing a national CORS. Technical standards (30 comments) underlined the vitality of utilising existing international standards like RINEX, adapting them

as needed to ensure network stability and functionality. Discussions included leveraging successful international models and focusing on creating a stable and reliable network. Legislative and regulatory considerations (26 comments) addressed the necessity of precise legal frameworks to handle any possible legal issues related to CORS use and referencing examples from other projects to guide the development of appropriate legislation.

Technology

Experts emphasised technology relevant to GNSS, such as cloud-based technology, as optimal for CORS, citing examples like GBAS. Discussions on technology focus (53 comments) included comparisons with international models (e.g., Japan's dual correction system) and the identified drivers for CORS advancement in Thailand (e.g., ICAO mandates). Infrastructure and equipment considerations (48 comments) highlighted the importance of viewing CORS as a national resource and acknowledged existing agency-specific networks as state investment assets. The conversation about tools and mobile devices underscored the potential for increased user accessibility through mobile-based applications and location-based services (LBS).

Technical aspects, particularly techniques (76 comments), hardware (e.g., cost-effective receiver replacements), and software (e.g., need for diverse software solutions) were extensively discussed. Data-related concerns spotlighted the need for data conversion for service usability and the value of diverse data streams (e.g., real-time, post-processing) to meet varying user requirements. Data access and delivery factors (e.g., prioritising private sector use) were also discussed. These findings will be further analysed in the next section.

Theoretical - Empirical congruency

Analysis of coded interview data reveals strong correlations between observed data and a pre-defined framework for understanding Thailand's CORS implementation challenges.

- Ownership and governance: The fragmented ownership and management of CORS networks in Thailand create significant obstacles. Lack of common purpose, awareness of existing initiatives, and a clear intermediary to facilitate collaboration were identified as key challenges.
- Power asymmetries: Unequal power dynamics significantly hinder effective CORS collaboration. This is evident in unequal access to resources, unclear authority, and ineffective leadership, as evidenced by past project failures.
- Interaction processes and supporting technologies: Challenges related to the interaction processes and supporting technologies highlight the need for improved awareness of existing technologies and their applications, enhanced knowledge development and technology transfer, and increased clarity and understanding among stakeholders.

- Setting direction of collaboration: Successful collaboration requires a well-defined authorisation protocol, clear network standards, and incentives to encourage participation from multiple stakeholders. This includes considering the economic benefits of CORS for various industries.

Conclusion

The pattern-matching analysis of the contents described above shows the compatibility and harmonious atmosphere between theories and field observations. The linkages of expert interview coding output and the predefined codes proved their close matches. As a result, it is demonstrated that there is a correlation between the concepts and actual facts. The findings improve the reliability of this study.

5.7 TIMELINE DATA ANALYSIS

The follow-up interviews were conducted to continue the information gathering from the preceding discourse on CORS in Thailand. The disposition is tailored to serve the process of extractive exploitation of GNSS CORS chronologically.

From the onset, the analysis has been subjected to the open views of the individuals. However, the first data gathering was in a pattern of group discussion. The latter set of data from each organisation came from one of those who engaged in the first session. This data was occasionally stored over a long period in regard to the availability of the interviewees and the occurrence of events. The timeline data investigation results are presented here.

Word Frequency

The coding result presents the frequency of the term that emerged during the follow-up interviews. The word with the maximum rate of occurrence is “**CORS**”, which has been at the heart of this study throughout the research. The word “**department**” was regularly mentioned, respectively. This word refers to the organisations involved in this collaboration project and the possible or prospective organisations that could join this endeavour. Subsequently, the other monotonous rate of repetition is “**GNSS**”; it was repeated nearly as frequently as “**national**” and “**station**”. Both in Thai and English, these terms are directly associated with this movement in light of technology and infrastructure. The prevalence of the word’s occurrence in the follow-up data is illustrated below.

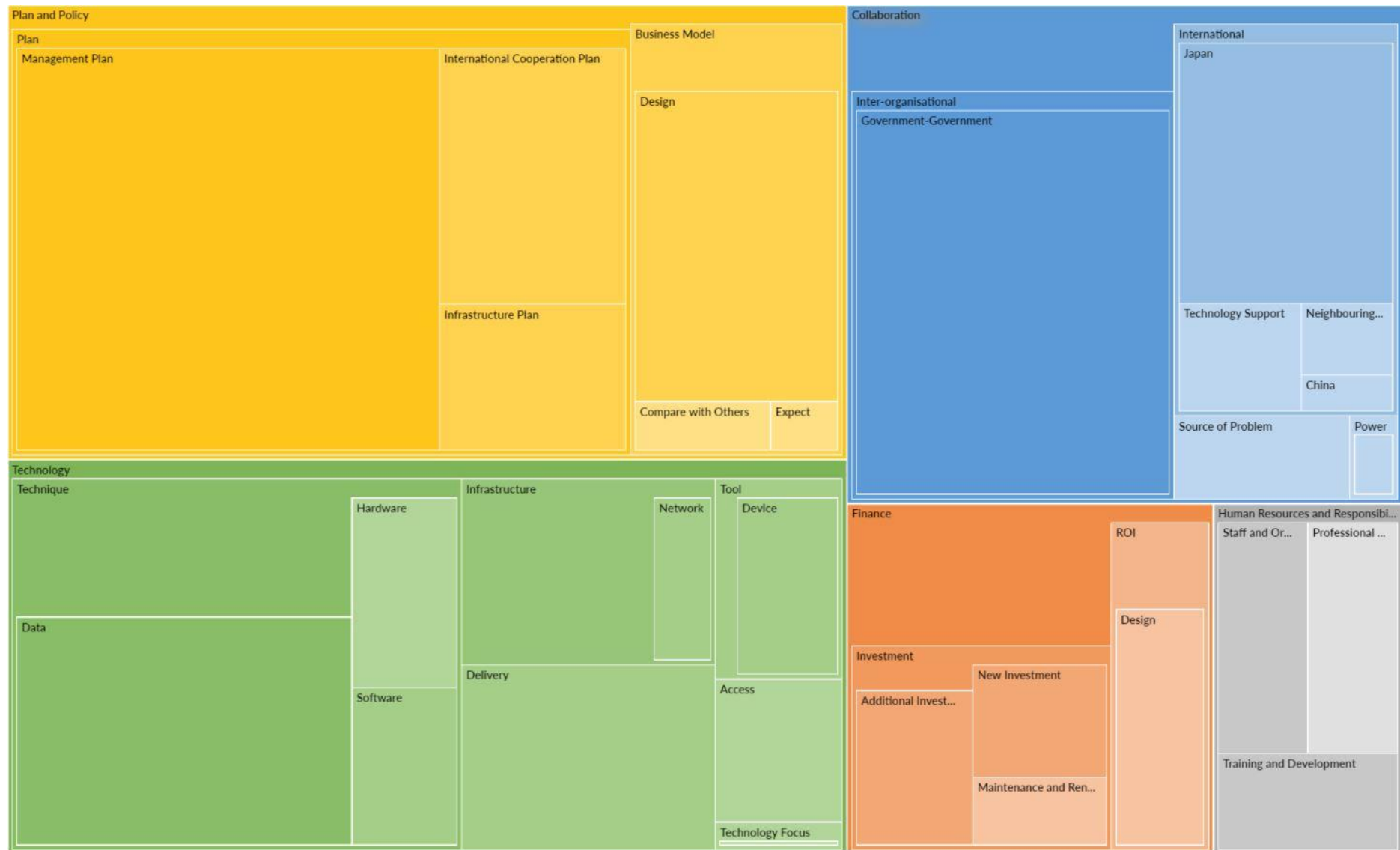


FIGURE 5.9 Hierarchy Chart result of follow-up interview data (Source: Author's own research)

Theoretical - Empirical matching

The earlier phases of data analysis used primary data gathered from face-to-face interviews. Conversely, the follow-up data were collected using online chats, calls and documents. After transcribing the data, the same themes generated from the framework were applied for coding. The following information demonstrates the results of the categorisation.

Collaboration

Collaboration on GNSS CORS has been underway through the subcommittee movement. This ongoing endeavour has proceeded under the alliance between various government organisations and universities. The respondents, who are the representatives of the CORS project stakeholders and the partakers of focus group interviews, updated the status of this project as per their acknowledgement. In the fiscal year 2021, collaboration efforts have remained largely stagnant. Cooperation with China remains non-existent, and there has been no progress in fostering relationships with neighbouring countries due to the complexity of establishing service connections, which necessitates an MOU with the Ministry of Foreign Affairs. Meanwhile, regarding Japan, although the experts involved have been replaced, this change is not expected to hinder ongoing or future cooperation. Notably, Japan's involvement is closely tied to technology development, as they are seeking to play a role in the CORS management of the RTSD, indicating their continued interest in technological collaboration.

Thirty-six comments highlighted the connections among Thai government organisations, revealing that they can be linked despite power asymmetry. This imbalance was evident in the differing numbers of CORS stations, with the RTSD lacking its own station at the time. The primary issue hindering the success of the CORS project was identified as the lack of progress, largely attributed to the disruptions caused by the coronavirus outbreak.

Finance

The pandemic has caused significant delays in processing CORS coordination, particularly in financial matters. Nine comments from three organisations underlined the current lack of budget, highlighting the financial constraints. While twelve statements indicated progress in investment, including new and additional funding, installations by the RTSD and DOL remain incomplete as planned. Concerns were also raised about maintenance and renewal, particularly regarding securing a maintenance budget, with suggestions to request funding from the Royal Thai Armed Forces Headquarters or the government. The potential benefits of CORS were discussed, emphasising ROI through services supporting education, research, and development, with organisations like Khon Kaen University, DSS, and GISTDA playing key roles. Additionally, plans for monetary management were outlined, with the Department of Working Capital tasked with handling revenue from these services.

Human Resources and Responsibilities

The interviewees provided insights into the current state of the CORS project in Thailand, focusing on the roles and responsibilities assigned to various organisations and individuals. They highlighted the leadership of Prof. Chalermchon, who deserves as the head of the working group. Three respondents discussed staff and organisational roles, noting that the project could be supervised by the Geodesy and Geophysics Division, the section responsible for surveying. Additionally, training and development were emphasised, with examples such as the Agricultural Land Reform Office (ALRO) requesting educational support, which led the RTSD to dispatch officers to provide explanations and training to relevant stakeholders.

Plan and Policy

Updates on the CORS project's plans and policies were discussed by multiple representatives, addressing infrastructure, management, and business strategies. Regarding infrastructure, it was reported that 282 reference stations (CORS) are planned: 181 by the DOL (47 additional stations to be installed in 2021), 80 by the RTSD (completed with no further plans), 15 by the DPT (completed), and 6 by the HII (completed). The management plan highlighted operational strategies, such as ensuring system maintenance during the insurance period, with response times dependent on CORS locations. Discussions on network development included 14 references to individual networks, such as the RTSD's setup of its own data centre, and 12 mentions of the central network, including the National Data Center's ongoing data connection tests with relevant organisations. Furthermore, 18 comments were made on the RTSD's role as the Semi-National CORS. Plans for international collaboration were also noted, particularly the Thai-Japanese Cooperation Working Group's focus on capacity building and promotion.

On the business front, participants shared details about private sector involvement, noting a gradual increase in users and envisioning a business model similar to the working capital office for aerial photography, with revenues from aerial photography and LiDAR sales. Proposed business plans included fee structures for private-sector services, with packages ranging from 1,000 baht for two weeks to 6,000 baht for a year. These plans aim to foster collaboration and benefit both private and Japanese business sectors.

Technology

The interview data highlighted key technological concerns related to the CORS movement, reflecting a timeline-based coding strategy grounded in a theoretical framework. Efforts to encourage positioning technology in Thailand were emphasised, with over 20 comments addressing infrastructure and tools. One participant noted that most organisations have nearly completed their CORS installations, with the RTSD fully established and the DOL progressing but not yet meeting planned targets. Coverage now spans the country, including border areas,

though mountainous regions like Tak and Kanchanaburi remain challenging for CORS implementation. Regarding tools, issues arose over the availability of rovers, with 20 purchased but insufficient to meet government sector needs.

Technical preparation was another focus, with 12 mentions of techniques such as baseline distances of 30 – 40 km, achieving +3 cm accuracy, and nationwide coverage. Hardware needs were identified, including storage for data backups at the RTSD, while software discussions centred on the Leica Spider Business Center, bundled with CORS and installed by the RTSD. Data-related concerns dominated discussions, with 23 comments addressing challenges such as limited data usage due to processing constraints, as noted in the RTSD's use of only 40 DOL stations to form a network. Data access and delivery also featured prominently, with the RTSD's service website, providing a platform for access. Improved internet bandwidth and the establishment of primary and secondary channels for data delivery were highlighted as critical advancements. This stage provides detailed, measurable insights into the frequency and content of responses, paving the way for a deeper analysis of these outcomes and their underlying causes in the next phase of the study.

Theoretical - Empirical congruency

Analysis of interview data reveals persistent challenges in Thailand's GNSS CORS implementation, confirming initial findings and adding new insights. The following are the patterns of the theoretical and observed character relationships in light of their conformities. The initial conceptual framework was placed as the rationale structure for the collation. Consequently, coded results were compared with the model to see the compatibility and discrepancies of findings.

- Ownership and governance: Fragmented ownership and management continue to hinder progress. Lack of transparency, limited opportunities for collaboration, and the absence of a clear intermediary to facilitate coordination are significant obstacles.
- Power asymmetries: Unequal power dynamics persist, evidenced by uneven budget allocation, differing levels of influence among agencies, and unequal access to information and resources. These power imbalances impede effective collaboration.
- Interaction processes and supporting technologies: Inadequate infrastructure and insufficiently practical designs remain significant challenges. A lack of comprehensive collaboration programs and effective coordination further hinders progress.
- Setting direction of collaboration: Strategies for improved collaboration include establishing clear quality guarantees for data products, defining network standards, and addressing technical challenges related to network integration. A long-term vision for a national data centre is also crucial.

Conclusion

The analysis of follow-up interview data provided the interconnections between coded data and preset codes. These consequences held an increase in the sense of relatedness of theories and observations. Besides, the interrelations between conceptual knowledge and the subjects contain significant congruity enhancement, leading to the research's internal validity.

As a qualitative analysis tool, pattern matching offers straightforward steps for capturing the substance of the resources used in the study. Coding data, both face-to-face and online interviews, employed similar work steps. All data was transcribed and themed, conforming to the developed framework. The theming outputs revealed a pattern that seems analogous to the ongoing CORS activities. The coding was undertaken according to the respondents' aspects and the evidence they provided as a supplement and then returned the statistical solutions. As a result, the succeeding section interpreted and measured the similarities and differences between the findings.

5.8 MORE IN-DEPH THAILAND CASE STUDIES ANALYSIS

The analysis of CORS management in both Australia and Thailand indicates relevant details involved in the outcomes achieved in each country. The application of the developed framework to explore these experiences yields significant and profound findings. These results reflect the current state of CORS implementation on a country-by-country basis, paving the way for future enhancements.

5.8.1 Thai Case Study

Thailand started deriving great benefits from GNSS reference stations in the 1990s. After that, CORS technology was implemented by various organisations. This multidirectional preparation has been taken into account as a consequence of the duplication of budget allocation on similar technology and restrictions on service distribution across organisational boundaries. The solicitousness about this issue has been put into consideration in many opportunities to find a solution to reap all possible advantages of the existence and lay the stratagems for the future of CORS management. Years later, the relevant components were constituted under the arrangement of the National Geo-Informatics Board to create a communal attitude towards the CORS system.

The GNSS CORS undertaking in Thailand has moved forward under the attention of multiple organisations that have an interest in this technology adoption. Most of the stakeholders already owned this system; nevertheless, their networks are insufficient due to limited coverage and technical development. The integration of the CORS owners and other bodies leads to brainstorming sessions attempting to solve the

problems. The succeeding passages will summarise the happenings in relation to the GNSS base station administration in Thailand.

TABLE 20 Cooperativeness in GNSS CORS development in Thailand (Source: Author's own research, summarised from Section C.2 and TABLES A-12 and A-26)

Cooperativeness	Activity	Achievement
Inter-organisational Collaboration	• The High Level seminar on creating the National CORS Data Center (National Geo-Informatics Board, 2017)	• The National CORS Data Center and the National Subcommittee on GNSS Network were established to manoeuvre the National CORS to achieve the collective goals.
	• The National Subcommittee on GNSS Network (National Geo-Informatics Board, 2017)	• Reach the conclusions of the requisitions for the National CORS Data Center prospective organisations.
	• The National CORS Data Center (National Subcommittee on GNSS Network, 2017)	• The national GNSS infrastructure concept and development plan were inspired by the Network of CORS Networks idea.
	• A roadmap for policies, standards, and applications (National Subcommittee on GNSS Network, 2017)	• The formal brainstorming session turned out the guidance for the policies, standards, and applications adoption.
	• Research and development for the start-ups and SMEs (National Subcommittee on GNSS Network, 2017)	• The services from the National CORS have prospected for the research society and small businesses as a preliminary scheme.
International Collaboration		
Japan	• The Japan - Thailand High Level Joint Commission (HLJC), (MFA, 2017)	• The official cooperation enhanced knowledge transfer and technology support potentiality between the Thai government organisations and foreign countries.
China	• Knowledge, technologies and human resources support (National Subcommittee on GNSS Network, 2017)	• The offers have not yet been finalised; however, the discussions indicated the Thai National CORS improvement feasibilities.

The activities regarding GNSS CORS in Thailand have been directed, conforming to the joint agreement in the seminars and meetings at a national degree. In order to examine how the cooperative league of cross-organisational CORS network has moved and the reasons for these attempts, numerous key elements were chosen as a backbone for these theories.

A performance measurement applied in the study of Australia's CORS management in qualitative and quantitative ways has also been considered for Thailand's case. These indicators have been used to value whether the ongoing CORS implementation project in Thailand meets expectations. TABLE 21 below illustrates the measure of GNSS CORS development in Thailand attainment that is associated with various issues. This

qualitative assessment considered the problems occurring in Thailand against the resolutions Thailand has tried to fix. It was systematically compared and contrasted to identify the issues and the responses presently working on.

TABLE 21 The qualitative measure considering an achievement in GNSS CORS development in Thailand (Source: Author's own research, summarised from Section C.2 and TABLES A-12 and A-26)

Issue	Resolution
No resource sharing	They have partially shared now.
No strategic plan	They have not reached conclusions about the Thailand strategic plan for GNSS CORS.
No policy	They want to have a GNSS CORS policy but have not adopted a policy.
No legal procedure	They have some ideas about exerting necessary ACTs and regulations from the exemplars in the DOL surveying ACTs and the laws relating to positioning management control in foreign countries.
No role and responsibility	They created the role play for some tasks, such as the temporary National CORS Data Center, the Working Groups for National CORS Data Center implementation, National CORS Data Center Management, and the Thailand-Japan Joint Commission.
No CORS standard (infrastructure, data, technique)	They have not built a standard but are interested in the System of Systems concept.
No central unit for CORS management	They expected a Board of National CORS consisting of representatives from relevant organisations, but the idea has not been implemented yet.
No data centre	They agreed to establish the National CORS Data Center but have not created it due to budget shortage; however, the RTSD is temporarily operating as the National CORS Data Center.
No central tool for data centre	They temporarily provide services via the data centre web portal, namely the RTSD GNSS Portal.
No business model	They do not have a business model, but they take the licensing strategy into consideration.
No co-planning on CORS investment	They have not formed a co-investment relationship but expected the policy covering this matter from the National CORS.
No maintenance, renewal, and expansion budget	They do not have a structural scheme but require fulfilment from the National CORS.

In addition to the preceding evaluation approach, some numbers have been used to prove the accomplishment of the attempts or the outgrowth that the project has been carrying through. The qualitative indication described the situation with an in-depth method, while the quantitative proof showed evidence of the improvement with plainly understandable figures. As a consequence, the combination of these logical measures can assuredly increase the reliability of the study of CORS movements in

Thailand. Nonetheless, the quantitative measure does not evidently reflect the actual endeavour in Thailand. This is because of the small amount of information and the slow-moving process of advancing Thailand's National CORS. The summarisation of this outcome can be seen in TABLE 22 below.

TABLE 22 The quantitative measure considering an achievement in GNSS CORS development in Thailand (Source: Author's own research, developed from TABLE A-12)

Strategy	Outcome
Government sector free service	Focus on providing free-of-charge services for governmental and educational organisations rather than profit-making. • Over ten users are from the government sector.
Profit	Each of the CORS operators offers solutions for non-governmental users with a variety of service packages. • DOL can benefit by \$2,200-2,800M per year from the registration of rights exploiting positioning usefulness. • Thirteen clients are from the private sector.

Conclusion

Thailand has distinctive features of political influence and the system of governance, which are the clue to development. Even though the CORS technology was initiated in Thailand in a comparable period with other countries and continues to grow, the system management is considered inefficient. A number of factors applied to the study to examine the Thai context turned out as described earlier. A varied group of works linked to the CORS implementation in Thailand have joined the movements. Nevertheless, success is hopefully forthcoming.

5.8.2 Primary Data Analysis Result

Interview Data Analysis

This section presents the analysis results based on the series of data collected over time: first data collection and second data collection (the lists of questions used for data collection can be found in the Appendix). The timeline data are integrated into the analysis to link with theories, comprising Collaborative Innovation, Networked Innovation, Innovation Ecosystem, and Stakeholder Theory. The empirical investigation encompasses diverse sectors of GNSS CORS in Thailand. It involves elaborate planning and discussions about CORS co-development barriers and enlists the support of multi-organisational joint working to solve the problems.

The scrutiny designed for carrying context and foundation for assimilating the ideas to usher in a scheme entailed CORS significantly in Thailand. The results of data analysis are described below.

TABLE A - 24 (in the Appendix) shows examples of coding outcomes from each category of codes. The pattern-matching algorithm was exerted to interrelate the precoded components and the interview contents. The coding stage returned outputs that provided the pattern of data. As a consequence, the results were placed in this table to see the similarities of patterns.

Earlier in this chapter, the explanation of congruency and discrepancies in the analytical work outcomes, between theoretical and observed, is separately stated in regard to the data collection process. The initial conceptual framework was brought for the tests to evaluate the consistency of findings in light of how well they match with the predefined elements. The key factors identified from the primary data, aligning with the initial conceptual framework, are summarised in TABLE 23.

It is possible to infer from the differentiation that the respondent groups are aware of most factors. Furthermore, the inferential judgement revealed that coded data from three approaches conformed to four initial conceptual framework constituents: ownership and governance, power asymmetries, interaction processes and supporting technologies, and setting direction of collaboration. Overall, almost every element was fulfilled by quotations from the research subjects, as supported by the transcripts. Therefore, it is logical to conclude the tendency of the study that the initial conceptual framework and the observed patterns are congruences, strengthened by all data collection strategies. TABLE 24 presents a summary of the findings based on the correlation between the coded data and key components of the initial conceptual framework, which forms part of the theoretical framework's outer circle. This conclusion is drawn by comparing data from three different collection methods. The table specifically highlights the items that are not explicitly evident in the data. However, this absence does not imply that the data contradict the framework; rather, it suggests that these aspects may not have been directly addressed or emphasised in the collected responses.

Based on the analysis of the conducted interviews, the key themes emerging from the participants' responses align with the developed theoretical framework. These themes are summarised in the table below, with each point specifically labelled to reflect the key issues identified. The interviewees' statements clearly highlight several critical issues: the inefficiency of government ownership, the impact of power asymmetries on CORS development, the challenges in the interaction process and ineffective technology management, and the overall lack of successful collaboration. The direct quotes from participants further emphasise these concerns, providing valuable insights into the existing obstacles.

TABLE 23 A summary of key factors from the initial conceptual framework identified in the Thai primary data. (Source: Author's own research, summarised from Section D.4 and TABLE A-24)

Ownership and governance	Power asymmetries	Interaction processes and supporting technologies	Setting direction of collaboration
1. Insufficient Planning and Coordination Here are some direct quotes from the interviews: - “The DOL is gradually installing its network in three phases due to budget constraints, while the RTSD is setting up its system independently. As a result, if CORS integration is attempted, it remains uncertain whether these networks can be combined into an extensive system.” - “Everyone has to be mindful of whether it falls within our authority. Are we permitted to proceed?”	1. Disparities in Power and Influence Here are some direct quotes from the interviews: - “CORS implementation would not have been possible without the presence of a military government.” - “While the DOL holds the most CORS data and the total number of CORS stations will eventually exceed a hundred, the RTSD will also operate 80 stations. Meanwhile, GISTDA, despite having minimal CORS infrastructure, strongly aspires to take the lead. This dynamic is likely driven by political influences.”	1. Deficiencies in Planning and Coordination Here are some direct quotes from the interviews: - “In some areas, certain organisations have already set up their CORS. Since we’ve also established ours within this radius, there’s no need for other departments to do the same. It’s better to share resources and focus on other priorities together.” - “When integrating base station locations, there should be a discussion on how to set them up and use them collaboratively. The placement should be strategically planned to maximise benefits for the country.”	1. Enhancing Collaboration and Policy Development Here are some direct quotes from the interviews: - “We need to collaborate with other countries since we’re not yet a technology developer ourselves.” - “The government, specifically the Prime Minister, should propose the policy, incorporating input from committee members (key stakeholders), the Permanent Secretary, and the Minister.”
2. Divergent Goals and Knowledge Gaps Here are some direct quotes from the interviews: - “The DPT had no intention of using real-time services; instead, it focused on providing RINEX data, allowing	2. Uneven Resource Distribution and Management Here are some direct quotes from the interviews: - “In the beginning, it should be the one with the most assets.”	2. Gaps in Technological and Financial Readiness Here are some direct quotes from the interviews: - “Technology has moved past that—people don’t watch traditional or digital TV anymore; they’ve switched to	2. Defining Authority and Decision-Making Processes Here are some direct quotes from the interviews: - “Maintenance budget requests shall be submitted to the Office of the National Geo-informatics Board (NGB),

Ownership and governance	Power asymmetries	Interaction processes and supporting technologies	Setting direction of collaboration
users to perform post-processing regardless of distance. In contrast, the DOL aimed to establish a network.” - “They focus solely on their areas of expertise”	- “They must also have the power to acquire resources on their own.”	YouTube. It’s the same with GNSS—everyone now relies on Cell-Based systems.” - “At that time, the ideal national CORS network was estimated at around 400 stations based on academic guidelines recommending a 30–50 km baseline distance. However, due to budget constraints and separate allocations for each organization, the plan was adjusted to add 200 more stations to maximize coverage as effectively as possible.”	which falls under the Office of the Prime Minister, by the Board, itself under the NGB's supervision. The Office of the NGB is likely responsible for budget preparation.” - “Clear protocols must be established in advance to define the authority levels and responsibilities for managing user access to the system.”
3. Weak Collaboration and Trust Here are some direct quotes from the interviews: - “We may not have had many opportunities to talk with each other in the past.” - “They must be open-minded, including being willing to disclose their methodology.”	3. Unclear and Ineffective Authority Here are some direct quotes from the interviews: - “Who grants these powers? Is it the law? You can't just suddenly have such authority without legal backing.” - “The defined authorities were outlined too broadly.”	3. Weak Infrastructure and Operational Support Here are some direct quotes from the interviews: - “There need to be fences, or the equipment might go missing.” - “A station's design can't be changed too much due to factors like the proper radius, location, and the person responsible for maintaining it. It can't just be placed in a wasteland—it needs electricity, staff, and security fences.”	3. Strategic Planning and Operational Design Here are some direct quotes from the interviews: - “Robust security measures must be implemented to protect executive access from unauthorised intrusion.” - “Government organisations will receive access to services at no cost, whereas private sector users will be subject to a fee structure.”

TABLE 24 A comparison of findings congruency of Thailand's case (Source: Author's own research, developed from TABLE A-27)

Key Factors from Initial Conceptual Framework	Data Analysis		
	Focus groups	Expert Interviews	Follow-up Interviews
Ownership and governance	All factors were addressed in the interviews	All factors were addressed in the interviews	All factors were addressed in the interviews
Power asymmetries	All factors were addressed in the interviews	All factors were addressed in the interviews	All factors were addressed in the interviews
Interaction processes and supporting technologies	All factors were addressed in the interviews	All factors were addressed in the interviews	Most factors were addressed in the interviews, except for • Lack of coordination on the CORS site planning • Lack of public service for the agricultural sector • Lack of awareness of the obsolescence of technology • Lack of keeping up with the evolution of disruptive technology • Lack of enlightenment of recognition and rationality
Setting direction of collaboration	Most factors were addressed in the interviews, except for • Design the product solutions	All factors were addressed in the interviews	Most factors were addressed in the interviews, except for • Legislate in this area • Adopt policies • Design the policies

The table above summarises the findings on whether the interview data from Thailand's case aligns with the initial conceptual framework. The comparison includes results from focus groups, expert interviews, and follow-up interviews. Notably, some key factors identified in the first round of primary data collection did not carry over

into the second round (highlighted in yellow). For example, concerns about the obsolescence of technology, the need to keep up with disruptive technological advancements, and the adoption of policies were mentioned initially but not later. This suggests that these aspects were either deprioritised, overlooked, or no longer seen as relevant from an innovation management perspective. Over time, participants seemed to lose interest or concern regarding these issues. The Initial Conceptual Framework provides insight into the significance of these factors, highlighting the necessary conditions for effective technology implementation. The findings demonstrate that while some of these factors remain critical, others are not functioning as expected, affecting the overall success of CORS development.

TABLE 25 Summary of key findings from the Thai primary data (Source: Author's own research, developed from TABLES A-25 and A-26)

Focus groups	Expert Interviews	Follow-up Interviews
The data indicates significant CORS development in terms of installations but lacks proper integration. While stations are built and operational, essential supporting components remain missing. <i>These components align with the initial conceptual framework, which enables the researcher to understand the importance of these factors.</i>	The data mentions the evolution of CORS technology and efforts toward cooperation, though key organisational barriers remain. <i>These organisational barriers align with the initial conceptual framework, which enables the researcher to understand the importance of these factors.</i>	The data highlights progress in CORS implementation and cooperation efforts, though challenges persist due to inter-organisational barriers. <i>These inter-organisational barriers align with the initial conceptual framework, which enables the researcher to understand the importance of these factors.</i>

The table above summarises the alignment between the primary data collected through various techniques and the Initial Conceptual Framework. The findings indicate that the aspects highlighted by interviewees align with the elements of the initial conceptual framework. This framework outlines the key factors necessary for the successful implementation of the technology. However, the interview data reveal that some of these factors are not functioning effectively. The table highlights consistent themes across the three data collection methods, showing that technology implementation progressed well, while challenges in network integration persisted. The alignment of primary data with the framework confirms the reliability of the findings. These results drive the need to explore why certain aspects in Thailand fell short and how they can be improved.

5.8.3 Success Evaluation Result

The success evaluation framework was applied to evaluate the effectiveness of CORS technology implementation in both Australia and Thailand. In the case of Thailand, the data for evaluation was gathered through interviewee responses to questions such as:

Do they have a data centre? Is there a central tool for management? Are roles and responsibilities clearly defined? Is there a central unit for managing CORS? Expert interviews and focus group discussions provided offer insightful details, with content analysis serving as the primary method for evaluating these measures.

The findings suggest that while Thailand has successfully installed and implemented CORS technology to some degree, several critical issues remain unresolved. For instance, there is no central direction, no integration, and no overarching business model to guide operations. As summarised in TABLE 26, the results show a mixed outcome: some aspects of the implementation were partially successful, while others were less effective or problematic.

TABLE 26 Evaluation results of CORS implementation success in Thailand (Source: Author's own research, developed from TABLES 19, A-12 and A-13)

Type of measurement	Issue	Evaluation Result
Qualitative	Resource sharing	Partially Successful
	Strategic plan	Not Successful Yet
	Policy	Not Successful Yet
	Legal	Not Successful Yet
	Role and responsibility	Not Successful Yet
	CORS standard (infrastructure, data, technique)	Not Successful Yet
	Central unit for CORS management	Partially Successful
	Data centre	Partially Successful
	Central tool for data centre	Partially Successful
	Business model	Not Successful Yet
	Co-planning on CORS investment	Not Successful Yet
	Maintenance, renewal, and expansion budget	Not Successful Yet
Quantitative	Preventable costs	Not Successful Yet
	Profit	Not Successful Yet

5.9 CHAPTER CONCLUSION

GNSS CORS is a ground augmentation technology to enhance GNSS satellite data quality. It can be implemented stand-alone or as part of the network. The key importance of CORS reliability is relevant to network denseness and coverage. As a result, the number of CORS stations is significant, as high degree as the appropriate distribution. The primary data collected from expert and focus group interviews reveals that each Thai government organisation has CORS stations to serve their internal tasks; for example, RTSD built its CORS for the control points of national mapping, and DOL expanded its CORS networks to facilitate the generation of land rights. However, the infrastructure they have in hand is not enough. They have then tried joining their network with others in order to fulfil their challenges and extend the covering area. Still, the CORS owners cannot perform cross-boundary linkage

without appropriate conditions due to limitations in resource sharing with the outside policy. In so doing, the coordination needs some practical and legal organisation. These prerequisites include the plan, policy, and law for making collaboration.

According to the success evaluation framework, CORS management in Thailand performed reasonably well in certain areas, including the initiation of resource sharing, the development of a central unit for CORS management, and the establishment of a data centre and its central tools. However, it fell short in other aspects. These included inadequate development of the strategic plan, policy and legal, unclear roles and responsibilities, insufficiently defined CORS standards (covering infrastructure, data, and technology), a poorly designed business model, a lack of co-planning for CORS investment, an insufficient budget for maintenance, renewal, and expansion, the absence of application of CORS to reduce the government's preventable costs, and a failure to adequately address profitability.

At the time of this study, based on both qualitative and quantitative evaluations, such cooperation had yet to be achieved. This shortfall can be attributed to several criteria discussed in this chapter: collaboration, finance, human resources and responsibilities, planning and policy, and technology. Thailand's complications in these areas can be compared to the challenges Australia faced in its earlier stages of CORS network integration. Australia initially encountered difficulties in consolidating CORS networks owned by multiple stakeholders. However, with strong technical, financial, and administrative support from various sectors, Australia developed tailored schemes for positioning services, including CORS services. Ultimately, these efforts enabled Australia to overcome these challenges successfully. The analysis provided in this chapter offers valuable insights into Thailand's circumstances and highlights the lessons from Australia's historical experience. The next chapter will adopt a comparative analysis approach to examine the similarities and differences between the two countries in terms of their situations and management strategies.

Chapter 5 delves into the history of Australian CORS management through secondary data and examines Thailand's CORS implementation efforts using primary data. While the primary focus of this study is on Thailand's CORS, Australia serves as a comparator to shed light on Thailand's experience. The analysis identifies the factors that contributed to Australia's success and contrasts them with the challenges Thailand faced. Chapter 6 will further explore these findings, examining what worked well in Australia and investigating the reasons behind the differing experiences in Australia and Thailand. It will also assess whether similar practices were implemented in Thailand and how variations in approach may have contributed to Thailand's less favourable outcomes. This comparison aims to derive actionable insights to enhance Thailand's CORS management.

Chapter 6

CROSS-CASE ANALYSIS

This chapter aims to demonstrate the findings conducted from the document and interview data analysis. The case studies analysis, as hereinafter provided, emphasises the similarities and differences between the CORS collaborative endeavours in Thailand and Australia based on the gathered pieces of evidence. The cross-case analysis has been processed based on this evidence.

6.1 A COMPARISON BETWEEN AUSTRALIA AND THAILAND

The GNSS CORS network refers to a system of positioning calculation segments and other facilities that are combined as the overall infrastructure to deliver the various types of products to multi-users who require location services for their particular purposes. Functioning and managing are necessary for providing high-quality products. The data acquiring and processing steps are each crucial for the operation part, as well as infrastructure handling, and the solution release mechanism is impactful for the organisation part. Involvement of the network governing requires careful consideration of Thailand's GNSS CORS situation. The imminent contribution will compare operation and management differences in the context of Australia against the present-day situation in Thailand.

The unification of CORS management plans in Australia came to fruition in the wake of the dynamic network activities. The solo works to deal with CORS technology were revised and turned into a collaborative venture to fulfil the national guidance. A reasonably practical policy is the key to this drive. In which they share their properties and responsibilities, the outcomes are beneficial for positioning society. This campaign was considered satisfactory by the professionals who took part in the development. The upshot linked with the movement includes the standards, integrated data centre, service portal, control and service bodies.

Similar to Australia, an assortment of CORS operations in Thailand has unfavourably affected the cross-party network tie-ups. The challenges embodied in solicitude are technology, inter-organisational collaboration, policy framework and business model, finance, law and regulation, and international partnership. Nonetheless, the scale of contentedness in GNSS CORS cooperation between the Australian and Thai is distinct.

6.1.1 General

Overall, Australia and Thailand have some similar features but also differences, too. A simple comparison between the two countries is the total area that comprises the land area and water bodies such as lakes, reservoirs, and rivers. Australia and Thailand are 7,692,024 km² and 513,120 km², respectively, which represent 5.2% and 0.3% of the world's landmass.

In light of geography, Australia is compounded by the tremendous solitary mainland and scores of small-scale islands located between the Southern Ocean, the Indian Ocean and the Pacific Ocean. It has no shared land border with another nation. It is the biggest country in Oceania and the sixth largest globally. Thailand, in contrast, is smaller and shares many land borders. The upper part of Thailand is a continent surrounded by the ASEAN countries, and the lower part is a strip of land where the west shoreline is along the sea of the Indian Ocean, while the east coast meets the sea of the Pacific Ocean. It is the fiftieth largest country in the world.

The topography of the two countries is detailed at variance. Australia has a prominent attribute of central and coastal plains, drainage basins, highlands and deserts, and sandy beaches. In comparison, Thailand is characterised by mountains and hills, smoothly undulating plateaus, flat and low-lying floodplains, and rugged and sandy coasts. The climates of Australia are diverse by virtue of its vast area. Its tropical climate is generally dry, warm and cool, and its temperate climate has mild conditions. It also has scorching and freezing weather in some areas. Contrastingly, Thailand has a bold type of climate. It is mainly tropical wet and dry, which is customarily very hot and summery.

By the standard of topology, the geographical and topographical landscapes and the atmospheric conditions influence the communications infrastructure's viability. In Thailand, the long and steep undulation of the mountains is one of the topmost obstacles. It blocks the mobile internet connection and limits the capacitive coupling of landline internet. Some of the CORS sites cannot roll consistently by means of interrupted internet connectivity. These momentous localities are near the borderline, which is not a populous zone. Inversely, Australia found that in densely populated cities, the internet service is unsatisfactory.

In terms of CORS infrastructure, the Australian government stated that there were about 325 stations in 2013. Comparably, by 2020, there were around 235 CORS stations in Thailand, though new sites were expected to be added in later years. The GNSS network growth differentiation between the two countries is not a focal point in the compositions. These figures are assumed to be equivalent in the sense of quality and quantity. The infrastructure density, which is proportional to their area's size, shows that Thailand is not very different from Australia in technology investment. However, the next section will describe other aspects of distinctness between these countries.

TABLE A – 14 (see in Appendix) shows the GNSS network management comparison between Australia and Thailand in various terms. The comparison results from previous information-processing procedures to capture the contents of CORS implementation in Australia and Thailand, then contrast the key similarities and differences between them. The terms used for the points of contrast are in the context of general information regarding the development of the CORS system that occurred in the data-compiling stage.

6.1.2 Technology

CORS infrastructure

Australia and Thailand have persevered in the GNSS CORS development in the same manner that technology has been invested separately. Several strategies have been introduced to get the most out of individually installed and operated CORS infrastructure. In view of device handling, Australian governments and researchers suggested the idea of a thick infrastructure. Such a statement is relative to GNSS networks that have CORS sites roughly tens to hundreds. These networks have a close link to the packed zone, mobile connection preeminence and internet quality. A System of systems framework describing three tiers of base station infrastructure was a core tactic used in Australia. It was also scheduled for real-time service support. On the plus side, trustworthy databases, so-called NGDB, were ushered in the geodetic data ingathering. Supplementarily, the APREF monitoring system was inserted for the CORS integrity, watching over Australia and the Asia-Pacific region. Another module slotted into these structures was the NGCI database, which evolved dynamically to respond to the CORS service request instantaneously. This database also assisted third-party SPs node diagnosis, benefiting both the custodian and consumer sides. These are positioning-related technologies that Australia has tried for CORS infrastructure management.

Thailand, by the same token, has been considering the system-of-systems approach and real-time service manipulation strategies. Nonetheless, taking action in response to these designs requires approval from the National Subcommittee on GNSS Network. In addition, fulfilling collaborative agreements requires significant time, so Thailand has to plan ahead to ensure the program's success, like in Australia.

Techniques

To strengthen the GNSS reference system, Australia has developed a number of scientific procedures to uplift its performance. One of those modalities is the TCAR concept, which sets the sights on subsiding the implementation workload. Another method Australia has used to achieve the touchstone is a server-based and thin-client platform. This platform can enhance service quality and lower the utiliser's appliance exhaustiveness. Several observation techniques, such as VRS and FKP, are looked ahead to be compatible with them. The software that was cooperatively produced and put into practice in Australia is SNAPper. It was declared that the qualification is as excellent as NRTK technology. Over and above that, the FSDF – a large-scale systematic arrangement to impose spatial data uniformity was themed to plot supply chains and solutions direction.

Thailand, consonantly, has been cogitating the TCAR method, which is applied in Australia. Nevertheless, the determining process takes time to put into practice.

Tools

Web server and web map server are taken to present CORS information and services in Australia. As an accessory to that, the web portal is one of the channels designed to enable clients to connect all available services, customer support, and user communities. These tools are advantageous to both data quality control and system overseers. The NGRS is one of the accesses that exposes geospatial data and relevant dependable content produced by various authorities in Australia. In opposition, the APREF web service put on view the continuously monitoring geodetic framework of GNSS reference base sites to maximise their potential in Australia and the Asia-Pacific. The NGCI web map, in common, is a tool for the centralised management of CORS at a national level, which includes business aspects. On the other side, spatial data learning has been displayed by the SKI. It covers the data transfer stage to knowledge sharing. Meanwhile, the FSDF service, which was put into effect abided by the ANZLIC Strategic Plan, has given prominence to supply chain magnification, adeptness enlightenment, and repetitive activities in Australia.

Along with those web services, the LBS is a prospectus of the Australian government to earn the gross profit and downsize the country's spending plan of positioning utilities.

In Thailand, a web-based service is under consideration. However, the implementation is under review by the National Subcommittee on GNSS Network and the admissible authorities.

6.1.3 Collaboration

The interoperating effort to prevail over the GNSS reference network's duplicative financial and managerial predicament in Australia unfolded after the Melbourne 2006 Commonwealth Games. The Australian state and territory jurisdictions were a patron of the AuScope projects under the NCRIS. Such projects were focused on fulfilling CORS service over a span of boundaries finely and empowering the NGRF added to VLBI and SLR techniques. In parallel with this, the CRCSI – the government-accorded research centre has aggrandised itself by multiplying GNSS and other spatial technologies' creativeness in miscellaneous societies. The attempts were conducive to the SPU in floating Australian space policy and gave rise to Australia's Satellite Utilisation Policy.

Furthermore, ANZLIC – the intergovernmental endeavour, had aggregated the team in close proximity to the foundation spatial data organisers in Australia. It promoted the ICSM to address the national technical standards and affected the ICSM working groups to make a move. Not only that, the NPI carried on with the positioning infrastructure arrangement. It came up with the NPI Plan to get a measure of CORS infrastructure subsidy and its contrivances. The NPI-AB, the Board, which encompasses multiple sectors of positioning-related authorities in Australia and New Zealand, is a crucial player which oversees the NPI projects and reports their

progression to the NPIPE. By the joint action of the PNT-WG, Geoscience Australia steps the NPI-AB obligation; the TWG inspects the work.

To reach an agreement on the CORS apportionment, Thailand ensures collaboration with applicable organisations. The High Level seminar on creating the National CORS Data Center took place to hold a discussion on such a topic. The National Subcommittee on GNSS Network was consequently formed for the National GNSS Infrastructure project implementation. It led to the National CORS Data Center, which is the project leader selection. The cooperative team assented to launching a roadmap for policies, standards, and applications covering the GNSS CORS requirement. Furthermore, they invigorated research and development for startups and SMEs.

6.1.4 Policy and Business Model

Policy and business model are the pressing necessity for following through on assembling the GNSS reference stations' members for uniting the national CORS network. They are both the instructions and regulations for the ongoing reforms.

Policy

The policy is a fundamental principle for a start on the CORS collaboration scheme in Australia. The Queensland Geospatial Reference Framework Policy has induced numerous dominant actors into the relations and policy change on CORS affairs. The national-level axis of this constructiveness is the NPI Policy. At the primitive stage, the NPI Plan kept on with ground infrastructure expenditure valuation to observe the Space Policy Unit precepts. The ICSM, as the standing committee of ANZLIC, has forged the technical standards on the grounds of this. They then instituted the ICSM GNSS CORS Coordination Group, a permanent sub-committee of ICSM, to organise the plan adhering to FSDF and ICSM and produce educational materials. Very quickly, the NPI-AB was systemised to be the central body governing the NPI projects and harmonising with the PNT-WG and IWG. Consequently, the NPI-AB has generated a report in cooperation with TWG and sent it to NPIPE for inspection.

Thailand officially embarked on policy development by issuing an Application Form to make headway on the GNSS CORS project. Even so, it has not been optimised and turned into a deliverable to make it production-ready.

Model and Strategy

A business model determines the entire way that the programme will be performed, ranging from infrastructure, procedures, policies, operations, and benefits. The models that have a bearing on CORS achievement in Australia are initiated by multiple proponents and executed by various sectors. The GNSS CORS Network Management Model was created to structure the running of the infrastructure and service, including commercialisation. It subsequently transpired to take advantage of the data service providers (DSPs) and the value-added resellers (VARs). One of the eminently sensible models that occupied almost the whole of the communal CORS process is the client-server based model. It hierarchised the CORS infrastructure and business plan vitally.

A service broker and a service provider (SP) were embraced to forward the burgeoning of both standard and value-added solutions delivery. This model also ran for the benefit of legal traceability. The multi-tier framework from the System of Systems initiative was remarkably beneficent.

The AuScope project exhibited some degree of supportiveness of Australian geodetic infrastructure, while the Organisational Roles in Precise Positioning partnership model detailed the CORS campaign stages. In conjunction with these, the PCG made the tier hierarchy more comprehensible and invertible. It guided the NSW Government to the CORSnet-NSW arrangement and became a pilot for the SydNET in applying server-based and thin client RTK services framework. Ultimately, the NPI Policy is a momentous one and can claim success in Australia's CORS mutual relations. The NPI Plan, NPI BMSC, and NPI Capability are meaningful elements in a programme moveability withal.

To ensure the CORS collaborative campaign expectation's potency, Thailand is inclined towards the Japanese business model. Such a business model surpasses the Australian model, which came to light in the exchange of views by various players in the context of profit return and wholly system organising. Yet, they have not decided on the implementation.

Guidelines

The inceptive Australian standard and code of practice on GNSS CORS emanated from a guiding principle permitted by the Land and Property Information (LPI) Division to put protocol for CORSnet-NSW. Thailand, however, has not yet set the rules for this system.

6.1.5 Finance

The public expenditure and revenue gain on GNSS CORS system and services exert influence on monetary resources interest at the national scale. Deciding the expenses on governmental infrastructure thereon needs to consider both speculative capital and attainment.

Return on Investment (ROI)

The Australian government and jurisdictions are obliged to the Preventable costs conception to give thought to Australia's CORS technology involvement worthiness. In Queensland, economic growth is encouraged by high-precision positioning. Despite the fact that the governments keyed into keeping the disbursement at a minimum more than doubling the business takings, the CORSnet-NSW, in cooperation with several government authorities, has serviced GNSS data packages for a charge. The CORS network supervision, as a consequence, was underwritten by these earnings.

Interviewees concerned about the National GNSS CORS project in Thailand concurred with the notion that CORS services are prioritised to support government organisation missions. However, the RTSD has been employing partnerships with the DOL to grant

the data's two-way sharing and released RTSD service packages for a standard purchase price. The RTSD is ruling the National CORS Data Center and will aspire to attain control of the national CORS services similar to the RTSD business plan but in the superior dimensions when the National CORS Data Center facilities are prepared.

Prospect

Even though the CORS were intentionally brought into play for public work, it became viable for business, too. According to the economic consultant organisation and the government CORS relevant units, Australia expected \$800 million to \$1.5 billion per year from activities that utilise positioning data, such as construction, farming, and mining. They are also predicted to be worth \$32-58 billion in these sections. Unceasingly furthering will reward the incomings between AUD\$73 billion and AUD\$134 billion within 2030.

In the part of profitmaking, Thailand has not valued the feasible lucre yet.

6.1.6 Legal

The administration of the law is a salient matter for applicative GNSS CORS activeness.

Legislation requirement

The apparent keystone of the proceedings will label all the allowances and prohibitions of CORS promotion. The judicial by the state and territory government is one of the weighty criteria that is a pillar of strength for Australia's CORS. To encourage the CORS unified model, they commended the legitimated significance of facilitating a coherent whole.

The legal capacity to direct CORS coordination in Thailand also necessitates the legislation for data sharing between organisations. The stakeholders require a definitive authority to break through the inter-organisational law barrier.

Relevant Act

The Act is a piece of legislation that is robust and already in force. It validates CORS's course of action. In Australia, Queensland's CORS undertaking conformed to the Act empowered by the State Control Survey. Both the Act and regulation were introduced to support this Australian publicity campaign. Those Acts and regulations, namely, the Australian Competition and Consumer Act 2010; Broadcasting Services Act 1992; National Electricity (South Australia) Act 1996; National Electricity (Victoria) Act 2005; National Measurement Act 1960; National Measurement Regulations 1999; and Telecommunications Act 1997.

Thailand has not correlated the Act to align with CORS project happenings. However, they composed the MOU on CORS data sharing between government authorities that own the infrastructure.

6.1.7 International Collaboration

The GNSS reference stations can induce a regular rise in positioning advantageousness through a topologically cohesive network formulation. The success of GNSS CORS in each country can be ensured by broadening the interconnection. International CORS linkage will revamp the geospatial data expedience at a greater level and boost global partnerships. Australia has cooperated with several countries under diverse circumstances. With Singapore, Australia has joined for algorithms co-development on data processing, including joint research on data management and communication systems. They finally got SNAPper as an outcome, and it has been used in the UNSW CORS system. The coordination between Australia and Japan has focused on natural hazard assuagement. Also, Australia has miscellaneous collaborative GNSS CORS research with New Zealand, China, the USA and European countries.

Further to that, some of the relationships are constituted as international associations; for instance, ANZLIC invigorated the spatial information projects in Australia, New Zealand, and the ASIA-Pacific. Australia is a fellow holding a position in the ICG founded for smoothing and steering the IGS activities. Australia takes part in the APREF that vitalises the pooled projects in Asia and the Pacific on geodetic datum burgeoning.

Similarly, Thailand has partnered with others abroad. The countries which have been patently supportive of Thailand's CORS collaboration instigation are Japan and China. Japan has nurtured Thailand through the signed and sealed contract, the Japan - Thailand High Level Joint Commission (HLJC). On the other hand, China insistently offers knowledge, technologies and human resources support.

TABLE A – 15 in the Appendix shows a comparison of GNSS CORS development between Australia and Thailand in terms of technology, collaboration, policy and business model, finance, legal, and international collaboration.

6.2 TIMELINE OF THE DEVELOPMENT

Further probing into the matter has sought coherence between the preceding research results. Accordingly, interconnectedness among those components and the link between their comprehensiveness were evaluated comparatively.

The previous steps of investigation had been done independently and returned their findings separately. This level of research has resorted to distinguishing between those findings. It is to recognise the likenesses and point out the differences between those inferences. The conclusion seeks to resolve an undesirable situation of GNSS CORS in Thailand and the study's validity. The analysed result is presented in this section.

6.2.1 Australia

Australia has developed the system of GNSS CORS over a period of time. Details in TABLE A – 18 and TABLE A – 19 in the Appendix are the summarisation of the CORS-related activities in Australia. It started with the emergence of the GNSS satellite, which led to the evolution of ground augmentation systems like CORS. Australia began the utilisation of CORS in 1992 and has expanded the CORS network for decades. In 1998, they commenced the discussion on CORS issues and continued co-working in relation to CORS until 2013 the accomplishment of developing an effective solution was announced. They now have the NPI Plan, the policies for CORS and other positioning services, and the responsibilities and authority were assigned to the actors under the supervision of the Board.

6.2.2 Thailand

CORS technology in Thailand began in 1996. The government department that installed the first CORS was the DPT. Subsequently, various organisations spread CORS technology throughout the country. The CORS administration's problems regarding their uncoordinated movements were officially addressed in 2011 by Rizos and Satirapod; however, concerns about this were pointed out earlier. In 2017, the Thai government started cooperation on CORS between the government organisations' own CORS and those involved with this technology. A joint relationship was also made between the Thai government and Japan in light of CORS technology and support. At present, Thailand has not completed the objectives to overcome those complexities. Additionally, the collaboration between organisations was delayed, and partnership with foreign countries was paused due to the Covid-19 pandemic. The encapsulation of the CORS development in Thailand can be seen in TABLE A – 20 and TABLE A – 21 in the Appendix.

The series of GNSS CORS development occurrences in Australia and Thailand relate the events to the actors at different points in time. As detailed in the tables, these relations are the critical moves that changed the direction of CORS in such countries. Or, at least, they could highlight the actions that each country attempted to take. Thus, those endeavours can be compared in terms of how each country has done and which way they have chosen.

The timeline started in 1978 when the DoD, USA, launched the NavStar (GPS). Fourteen years later, Australia initiated New South Wales' first CORS. The CORS technology evolved into a network system in 1994 by the US government; synchronously, Australia developed the first CORS network. Two years later, Thailand had the first non-networked CORS. In 1998, a discussion on CORS technical services was held in Australia, and many activities have been commenced since then. Quite the contrary, Thailand completed the first CORS network for real-time services in 2008, and it could be noticed that there were multiple CORS owners in Thailand. The issue was reaffirmed in 2011, and the efforts to achieve this complexity were officially established in 2017. Australia eventually declared the effectuation of the NPI Plan to

attribute the authority and responsibilities of the players in 2013 and instituted the NPI-AB as the central body for governing the Australian-wide CORS in 2018. Three is proof of Australia's attainment of CORS associateship aims. Contrastingly, Thailand has not yet reached the completion of the collaboration on CORS.

6.3 FINDINGS COMPARISON BETWEEN THAILAND AND AUSTRALIA

This research project is reinforced by two prime types of data analysis: within-case and cross-case analysis. The investigation results, as previously described, presented their distinct findings that adhered to the different sources of data. This section compares and contrasts those findings, with reference to the keys derived from the literature review settled as the theoretical framework. Such keys were applied to the examinations both in the secondary data case studies and interview data coding. The result of this comparison can be seen in TABLE 28.

It could be inferred that data analysis mechanisms returned similar findings and complied with the cardinal keys: *Technology, Finance, Human Resources and Responsibilities, Plan and Policy, and Collaboration*. Other features were put in use to provide more extensive details of the premier keys. All sets of data scrutinisation showed their consistencies with the master keys, but some minor attributes were not mentioned in the interviews, particularly the follow-up. These missing contents are because follow-up interviews were performed online through chats and phone calls with the same participants who already provided their personal feelings about such topics; they only updated new information to the timeline data collection.

6.3.1 Comparison of Data Analysis Results

Based on the initial conceptual framework, Australia demonstrated full alignment with all identified factors. In contrast, while some elements were acknowledged in Thailand's interviews, many key components remain unaddressed. TABLE 27 provides a summary of the findings, analysing the alignment between the key factors from the initial conceptual framework and the case studies in Australia and Thailand.

TABLE 27 A comparison of findings congruency of Thailand and Australia case studies
(Source: Author's own research, summarised from Section C.1 and TABLE 23)

Key Factors from Initial Conceptual Framework	Data Analysis	
	Australia	Thailand
Ownership and governance	All factors were presented in the evidence	All factors were addressed in the interviews
Power asymmetries	All factors were presented in the evidence	All factors were addressed in the interviews
Interaction processes and supporting technologies	All factors were presented in the evidence	Most factors were addressed in the interviews, except for • Lack of coordination on the CORS site planning • Lack of public service for the agricultural sector • Lack of awareness of the obsolescence of technology • Lack of keeping up with the evolution of disruptive technology • Lack of enlightenment of recognition and rationality
Setting direction of collaboration	All factors were presented in the evidence	Most factors were addressed in the interviews, except for • Design the product solutions • Legislate in this area • Adopt policies • Design the policies

Numerous examples of quotes from the interview participants were given earlier in the theoretical-empirical matching results of each interview type, namely focus groups, expert interviews, and follow-up interviews. The comparison between those findings will be represented in terms of the frequencies of each criterion that were counted to the codes. Since each data-gathering group required different numbers of sharers and the observation took divergent paths and timeframes, the quantity of repetition is not given importance in line with greater or smaller than other procedures. Yet, it was used to reassert the positions of the partakers towards the matters. Also, it can affirm the issues that were of interest to them more than other minor cares. TABLE A – 25 in the Appendix demonstrates information on such results.

According to the table, the maximum share of ideas from the focus group interview members is about the *LBS*, which was repeated 214 times. The views on this point were nominated by all six parties who joined the discussions, and they

were quite controversial in agreeing on the use of mobile devices for fieldwork and disagreeing on using them. This point seemed to vary on the speakers' responsibilities, and it was the most variety of opponents in the research. Besides, the nonverbal expression that showed the participators' reactions to the subject they were talking about underlined the *Paralinguistics* when they mentioned something in relation to the *Central Unit*. The contributors from all the organisations that took part in the conversation reacted 100 times using dissimilar tones and pitches when they made a comment in association with this substance. To the experts, the *Source of the Problem* was the majority of concern. All experts gave the perspectives involved with this concern 69 times, and the thoughts varied regarding their field of specialism and involvement in the CORS project. For the follow-up interviews, the priority was the *Inter-organisational collaboration* between the government organisations. It is the greatest part of attention, composed of 30 comments from six representatives.

In conclusion, the efforts to achieve successful CORS implementation in Thailand were demonstrated through various perspectives of the involved parties. However, these efforts primarily highlighted the absence of essential elements that Thailand should have but have yet to implement. In contrast, Australia previously encountered similar challenges but recognised them as critical factors that needed to be effectively addressed, ultimately leading to successful CORS management. The table below presents a comparative analysis of the findings from this study, illustrating the success of Australia and the unsucccess of Thailand in relation to the key factors identified in the developed theoretical framework.

TABLE 28 A comparison of findings between Thailand and Australia (Source: Author's own research, summarised from Section C.1 and TABLES 23 and A-26)

Key Factors Regarding Theoretical Framework	Data Analysis Results	
	Australia	Thailand
Technology	All factors have been thoroughly considered and effectively implemented.	All relevant factors were acknowledged, with some emphasised as important, yet none have achieved success or met expectations.
Human Resources and Responsibilities	All factors have been thoroughly considered and effectively implemented.	All factors were acknowledged, and some were considered with initial conclusions drawn, but none have been successfully implemented.
Finance	All factors have been thoroughly considered and effectively implemented.	Some factors have been addressed, and steps have been taken for improvement, while others remain unconsidered. For example, international financial support, preventable cost and profit.
Plan and Policy	All factors have been thoroughly considered and effectively implemented.	All relevant factors were acknowledged, with some progressing through initial steps, though none have yet achieved full success.
Collaboration	Successful inter-organisational and international collaboration was achieved, with all relevant factors fully realised.	Inter-organisational and international collaboration were considered, with strategies implemented toward success, but several relevant factors remain unresolved.

6.3.2 Comparison of Success Evaluation Results

The evaluation of success in Australia and Thailand, as previously presented, summarises the extent to which each country has achieved its goals based on both qualitative and quantitative measures. The table below provides a comparative summary of these results. While Australia has successfully met all the evaluated criteria, Thailand has only achieved partial success in certain areas, with others remaining unfulfilled. These findings confirm the incomplete and unsuccessful implementation of CORS technology in Thailand.

TABLE 29 A comparison of evaluation results of CORS implementation success in Australia and Thailand (Source: Author's own research, developed from TABLES 18 and 25)

Type of measurement	Issue	Evaluation Result	
		Australia	Thailand
Qualitative	Resource sharing	Successful	Partially Successful
	Strategic plan	Successful	Not Successful Yet
	Policy	Successful	Not Successful Yet
	Legal	Successful	Not Successful Yet
	Role and responsibility	Successful	Not Successful Yet
	CORS standard (infrastructure, data, technique)	Successful	Not Successful Yet
	Central unit for CORS management	Successful	Partially Successful
	Data centre	Successful	Partially Successful
	Central tool for data centre	Successful	Partially Successful
	Business model	Successful	Not Successful Yet
	Co-planning on CORS investment	Successful	Not Successful Yet
	Maintenance, renewal, and expansion budget	Successful	Not Successful Yet
Quantitative	Preventable costs	Successful	Not Successful Yet
	Profit	Successful	Not Successful Yet

6.3.3 Comparison of CORS Development Experience

As summarised in TABLE 28, the primary data collected from Thai interviewees revealed significant challenges aligned with key factors from the initial conceptual framework. These challenges are believed to hinder the efficiency of CORS development in Thailand. In contrast, applying the same framework to Australia yielded more favourable results. The table below highlights the outcomes of CORS development in Australia and Thailand, emphasising the differences in their experiences.

TABLE 30 Comparison of CORS development experiences in Australia and Thailand (Source: Author's own research, summarised from Section C.1 and TABLES 23 and 24)

Key Factors from Initial Conceptual Framework	CORS Development Outcomes	
	Australia	Thailand
Ownership and governance	Cross-boundary infrastructure sharing and collaborative management have reinforced issue resolution.	Individual ownership and management issues persist due to the partial effectiveness of the collaboration.
Power asymmetries	The challenges were addressed through effective collaboration among key stakeholders.	Power imbalances remain unresolved, as joint-working conditions have failed to address this issue.
Interaction processes and supporting technologies	The jointly developed solutions proved effective with appropriate support from multiple sectors.	Stakeholder interaction remains ineffective due to the lack of clearly assigned authority, policies, and legal frameworks.
Setting direction of collaboration	The lack of an active co-working environment was addressed by establishing multi-stakeholder collaboration and providing guidelines for effective CORS implementation.	Efforts have been made to establish cross-sector collaboration to define the direction for Thailand's CORS, but it has yet to be effective.

The table illustrates the efforts of both countries in implementing CORS, drawing attention to their progress toward project goals and the respective outcomes achieved. By examining the table, it is evident that Australia possessed more of the key factors identified in the developed theoretical framework, making success more attainable. The concept of ownership and governance played a crucial role in ensuring effective collaboration by establishing clear agreements on authority and responsibilities in managing shared assets. Australia successfully implemented this key concept, whereas Thailand has made some progress but has yet to fully integrate CORS networks and establish joint management due to the absence of specific laws, policies, and authoritative oversight. In terms of power asymmetries, Australia effectively balanced these dynamics, preventing dominance by any single stakeholder and minimising conflicts. This contributed to smoother cooperation among stakeholders, particularly by maintaining a balanced proportion of asset ownership. Yet, Thailand continues to struggle, further complicated by political challenges. Additionally, with strong sectoral support, Australia succeeded in generating a framework for stakeholder interactions and supporting technologies, enabling equitable participation. On the contrary, Thailand is still in the process of establishing these networks and addressing existing technological gaps. Moreover, Australia established a well-defined direction for collaboration, with a shared understanding of objectives and implementation strategies, making the process more effective. In contrast, Thailand has only implemented partial solutions, resulting in slower progress and persistent challenges in CORS cooperation.

The analysis of factors from the initial conceptual framework and the comparison of Thailand's experience with Australia's early development highlight the reasons behind Australia's greater success. With more key factors in place, Australia effectively addressed its challenges, as evidenced by its accomplished execution. Conversely, Thailand has ongoing difficulties due to the absence of specific laws, policy gaps, and unresolved power asymmetries, which led to its less successful achievements and continued obstacles in CORS implementation. Ultimately, the overall framework of collaboration, represented by the outer circle, demonstrates that Australia's case study follows a more structured and effective approach, leading to greater success in CORS development compared to Thailand.

6.3.4 Factual Comparison between Australia and Thailand

The table above demonstrates the clear differences between Australia and Thailand in CORS development, identifying critical factors from the outer layer of the theoretical framework. The next step involves examining the factors within the inner layer to gain deeper insights into the establishment of collaboration. Based on key aspects such as technology, human resources and responsibilities, finance, and policy planning, the theoretical framework outlined in TABLE A-11 and TABLE A-12 in the Appendix illustrates the achievements in GNSS CORS development in Australia and Thailand, respectively. The table below provides a comparative summary of the key elements that contributed to each country's success, highlighting the factors that enabled Australia to achieve greater success than Thailand.

TABLE 31 Factual comparison of Australia and Thailand in terms of factors contributing to GNSS CORS implementation success (Source: Author's own research, developed from TABLE A-17)

Key Factors	Implementation Activities	
	Australia	Thailand
Technology	Key GNSS CORS stakeholders—including government agencies, private companies, and academia—have worked together to tackle challenges in infrastructure, essential techniques, relevant tools, platforms, and data delivery and accessibility, contributing to Australia's success.	Experts and stakeholders emphasised the need for a technology-driven approach, proposing advanced techniques like system-of-systems, TCAR, and web-based services, though no final consensus has been reached.
Human Resources and Responsibilities	Government organisations and cooperative bodies played a key role in Australia's successful CORS implementation by supporting experts and staff, defining roles and responsibilities, and facilitating organisational design and personnel training.	Attempts have been made to address role and responsibilities assignment issues, but limited authority and collaboration resulted in only temporary positions. Additionally, personnel training remains unaccomplished due to insufficient expertise.
Finance	Government funding, along with international and cross-sector cooperation, supports CORS development, maintenance, and renewal. Meanwhile, revenue management, preventable cost strategy, and sustainable cost-saving approaches ensure financial success.	Government organisations received budgets for GNSS CORS, but government funding alone is insufficient for a nationwide network, and expected private sector revenue has yet to materialise.
Plan and Policy	The NPI-AB developed the NPI Plan and NPI Policy, while collaboration with GNSS CORS coordination groups led to the establishment of business models, a strategic plan, and various relevant frameworks, all supported by legislation, contributing to Australia's success.	The National CORS development and related committees have made partial progress in implementation planning, but policy and legal adoption remain pending. Business models, standards, and guidelines are under consideration but have yet to advance.

6.3.5 Comparison in Terms of Theoretical Framework

The details outlined below summarise the progress made by Australia and Thailand in achieving success in GNSS CORS development. This comparison highlights the extent to which each country has advanced, showcasing Australia's more comprehensive and effective implementation, while Thailand continues to face challenges. The conclusions drawn from this analysis provide insights into the key factors that

contributed to each country's outcomes and the areas that require further improvement.

TABLE 32 Factual comparison of Australia and Thailand in terms of theoretical framework
(Source: Author's own research, summarised from Section C.1 and TABLES 26 and A-16)

Key Factors	CORS Development Achievement	
	Australia	Thailand
Technology	Effective collaboration among diverse stakeholders has been instrumental in the successful development of Australia's CORS, especially in technological advancements. Through inter-organisational and international cooperation, CORS infrastructure, essential techniques, relevant tools, delivery and access procedures have been fully developed.	The lack of effective collaboration has impeded progress in achieving Thailand's CORS goals, particularly in technological development. Many aspects, including CORS infrastructure, essential techniques, and potential tools, are still in development, while data delivery and access conditions remain under consideration. The absence of collaboration, uncertainties in power and authority, and the lack of a structured process and technological development plan have hindered progress toward an optimal level.
Human Resources and Responsibilities	Effective collaboration among diverse stakeholders has successfully addressed key goals, including human resources and responsibility management. With support from various cooperating organisations, multidisciplinary professionals and researchers advanced Australian CORS, while general staff participated in co-working programs. This collaboration also enhanced organisational design and personnel training, ensuring well-structured roles and human resource management.	The absence of effective collaboration has stalled progress in achieving Thailand's CORS goals, especially in human resource management and role allocation. Unresolved issues in roles, responsibilities, and authority have led to a shortage of professionals, insufficient staff, poor organisational design, and a lack of personnel training programmes.
Finance	Effective collaboration among diverse stakeholders has successfully enhanced budget allocation and profit management. Collaboration across sectors led to an effective investment, maintenance, and renewal plan for Australian CORS, with a strong return on investment and significant preventable cost benefits for the economy.	The lack of effective collaboration has impeded financial progress, affecting both funding management and profit generation. Financial constraints in infrastructure investment hinder the development of Thailand's CORS network, while budget allocation for installation, maintenance, and renewal remains inadequate. Additionally, ROI management is ineffective.
Plan and Policy	Effective collaboration among diverse stakeholders has successfully established plans, policies, and laws for Australian CORS. Collaboration across sectors enabled the adoption of essential policies, while legal support ensured successful CORS implementation. Additionally, a strong technical model, strategic planning, and an effective business model, along with guidelines and standards, further strengthened CORS development.	The lack of effective collaboration has hindered progress in developing the CORS plan, policy, and legal framework. The implementation of Thailand's CORS lacks established policies and legal frameworks, while the business model, technology management strategy, technical model, plans, guidelines, and standards remain underdeveloped.

TABLES 30 and 31 highlight key differences in CORS implementation between Australia and Thailand, emphasising the inner layer factors of the theoretical framework. Australia's well-prepared infrastructure, advanced technology, and efficient data accessibility enabled successful collaboration, whereas Thailand's partial management hindered progress. In human resources, Australia clearly defined roles, supported personnel, and provided structured training, while Thailand made attempts without a clear development plan. Financially, Australia ensured sustainable revenue management and cost-saving strategies, whereas Thailand's budget and revenue plans lacked implementation. Lastly, Australia's strong policies, legal frameworks, and business models fostered collaboration, while Thailand's progress remained limited due to the absence of structured regulations. These factors explain Australia's increased achievement in CORS collaboration.

As summarised in the table above, effective collaboration among diverse stakeholders has been the key to Australia's success in overcoming GNSS CORS implementation challenges. This collaboration encompassed multiple critical aspects, including technology, human resources and responsibilities, finance, and policy and planning. With strong support from various sectors, Australia has successfully navigated these areas, whereas Thailand's CORS development has been hindered by the lack of coordinated efforts among key stakeholders. This absence of effective cooperation has prevented Thailand from fully addressing essential factors, making stakeholder collaboration a crucial element in Australia's superior performance. Australia's success over Thailand in GNSS CORS development can be attributed to sufficient financial support, advancements in technology, the involvement of multi-disciplinary professionals, and well-established strategic plans, policies, and laws. These elements serve as the foundational components of the developed theoretical framework, reinforcing its validity and practical relevance. The alignment of these factors with the framework confirms its effectiveness in guiding successful implementation, highlighting the crucial role of financial stability, technological progress, expertise, and governance in achieving sustainable CORS development.

6.4 CHAPTER CONCLUSION

This chapter was conducted to explore the reasons behind the successes and shortcomings of CORS implementation in Thailand, using Australia as a comparison to provide deeper insights. Through the application of the developed framework, the analysis revealed that while Thailand achieved some success, such as building numerous CORS stations and partially making the technology functional, significant challenges remain. These include insufficient infrastructure to fully integrate the network and the inability to establish effective cross-boundary linkages. By contrasting Thailand's experience with Australia's, it becomes evident that Australia managed to overcome similar challenges and achieve better outcomes.

The comparisons clearly illustrate a significant difference between Australia and Thailand, indicating that Australia had a more structured and well-defined approach to collaboration.

With greater clarity in ownership and governance, Australia managed power asymmetries more effectively. Although both countries had similar technology, Australia demonstrated better infrastructure management. Additionally, Australia had a more strategic approach to finance, investment, and return on investment. The lack of unified joint efforts was a major reason for Thailand's weaker collaboration, alongside other factors such as power asymmetries. While Australia's success can be attributed to aligning with both the inner and outer layers of the theoretical framework, Thailand lacked an integrated approach to CORS implementation. This comparison highlights the disparity in success, showing that Australia outperformed Thailand.

The findings from this chapter set the stage for the next, which will discuss why the Thai experience was less successful based on this exploration. The upcoming chapter will analyse what Australia did differently, what practices were adopted or missed in Thailand, and how these variations influenced the outcomes. Using the theoretical framework, it will explain why things worked better in Australia and provide lessons that can be applied to improve Thailand's CORS management.

Chapter 7

DISCUSSION OF RESEARCH FINDINGS

The exploration has employed several analytical techniques to uncover the truth and present a new aspect of realism. The reasoning achievements have commenced with multifaceted interpretations. This chapter will finalise the outcomes of the research investigation and discuss those results within the context of the research problems and the research aims.

This study has firmly established the links between case evidence and an evaluation framework. The cross-analysis of cases has also been taken to capture the common and different experiences in disparate countries. As the research has placed emphasis on GNSS CORS technology and paid attention to the Thai situation, the final output will be the practical guidelines for CORS implementation in Thailand. The development in this chapter will then lead to the conclusion of this study.

7.1 INTERPRETATION OF FINDINGS

In Chapter 3, a collaborative innovation theoretical framework was developed from the literature to structure the model for guiding and interpreting this research. The framework integrates the outer layer from the conceptual framework with more detailed elements in the inner layer, combining key factors essential for driving success in GNSS CORS collaboration.

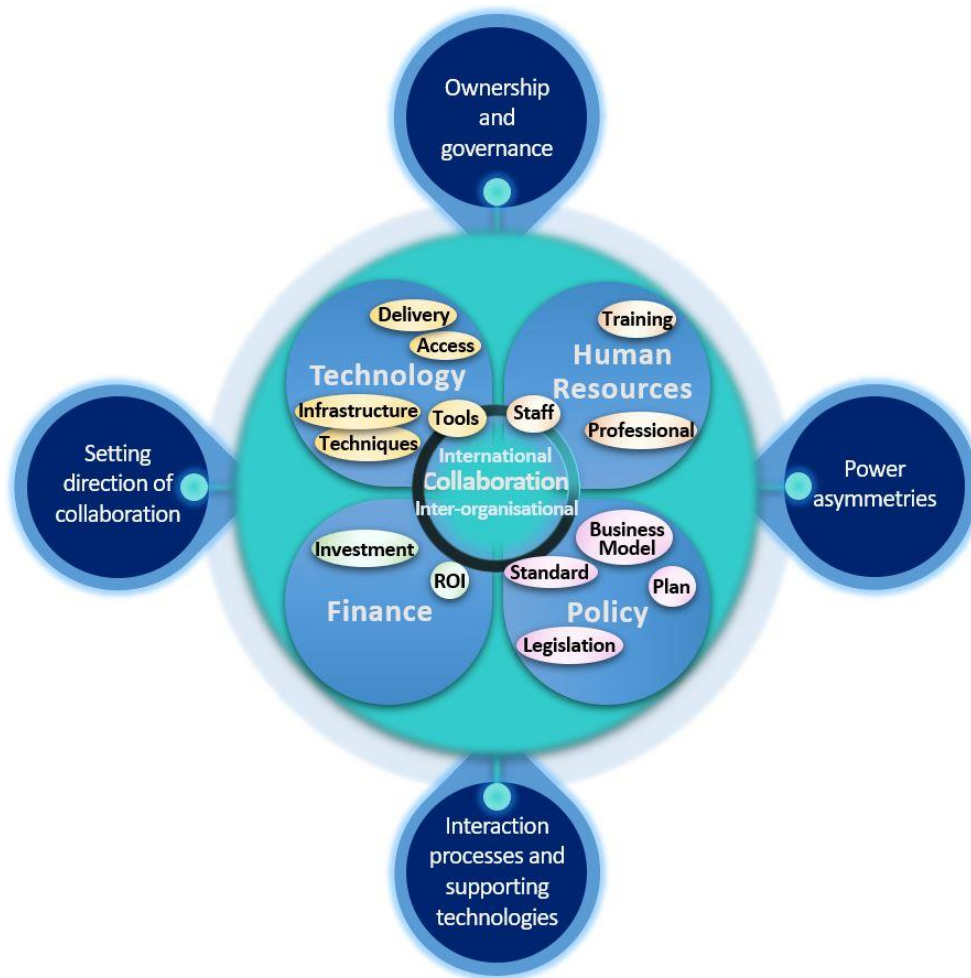


FIGURE 7.1 Collaborative innovation theoretical framework on GNSS CORS technology for this study (Source: Author's own research)

Referring to the theoretical framework outlined in FIGURE 7.1, the findings presented in TABLES 30, 31, and 32 reveal that the implementation of CORS in Thailand has encountered significant challenges across multiple dimensions, including technology, human resources, finance, and policy. Key issues such as unclear ownership and governance, noticeable power asymmetries, ineffective interaction processes, and a lack of clear collaborative direction have contributed to the underperformance of the endeavour. The primary shortcoming appears to be the absence of a strong strategic direction and leadership, which has hindered the resolution of Thailand's CORS implementation issues. Consequently, the current state of this effort reflects numerous unresolved details that impede effective collaboration. The following section will interpret the findings in relation to the existing literature to explain the underlying reasons for the lack of strategic direction, its significance, and its impact on the success of collaboration.

7.1.1 Interpretation of Findings Regarding Key Factors from the Initial Conceptual Framework

As summarised in TABLE 30, the comparison of CORS development experiences between Australia and Thailand highlights a clear alignment between the key factors from the initial conceptual framework and the analytical outcomes.

Australia's CORS management benefits from cross-boundary infrastructure sharing and collaborative management, which have strengthened issue resolution and aligned with the ownership and governance factor. In contrast, Thailand's CORS management still operates under individual ownership, with persistent management issues due to the partial effectiveness of collaboration. While this aligns with the ownership and governance factor, it does not fully comply with it. Ownership and governance are essential components of effective collaboration, as stressed by several authors. For instance, Bommert (2010) noted that clearly defined ownership and responsibilities significantly influence stakeholders' decisions to support innovation. Australia's successful implementation of these principles through the NPI Policy (ANZLIC, 2010) stands in sharp contrast to Thailand's struggles, which reflect a failure to effectively align with this critical notion.

In terms of power asymmetries, Australia has successfully addressed challenges through effective collaboration among key stakeholders, aligning with this element of the theoretical framework. On the contrary, Thailand continues to face unresolved power imbalances, as joint-working conditions have failed to mitigate these issues, leaving this aspect of the framework incomplete. Several authors have underscored the importance of addressing power asymmetries to establish effective collaboration. For instance, Nambisan (2008) identified a critical success factor by noting that collaborative problem-solving in the public sector frequently exhibits significant power and resource asymmetries. Australia's collaborative framework aligns closely with this principle, as demonstrated by the establishment of the NPI Advisory Board (Geoscience Australia, 2018), whereas Thailand has struggled to do so.

Additionally, Australia's jointly developed solutions have proven effective due to strong support from multiple sectors, fully aligning with the theoretical model. However, in Thailand, stakeholder interaction remains ineffective due to the absence of clearly assigned authority, policies, and legal frameworks, resulting in only partial alignment with the interaction processes and supporting technologies factor. A number of scholarly works focus on the value of interaction processes and supporting technologies in facilitating collaboration. For instance, Lundvall and Borrás (2005) argue that fostering dialogue and interaction in policy formulation among government authorities, business groups, trade unions, and academic institutions is essential for developing socially relevant, coherent, and implementable policy programs. While Australia aligns well with this perspective through the Organisational Roles in the Precise Positioning partnership model (Higgins, 2008), Thailand has yet to fully embrace this approach.

Finally, Australia has successfully set the direction for collaboration by establishing a multi-stakeholder framework and providing clear guidelines for effective CORS implementation. In Thailand, although efforts have been made to develop cross-sector collaboration for defining the direction of CORS, these initiatives have yet to be fully effective, leading to incomplete alignment with this factor. Numerous scholars emphasise the importance of a strategic direction in collaborative efforts. For example, Sørensen and Torfing (2011) concluded that clear overall planning and direction are essential to appropriately facilitate collaboration. Australia has effectively adopted this approach through the Australian strategic plan for GNSS (ASC, 2012), whereas Thailand has yet to align with this principle.

The initial conceptual framework provided a foundational lens to explore the essential components of collaboration in GNSS CORS implementation. The findings show that factors such as ownership and governance, power asymmetries, interaction processes and supporting technologies, and the strategic direction of collaboration significantly influence the success of cross-sector initiatives. In the case of Thailand, the framework helped identify challenges related to fragmented ownership, limited stakeholder engagement, and unclear policy direction. While attempts were made to initiate collaboration, the lack of structured coordination and formalised roles hindered progress. Conversely, Australia demonstrated how aligning with these core concepts—particularly through shared ownership, inclusive governance, and clear communication channels—can result in more effective and sustainable implementation outcomes.

7.1.2 Interpretation of Findings Regarding Key Factors from the Theoretical Framework

The summary of key factors in the inner layer of the theoretical framework (TABLE 31 and TABLE 32) demonstrates that Australia has been more successful than Thailand in achieving effective collaboration. In terms of technology and related components, Australia successfully addressed challenges in infrastructure, essential techniques, tools, platforms, and data accessibility through multi-sector cooperation, reinforcing its alignment with the collaboration concept. In contrast, while Thailand has made several attempts to address technological issues and has shown interest in leveraging technology for collaboration, these efforts have yet to yield success. The literature review underscores the critical role of technology in innovation management, a theme that is particularly emphasised in this study on CORS implementation. Several studies reinforce this perspective. For instance, Australia adopted a client-server-based model for data access (Rizos and Van Cranenbroeck, 2006), which facilitates technological advancement. This aligns with Sørensen and Torfing's (2011) assertion that new technologies for communication and information, alongside evolving knowledge systems, have been key drivers of numerous public sector innovations. Although Thailand has made efforts to integrate technological components into its CORS management, the available evidence indicates that these initiatives exhibit only partial

and inadequate preparation and achievement, ultimately failing to fully align with Sørensen and Torfing's concept.

Regarding human resources and responsibilities, Australia effectively supported experts and staff, defined roles, and facilitated organisational design and personnel training, underscoring the importance of this factor in collaboration management. Thailand, despite numerous efforts, has yet to achieve success in this area, though its initiatives highlight the significance of this factor in contributing to collaboration. Several studies in the literature have addressed this topic. For instance, CRCSI organised local staff training (CRCSI, 2012; 2013; 2014) in line with human resource development concepts. This approach aligns with Adner's (2006) observation that several innovation ecosystems underscore the importance of intermediaries positioned between innovation and the end user, as well as the need for investing in new tools and training to ensure successful implementation. Although the findings in Thailand indicate that key stakeholders are interested in human resources and authority issues, these initiatives have not been effectively implemented, resulting in a misalignment with Adner's concept.

Financially, Australia has secured sufficient funding for CORS development, maintenance, and renewal, along with revenue management, cost-saving strategies, and sustainable budgeting, emphasising the realisation of this factor in cross-sector collaboration. Conversely, Thailand continues to face financial constraints in investment and maintenance, struggling with profit management despite recognising the importance of financial stability for successful collaboration. Numerous studies in the literature have examined financial considerations. For instance, GPSnet incurs annual operational costs of \$650,000 and a five-year fixed investment of \$13.25 million (Hausler, 2014), reflecting the financial dimension of the theoretical framework. This aligns with Abidin's (2010) assertion that sustained financial support for the operation and maintenance of CORS is essential and should be planned on a long-term basis. While its importance is acknowledged, financial management in Thailand has not met expectations, failing to align with Abidin's concept.

Finally, Australia has established policies, business models, strategic plans, and various supporting frameworks, all reinforced by legislation to drive successful collaboration. While Thailand acknowledges the importance of planning and policy for GNSS CORS collaboration, it has yet to achieve success in implementing policies, legal frameworks, business models, standards, and guidelines. The literature underscores the multidimensional nature of these issues by drawing on a diverse body of research. For instance, the establishment of the National Positioning Infrastructure (NPI) Policy (ANZLIC, 2010) aligns well with the planning, policy, and legal aspects of the theoretical framework. This is consistent with Janssen *et al.* (2016), who emphasise the critical role of coherent policies and strategic plans in ensuring the reliability, compatibility, homogeneity, and sustainability of positioning infrastructure. Key stakeholders consider policy and law to be essential drivers of success in Thailand; however, their absence significantly deviates from the framework proposed by Janssen *et al.*

When comparing findings with the developed theoretical framework, which includes refined and expanded elements such as technological infrastructure, human resource capacity, financial planning, and policy/legal support, the analysis reveals a deeper layer of understanding. Australia's success can be attributed to its strategic handling of all inner-layer factors, including the deployment of technology, investment in skilled personnel, well-managed funding, and a strong legislative foundation. These align directly with the theoretical framework, indicating a comprehensive and integrated approach to collaboration. In contrast, Thailand's efforts remain partial. Although there is a clear recognition of the importance of each factor, limitations in resource availability, institutional readiness, and legal structure have led to incomplete alignment with the theoretical framework. This gap highlights the need for Thailand to strengthen integration across all identified factors to move towards successful CORS collaboration.

7.1.3 Discussion Based on Theoretical Framework

In the earlier chapter, the research individually examined the case studies of Australia and Thailand to gain an in-depth understanding of each context, followed by a comparative analysis to identify key differences and situations. The results presented in TABLES 30, 31, and 32 highlight the specific focus areas of each analysis; however, they collectively reveal that Australia and Thailand adopted differing approaches and strategies in their implementation efforts. When these activities are examined through the lens of the theoretical framework—where each layer represents a key predictor of successful technology implementation—the findings indicate that Australia demonstrates a more comprehensive fulfilment of these factors, suggesting a higher likelihood of overall implementation success. Examining the theoretical framework from its outer to inner layers reveals that better management of ownership and governance, power asymmetries, interaction processes, and setting direction—along with improved management of technology, human resources, finance, and planning and policy frameworks—proactively contributes to stronger inter-organisational and international collaboration. Consequently, Australia outperforms Thailand in key collaboration factors and has successfully implemented GNSS CORS in line with the core principles of the developed theoretical framework, which integrates both conceptual models and practical elements to support more effective collaboration. Overall, across all key areas—whether to a greater or lesser extent—Australia consistently demonstrated stronger performance compared to Thailand. This comprehensive advantage helps explain why Australia has ultimately achieved greater success in its GNSS CORS implementation.

Why Australia Outperforms Thailand: Insights from the Theoretical Framework

In practice, real-world implementation often faces challenges. Although the technology may function adequately and individual stakeholders may benefit, the broader national advantages are often unrealised due to weak collaboration. This is particularly true for complex projects involving new technologies, multiple stakeholders, and government participation, where success depends on clear

governance, leadership, interaction structures, business models, and balanced power dynamics. The inner layer of the framework—technology, finance, human resources, and policy—represents the immediate causes of barriers to effective implementation. The outer layer explains why these issues arise, highlighting systemic problems such as poor governance, unclear roles, and weak stakeholder coordination. While both layers are critical, case studies show that governance is a key enabler of collaboration. Success requires a clear strategic direction, well-defined ownership and leadership, active coordination, and effective management of power imbalances. When outer-layer factors fail, they undermine the inner layer, ultimately impeding both inter-organisational and international collaboration. The consistent differences between the two countries favour Australia, largely due to stronger performance across all elements of the framework. Its collaborative efforts were not driven by a single factor but by the integration of both layers. In contrast, Thailand's limited progress is tied to its failure to address governance gaps and power imbalances, primarily because of a dominant but uncoordinated government role. These shortcomings demonstrate a misalignment with both the inner and outer layers of the framework. Based on the interpretation, this misalignment stems from the fact that the necessary components for successful collaboration have either not been fully implemented or remain underdeveloped in Thailand, as evidenced during data collection and confirmed in the findings.

7.2 DISCUSSION BASED ON THEORIES

The study of the histories of situations in Australia and Thailand used the same criteria to evaluate the variety of materials. The systematised procedures produced the outputs, as shown in the earlier section. As a consequence, the following part will present the interpretation of findings in line with the theoretical underpinnings.

7.2.1 Collaborative Innovation

Collaborative innovation fosters openness to shared opportunities, enabling organisations to leverage and exchange technical expertise and financial resources. It supports co-creation across sectors, involving joint efforts within the public sector or partnerships with private industry and research communities. Building on this framework, this study examined the state of GNSS CORS in Thailand, with a focus on government oversight in multi-organisational collaboration. Three types of interviews were conducted to gather diverse perspectives on CORS implementation. The collected data were systematically analysed against a conceptual theme of key cooperative factors. Many interviewees highlighted persistent challenges, particularly the fragmented ownership and management of CORS. One respondent explained that each organisation has a different number of stations built according to their specific needs due to budget limitations.

Findings suggest that Thailand's current CORS governance only partially aligns with collaborative innovation principles. While efforts to connect government CORS-owning agencies, researchers, and stakeholders exist, they have yet to achieve their intended impact. The establishment of bodies like the Subcommittee on GNSS Network indicates a growing awareness of the need for coordination. However, the prevailing focus on internal organisational priorities continues to hinder cross-boundary collaboration. Realising the full potential of CORS technology in Thailand requires a stronger collective vision, co-investment, and shared use of resources to support joint value creation. In contrast, Australia's experience affirms the effectiveness of collaborative innovation. Its coordinated approach to CORS management successfully addresses fragmentation and promotes innovation. Thailand has shown some progress, particularly through international initiatives such as the Tropospheric and Atmospheric Research Community (TARC), which involves GNSS data sharing with Australia and Southeast Asian countries (Roberts and Stanaway, 2009). This example demonstrates the benefits of collaborative innovation as outlined by Bommert (2010). For long-term success, Thailand needs to expand its commitment to collaborative innovation to improve CORS implementation and leverage cross-sector partnerships more effectively.

7.2.2 Networked Innovation

Networked innovation supports collaborative value creation by linking innovators to enhance technology, market access, and non-profit opportunities. Internal and external networks are crucial in shaping successful outcomes by fostering evolving structures and dynamic interactions among actors and organisations. In Thailand, the limited coverage of individual CORS systems has restricted nationwide service quality due to resource constraints, underscoring the need for interconnected networks. This study found that agencies such as the RTSD and DOL signed MOUs to share CORS resources, reflecting elements of networked innovation. However, while these agreements enabled basic resource sharing, they did not extend to joint funding or co-development—key components of true collaborative value creation. These findings reinforce the relevance of the networked innovation paradigm, as various organisations have attempted to build networks for innovation management. Still, gaps persist between theoretical ideals and practical outcomes, largely because Thailand's networks lack systematic structure and coordination. To address this, networked innovation should remain a guiding framework for advancing GNSS CORS collaboration. In contrast, Australia's success illustrates the practical application of networking theory in managing innovation stakeholders and generating value. While Thailand has promoted intergovernmental and international cooperation, its outcomes have been more limited. Strengthening collaborative mechanisms to facilitate the sharing of resources, expertise, and technology could help reduce inefficiencies and foster co-created value in Thailand.

This study's findings align with networked innovation theory, particularly its emphasis on leveraging assets across organisational boundaries. Australia exemplifies this

through the coordinated sharing of CORS infrastructure among government agencies. The ICSM permanent subcommittees, for example, played a key role in facilitating network sharing (ANZLIC, 2014a), consistent with principles outlined by Chesbrough (2003b). While Thailand has taken steps toward fostering such networks, these efforts have yet to achieve their full potential.

7.2.3 Innovation Ecosystem

An innovation ecosystem facilitates the transformation of ideas into value by integrating knowledge and promoting co-creation among partners who share resources and risks. It supports collaboration, customer needs assessment, and stakeholder engagement, often extending beyond internal efforts to include external contributions that enhance market value.

Building on this concept, the present study outlines an ecosystem framework tailored to CORS governance in Thailand by integrating relevant theories and literature to align with the advancement of GNSS reference stations. Insights from participants highlighted several challenges: limitations in CORS technology and cooperative management, insufficient financial and human resources, unclear organisational roles, weak legal frameworks, and the absence of effective strategies. These findings reflect the core principles of the innovation ecosystem model, underscoring the need for collaboration among stakeholders, coordination across upstream and downstream components, and alignment with market processes. However, despite recognising the importance of shared resource investment and responsibility, Thailand has yet to realise their potential benefits. In line with innovation ecosystem theory, sustained collective action remains critical to advancing CORS implementation in the country.

Case studies from both Australia and Thailand further illustrate the ecosystem's relevance. Both countries have encountered difficulties in CORS data sharing among government agencies and across sectors. From these cases, four primary factors emerged as crucial to successful collaboration: technology, finance, organisational responsibility, and strategic planning. This study's findings reinforce the principles of the innovation ecosystem framework. For instance, Australia has effectively managed CORS components, as noted by Hausler and Collier (2013b), aligning with the frameworks proposed by Adner (2006) and others. In contrast, while Thailand recognises the importance of these elements, it continues to face implementation challenges. Although the outcomes may not yet fully reflect Thailand's situation, the innovation ecosystem model offers a valuable guide for future development.

7.2.4 Stakeholder Theory

Stakeholder theory emphasises the involvement of multiple actors in shared initiatives, highlighting how differing interests and perceptions can shape the innovation process. Applying this theory helps clarify stakeholder perspectives during the development and implementation of new systems.

This study investigates GNSS CORS collaboration in Thailand by engaging key stakeholders responsible for managing CORS assets of varying scales. The findings reinforce stakeholder theory, showing that perceptions of joint development are influenced by individual or team-specific viewpoints, which often differ across groups. Recognising these perspectives is critical for designing and implementing effective collaboration strategies. The evolution of these efforts aligns with stakeholder theory, and the consistency of research findings further supports this theoretical connection. At the outset, the stakeholders included CORS asset owners with unequal levels of authority, shaped by the size of their holdings and their institutional roles. To improve future implementation, input should also be sought from actors in national legislation, industry, and other relevant sectors. In contrast, CORS collaboration in Australia—despite involving both central and territorial government stakeholders—achieved successful outcomes. This underscores the practical relevance of stakeholder theory and reinforces the recommendation to enhance stakeholder engagement in Thailand.

Ultimately, the research findings affirm the importance of involving key actors in collaborative projects. Efforts to engage CORS owners and stakeholders in national initiatives, as described by Rizos et al. (2003, 2004), reflect principles outlined by Donaldson and Preston (1995), among others. Despite the involvement of multiple government agencies, Thailand has struggled to foster effective collaboration—highlighting the need for stronger alignment with stakeholder theory in practice.

7.2.5 Conclusion of Findings and Theories Comparison

The alignment between the collected data and the underlying theories was assessed using four practical factors derived from the literature: technology, finance, human resources and responsibilities, and planning and policy. This evaluation also considered stakeholder responses related to collaboration outcomes. The findings are summarised as follows:

Objective

To see if these issues are the factors that are significant to the GNSS CORS administration in Thailand.

Results

1. **All factors are significant:** Technology, finance, human resources and responsibilities, and planning and policy are crucial ecosystems for the success of the CORS implementation in Thailand.
2. **Clear leadership is essential:** The most critical factor is a clearly defined direction for collaboration, led by a central CORS management authority. The study highlighted the wide range of responsibilities expected from this central actor.

3. **Divergent views on LBS tools:** Opinions varied regarding the necessity of LBS portable tools—some viewed them as useful for fieldwork, others raised security concerns, and some were unaware of their potential benefits.
4. **Collaboration targets unmet:** The planned National CORS Data Center has not yet been fully established.
5. **Progress through RTSD efforts:** Significant progress includes the completion of the RTSD's CORS installation and successful inter-agency CORS connections that enabled service delivery.
6. **Institutional progress:** A key formal outcome was the establishment of the Subcommittee on GNSS Network, appointed by the National Geo-Informatics Board.
7. **International agreement:** A formal CORS cooperation agreement between Thailand and Japan was signed and made official.
8. **Formation of working groups:** Three working groups were established:
 - National CORS Data Center Planning
 - National CORS Data Center Management
 - Thailand–Japan High Level Joint Commission
9. **Budget constraints:** A lack of adequate funding remains the main barrier to establishing and operating the National CORS Data Center.
10. **Resource limitations:** Although the Subcommittee assigned the RTSD to manage the National CORS Data Center, a lack of resources for data processing and archiving has stalled progress.
11. **Incomplete business model:** A financial return model for the National CORS has not been finalised, though the RTSD has begun marketing its individual CORS network.
12. **Lack of regulatory framework:** No standards, policies, or legal frameworks have been finalised for the National CORS.
13. **Paused international cooperation:** Collaborative efforts with countries like Japan and China are currently on hold.

Based on the case studies and alignment with the theoretical framework, the findings show that collaboration is significantly hindered without a unified governance structure. Effective collaboration requires a clear structure—often led by the government—to coordinate efforts. In Thailand, simply instructing organisations to collaborate without guidance on how to do so has proven ineffective. In contrast, Australia's more structured approach to CORS management illustrates the importance of clear direction in collaboration. Therefore, a defined collaborative framework is

essential for Thailand. Nonetheless, all components outlined in the theoretical framework remain critical, as supported by the underlying theories.

7.3 DISCUSSION OF RESEARCH PROBLEMS

The outcomes from the analytical stage were used to interpret the relationships between findings and to clarify the core ideas supporting the development of cooperative procedures in the CORS initiative. Ultimately, the most consistent conclusion is that the study's findings directly address the research problems and aims.

The motivation for this study is:

"The lack of effective collaboration on the GNSS CORS network between government organisations in Thailand"

This study considers six research problems and four research aims. The first aim is " *To obtain an understanding of how effectively GNSS CORS technology was managed between government organisations that involve this technology in Thailand.*" In conjunction with the second aim, " *To understand the role of the governments in supporting and encouraging the development of GNSS CORS operational partnership* ", the study follows a thematic direction grounded in content analysis and case studies analysis, using an abductive qualitative approach. These aims guide the investigation in addressing the following research problems.

To obtain an understanding of how effectively GNSS CORS technology was managed between government organisations that involve this technology in Thailand.

To understand the role of the governments in supporting and encouraging the development of GNSS CORS operational partnership.

7.3.1 The Nature of the Inter-Organisational Collaboration on GNSS CORS Implementation between Government Organisations in Thailand.

This study addresses the lack of formal partnership agreements on GNSS CORS among Thai government agencies. Drawing from multiple data sources, the investigation confirmed the absence of coordinated CORS co-management. Initial findings, based on Krueger's (1994) and Rabiee's (2004) seven criteria, captured the perspectives of key stakeholders. Participants described uneven development progress and emphasised the need for future collaboration. Their views highlighted the importance of data sharing, avoiding redundant investments, and expanding GNSS infrastructure coverage.

The Thai case study reinforced the central issue: a lack of inter-agency coordination. Current collaborations are limited to bilateral MOUs, with no centralised framework guiding national efforts. The findings also emphasised the government's essential role

in promoting cooperation, and the need for clearly defined responsibilities among stakeholders. The success evaluation framework—rooted in innovation management theories and practices—was applied to assess Thailand’s readiness for coordinated CORS development. It revealed key sources of fragmentation and proposed solutions focused on role definition and institutional alignment. These insights aim to guide Thailand toward more unified, efficient, and sustainable CORS management.

7.3.2 The Nature of the International Collaboration on GNSS CORS Implementation between Thailand and Foreign Countries.

This study employed an evaluation design to examine the lack of coordination in CORS management between Thailand and other countries. By analysing the interconnected elements of technology, human resources, finance, and policy, the research identified key barriers to international CORS collaboration. These factors were assessed to understand Thailand’s efforts to foster cross-border cooperation.

Findings revealed that Thailand, through both individual agencies and joint initiatives, has shown interest in international partnerships. A notable example is the Memorandum of Cooperation signed by Thailand’s Ministry of Science and Technology and Japan’s Ministry of Land, Infrastructure, Transport and Tourism for establishing an Integrated Data Center. Additionally, informal negotiations have taken place with China, while other partnerships—mainly in research and education—exist with international institutions. Australia served as a comparative case, offering insight into successful cross-national alliances in positioning technologies. Drawing on Australia’s experience, the study gained a clearer understanding of the origins of Thailand’s fragmented approach and the critical role of government in fostering CORS integration. This comparative perspective underscores the importance of structured support and strategic partnerships to advance Thailand’s positioning infrastructure on a global scale.

7.3.3 The Nature of the Data Sharing and Central Network of GNSS CORS in Thailand.

Due to the lack of inter-organisational collaboration, Thailand’s GNSS base station system remains decentralised. This issue is reflected in the fragmented infrastructure managed by independent CORS owners. The study explores initiatives related to cross-organisational facility access, data sharing, and data standardisation. Empirical findings highlight the challenges posed by the absence of a unified GNSS network, where an integrated system is needed to consolidate individual networks into a single, cohesive structure. The aim is not only to merge GNSS capabilities but also to deliver uniform and standardised services.

The research was systematically developed by comparing evidence against the conceptual framework. The findings highlight the root causes of Thailand’s fragmented approach to CORS development and underscore the need for stronger government leadership in fostering collaboration on this issue.

7.3.4 The Nature of the Central Unit for GNSS CORS Management in Thailand.

The investigation into GNSS CORS development in Thailand revealed a widespread call for unity among CORS owners and the need for a central coordinating body. While stakeholders agreed on the importance of such a body, its ideal structure—whether a central authority or an advisory board—remains unresolved. Currently, the Royal Thai Survey Department (RTSD) has been appointed as the interim National CORS Data Center, accepted due to its extensive network coverage, technical expertise in positioning, and political influence. Sustained progress depends on strong leadership and organisational commitment. The success of the National CORS initiative hinges on the ability of a respected institution to lead the integration. Smaller stakeholders, with limited or no infrastructure, are expected to align with this effort over time. Under RTSD leadership, the National CORS Data Center is expected to unify existing networks, deliver GNSS data services, promote commercial applications, expand coverage, and maintain infrastructure.

The study, using the adopted theoretical framework, confirms the central issue: a lack of coordinated CORS provision. It also reinforces the importance of government endorsement in mobilising stakeholders and fostering collaboration essential for national-level GNSS infrastructure development.

To gain a comprehensive understanding of the complex and multifaceted aspects of using Location-Based Services as an administration tool for managing the GNSS CORS

The feasibility of using Location-Based Services (LBS) to manage the CORS system is addressed in the research aim: *"To gain a comprehensive understanding of the complex and multifaceted aspects of using Location-Based Services as an administrative tool for managing the GNSS CORS."* This aim explores whether mobile devices are beneficial or detrimental to collaborative efforts within Thailand's national GNSS network. It seeks to raise awareness of both the existing and potential innovations in this field. The study also aims to uncover the rationale behind the acceptance or rejection of LBS for system management. Accordingly, the research addresses the following problem.

7.3.5 The Nature of the Futuristic Technology as an Administration Tool for GNSS CORS Management in Thailand.

Detachable devices offer clear convenience, but their desirability depends on user context and background. Advanced tools are not always beneficial if users find them difficult to operate or unnecessary. Some communities may adopt cutting-edge technology early, yet its implementation can be challenging in specific sectors. Mobile devices, in particular, raise concerns about security, unauthorized access, and a higher risk of loss compared to stationary office-based equipment. These concerns were voiced by most respondents, helping explain the limited use of Location-Based Services (LBS) in Thailand's GNSS CORS system. Conversely, some LBS users highlighted

the benefits of portability, such as real-time access, ease of fieldwork, fast responses, and instant reporting. This user satisfaction has contributed to the advancement of portable tools for CORS management.

Despite the overall hesitation, the study revealed a divide: while quantitative findings suggest a broad reluctance to adopt mobile technology for GNSS operations, qualitative data from a smaller but more engaged group reflected the interest in using such tools. This contrast points to a potential for wider acceptance if usability and security concerns are addressed.

To understand the effect of implementing the adopted GNSS CORS management policy framework

This research was undertaken with high expectations of integrating CORS management knowledge and experiences gained through careful analysis. Its purpose was to synthesise various insights derived from implementing a proposed policy framework for CORS execution in Thailand. The research aim, "*To understand the effect of implementing the adopted GNSS CORS management policy framework*", guided the study toward a follow-up phase of the examination. The following research problem focused on enhancing understanding of the framework's potential impact, which this study sought to address.

7.3.6 The Nature of the Policy Framework for GNSS CORS Management in Thailand.

The experiential comparison between Thailand and Australia reaffirmed that the absence of robust policies, relevant regulations, uniform standards, strategic planning, and sustainable business models significantly affects the direction of CORS implementation in Thailand. This study proposes recommendations aimed at shaping a policy framework and addressing key governance issues for GNSS reference stations in Thailand. These issues include mandatory codes, regulatory controls, and best practices that incorporate both tacit and explicit knowledge to standardize and enhance technology management.

As a result, a ready-made framework has been developed to help address the current policy gap. The proposed CORS implementation framework for Thailand focuses on four core dimensions: technology, human resources, finance, and policy. With these foundations, there is reason to be optimistic about the future development of GNSS reference stations and related industries in Thailand.

7.4 DISCUSSION OF SUCCESS EVALUATION

The preceding discussion connects this study to its theoretical foundations, highlights how the analysis addresses the research problems, and explores the development process of a CORS policy framework. This section also considers the concept of "success" in managing

CORS technology. The study investigates the challenges of CORS management in Thailand, particularly the fragmented ownership and duplicated funding for GNSS reference base development. Various government agencies operate independent CORS networks without coordination or data sharing, leading to redundant coverage and inefficiencies. By reviewing literature, and theoretical models, and involving all relevant stakeholders, the study examines why collaboration in CORS administration remains limited in Thailand. Based on the analytical findings, the following section presents the study's key conclusions.

7.4.1 Why Has GNSS CORS Technology Management in Australia Been Done Successfully?

This research examines the development and management of GNSS CORS technology, focusing on the challenges of separated ownership and control at the national level. Australia was selected as a comparative case due to its contextual similarities with Thailand and its proven success in addressing such complexities. As discussed in Chapter 5, both countries share a pattern of individual CORS ownership; however, Australia has achieved significantly better outcomes, as confirmed by a theoretical evaluation framework incorporating both quantitative and qualitative measures.

The framework, grounded in existing literature and validated through case analysis, identifies four critical success factors: finance, human resources and responsibilities, planning and policy, and technology. Australia's financial stability has enabled sustained infrastructure development, running asset maintenance, and investment in research and development. Skilled personnel from diverse sectors contribute to effective system operations, supported by continuous training and well-defined roles. Crucially, national planning is reinforced by comprehensive policies—such as the NPI Plan and NPI Policy—underpinned by legislation and supported by practical business models. These elements provide legal clarity, empower stakeholders, and ensure commercial viability. Additionally, technological innovation and international collaboration contribute to the ongoing advancement of CORS applications. Collectively, these factors explain Australia's success in managing GNSS CORS technology.

Why did they do it that way?

The overall evidence indicates that Australian state and territory governments shared aligned goals in establishing an interconnected CORS network across jurisdictions. This collaborative effort was further supported by numerous research publications, funded by government agencies, the private sector, and international partners. These publications helped promote the concept of coordinated CORS use both locally and globally, raising public awareness and encouraging broader participation. At the same time, they highlighted the potential benefits of CORS technology across various sectors, strengthening the initiative's legitimacy. Academic papers and conference presentations received recognition from the scholarly community, further validating the approach. This academic endorsement, along with support from public and private stakeholders, helped build momentum for implementation. As the conceptual

framework proved practical and transparent, it became easier to obtain stakeholder and governmental endorsement.

These developments explain why Australia successfully advanced national collaboration on CORS. The history of this progress has been consistently documented through official reports and academic literature.

7.4.2 Why Has GNSS CORS Technology Management in Thailand Not Been Done Successfully?

This study reveals persistent challenges in Thailand's GNSS CORS management, as identified through focus group discussions with officers from six government agencies, each operating its own CORS system. These intra-organisational interviews, followed by individual follow-ups with five representatives, yielded consistent perspectives. Additional insights from university experts and official documents further supported the analysis. Applying the framework's four success dimensions—finance, human resources and responsibilities, planning and policy, and technology—several critical issues emerged. Financial constraints remain a central barrier, with inadequate funding delaying the establishment of the National CORS Data Center and limiting national coverage. Human resource shortages, particularly in technical expertise, and underdeveloped training programmes restrict system optimisation. While some collaborative structures—such as the GNSS Subcommittee and various working groups—have been established, the core body for CORS integration remains incomplete due to the absence of relevant policies and legislative support. Technologically, the system suffers from limited spatial coverage, potentially outdated infrastructure and lacks readiness for network integration. CORS services are still concentrated on the support for surveying and mapping, with limited cross-sectoral applications due to insufficient technology awareness and promotion.

The findings highlight the primary causes of failure in CORS implementation in Thailand, as revealed through the applied theoretical framework. Key constraints include technological limitations, financial shortcomings, poor HR practices and an underdeveloped policy framework. Initial conceptual framework factors—such as fragmented ownership and governance, power imbalances, poor stakeholder interaction, and the absence of strategic collaboration and leadership—further exacerbate these challenges. This gap underscores the need for strategic engagement, drawing lessons from models like Japan, where government-led technology advocacy has been effective. Overall, the findings emphasise the importance of coordinated planning, resource allocation, and stakeholder alignment to advance Thailand's national CORS development.

Why did they do it that way?

According to the interview participants, efforts to resolve CORS-related challenges in Thailand have required strong government intervention. The military government recently prioritised the advancement of this technology, elevating it to national

significance. Participants suggested that political authority played a crucial role in addressing systemic issues, noting that key meetings would likely not have occurred without the military government's involvement. This influence extended to leadership decisions within the initiative. The Royal Thai Survey Department (RTSD), a military agency, was appointed to lead the National CORS effort. Some participants expressed concerns over this choice, as the RTSD had not yet deployed its own stations at the time. Questions arose about the Department of Lands (DOL), which owned more CORS assets and could have been a logical leader. Nonetheless, these concerns were ultimately set aside, given that the RTSD had established the second-largest network and, more importantly, possessed recognised expertise in geospatial positioning. The RTSD is also responsible for Thailand's major control points and employs a substantial number of skilled staff in this domain.

Why did they think that way?

In light of this issue, several respondents highlighted the RTSD's leadership as a reflection of military influence, particularly amid ongoing disputes over organisational roles in managing the National CORS Data Center. Multiple agencies asserted their suitability for this role, claiming they could lead the initiative; however, these proposals were ultimately rejected by other stakeholders. Currently, the collaboration is advancing toward a final decision by the Board, with no further formal objections.

According to participants, the partnership has faced difficulties due to insufficient engagement from some stakeholders. Their formal participation was driven more by a desire to follow prevailing trends and gain access to other organisations' systems than by a genuine commitment to collaboration. One interviewee noted that the leadership exercised unilateral authority, steering the initiative independently. The perceived opacity of the process—driven by the RTSD's closed system—has left many stakeholders unaware of the project's progress. Some respondents even suggested the researcher contact other agencies to obtain updates.

Furthermore, participants highlighted a lack of transparency and support structures. There is limited academic engagement, a lack of material assistance, and no clearly defined implementation plan. As a result, interviewees expressed doubt about the potential for successful completion of the National CORS Data Center.

In conclusion, the findings clarify why Thailand has yet to achieve optimal outcomes in managing GNSS CORS implementation. These shortcomings are closely linked to broader issues in governance, coordination, and technology adoption. One key debate among interviewees concerned the use of Location-Based Services (LBS) technologies, particularly mobile devices, as administrative tools in CORS collaboration. While some participants rejected their use—citing concerns over suitability for high-level management and national security—others highlighted the advantages of flexibility, user control, and secure access, based on their operational experience. These differing views illustrate a lack of consensus on the appropriateness of mobile technology.

The comparative analysis between Australia and Thailand, guided by a unified set of evaluation criteria, affirmed the robustness of the developed evaluation framework. The contrast in outcomes—Australia’s success and Thailand’s continued challenges—demonstrates the framework’s relevance and applicability. Although this research cannot guarantee that the proposed policy recommendations will resolve Thailand’s CORS management issues, it offers evidence-based guidance that could support more effective policy development. The insights generated through this study are intended to contribute to advancing Thailand’s GNSS CORS collaboration and overall system governance.

7.5 DISCUSSION OF KEY POINTS ON THE CORS POLICY FRAMEWORK

The analysis mechanisms in this study provide a route to pursue matters concerning adopting a national policy framework on GNSS CORS. This part will be a discussion of the study results to address the fundamental concerns that are prerequisites for the policy in Thailand. In closing, it will adopt the existing policy to derive elementary constitutional principles on which other countries were built and prosecute the policy agenda for Thailand.

7.5.1 Key Points on the Australian CORS Policy Framework

How did they do?

In the case study analysis, CORS management in Australia faced complexities for over a decade, with various sectors attempting to resolve persistent challenges. These efforts culminated in the development of a national policy and plan for geospatial management, with a strong emphasis on CORS—the National Positioning Infrastructure (NPI) Policy. While the NPI encompasses a range of positioning technologies, the policy was specifically tailored to address CORS deployment, service provision, coverage, and product delivery. The NPI Policy was shaped partly by a 2008 expert-led model and established five core principles: purpose, interoperability, performance, governance, and privacy. It ensured national alignment and long-term sustainability across environmental, social, and economic dimensions. Adopted in 2010, the policy was followed by the creation of the NPI Plan and the establishment of the NPI Advisory Board (NPI-AB). This coordinated approach eliminated fragmented ownership and control of CORS and established a centralised access point for national positioning services in Australia.

Why did they do it that way?

The development of the NPI Policy involved input from diverse sectors, bringing together key stakeholders to share insights on the systematic deployment of positioning technology. Expert contributions were carefully considered, and proposed practices were refined through collaborative discussion. The policy's implementation framework guided the selection of participating organisations, ensuring alignment with declared procedures. Once adopted, the policy provided a foundation for subsequent actions and progress. This process reflects Australia’s belief that

coordinated efforts, skilled human resources, and effective policy implementation are essential to resolving challenges in GNSS CORS management and guiding future development.

7.5.2 How Can This Experience Benefit Thailand?

Thailand faces challenges similar to those previously encountered by Australia, including fragmented ownership of CORS assets, lack of service sharing, and the absence of a central coordinating body. The ongoing collaborative programme involves multiple stakeholders, including academic experts—paralleling Australia’s earlier experience. Given these similarities, adopting Australia’s NPI Policy as a pilot model for Thailand is a practical consideration. Further adaptations can be evaluated by the Subcommittee on the GNSS Network to enhance relevance and effectiveness.

Due to its structured and contextually suitable design, the NPI Policy offers a viable framework for Thailand. The following discussion explores how this policy can guide Thailand’s CORS development.

7.5.3 How Can the Australian CORS Policy Framework be Applied to Thailand?

This research aims to support the development of a GNSS CORS policy framework in Thailand. Through comprehensive data collection, analysis, and interpretation, the study assesses the feasibility of establishing national guidelines for CORS implementation. Drawing on multiple theoretical perspectives and diverse stakeholder insights, the following section presents policy recommendations to enhance CORS collaboration in Thailand.

What are the primary foundations that guided the development of Australia’s CORS policy framework?

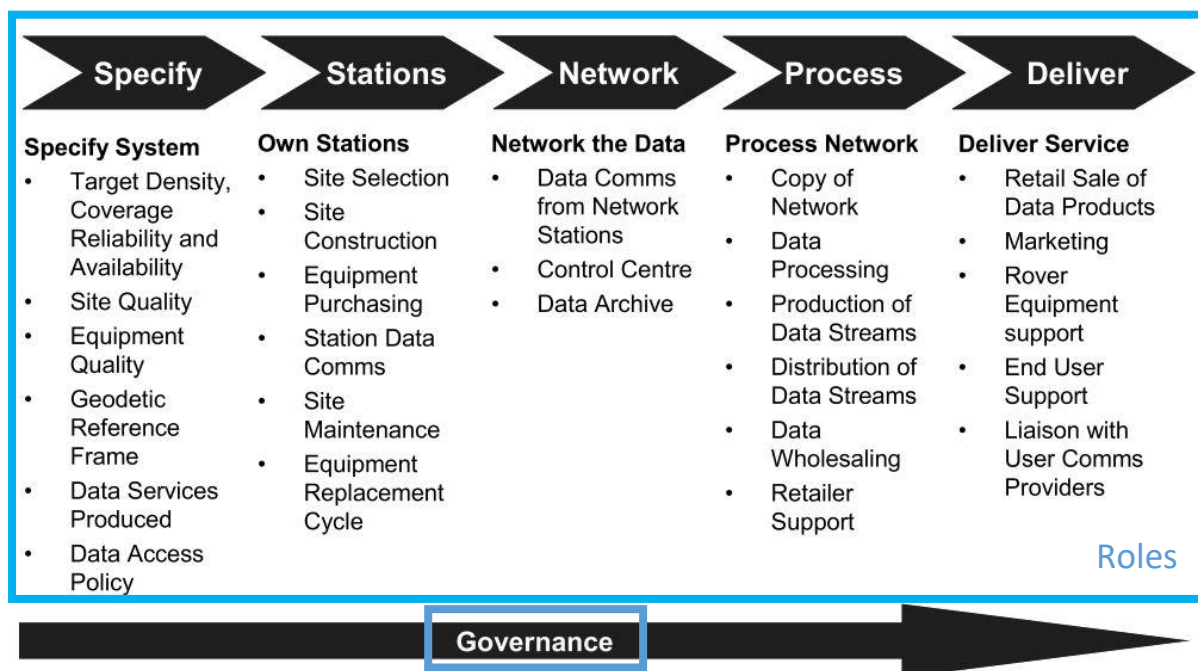


FIGURE 7.2 An organisational model for GNSS CORS in Australia by Higgins (2008)

Australia's GNSS CORS management was deemed successful based on the evaluation framework applied earlier. However, establishing a national policy for a unified GNSS reference base required sustained, multi-sectoral effort, particularly from the research community. Key contributions included multidisciplinary proposals such as Rizo's (2007) "system of systems" infrastructure model and Higgins' (2008) organisational role model (see FIGURE 7.2). While the NPI Policy adopted only selected aspects—Specify, Station, and Network—it provided clear principles outlining organisational responsibilities. Ultimately, Australia developed the NPI Plan and supporting elements in line with this policy, resolving previous issues related to an uncoordinated GNSS reference station network.

In what ways can Australia's CORS policy framework be adapted for implementation in Thailand?

Given the similar challenges in CORS implementation experienced by both Australia and Thailand, adopting a policy framework modelled on Australia's successful NPI Policy is expected to significantly enhance Thailand's capacity to manage this technology effectively. It is rational to learn how Australia created and specified the organisations' roles for the above reasons. The summary in TABLE A – 28 in the Appendix shows particular characteristics of the elements that played an important role in these movements. These criteria can be applied in Thailand because of the similarities in the circumstances. The technical information and management design presented in the table will serve as a foundation for establishing a comprehensive policy for the National CORS in Thailand.

7.6 CHAPTER CONCLUSION

Chapter 7 interprets the findings and identifies a lack of clear strategic direction and strong leadership as the key issues. This root cause explains many of the subsequent problems observed. For example, it resulted in power asymmetries that magnified challenges in both the outer and inner layers of the theoretical framework. Uncertainty regarding the business model—with no consensus on its ideal structure—further exemplifies how the absence of strategic guidance negatively impacted decisions related to infrastructure investment and maintenance budgeting.

These insights are significant because they form the basis for recommendations aimed at enhancing collaboration through the development of a policy framework for GNSS CORS management, as detailed in the following chapter. The proposed framework offers a comprehensive implementation guide that sets broad parameters while maintaining flexibility regarding specific details, such as investment scale. Consequently, this policy framework could serve as an effective tool for addressing the challenges associated with CORS implementation in Thailand.

Chapter 8

CONCLUSION

This thesis has detailed the undertaking of this research, including the study of the literature, the collection of data, the analytical work using an assortment of scholarly approaches, and the interpretation of the outputs. This chapter will provide an overall summary of the research presented.

This chapter will contextualise these studies and findings in pursuit of the specific research objectives. It will conclude with avenues for future research in this field of interest.

8.1 RESEARCH OBJECTIVES – RESEARCH QUESTIONS CONCLUSION

The area of enquiry was set on the development of the structure outlined for CORS management in Thailand. This particular attention has also added a series of events in Australia to give a capability of proof. The framework of research methods and techniques has framed the scope of the study qualitatively in collaborative innovation for the association between government organisations. Both the analysis of cases and fieldwork data then produced the results asserting the suppositions.

In this study, empirical findings responded to the research questions accordingly. How the findings address the research questions is described below.

RQ 1 How can we evaluate the success of technology management?

To answer the question of "How can we evaluate the success of technology management?", this study examines the cause of what has happened in past implementations and how those developments unfolded. The literature review reveals that the success of implementing advanced technological systems—particularly satellite-based positioning technologies like CORS—depends on four core elements: technology, human resources, finance, and policy. These components form the foundation of a systematic methodology to judge the performance and cohesion of such technology initiatives. By identifying and validating these determinants through scholarly works and international comparisons, the study builds confidence in their reliability and applicability. The developed evaluation framework, grounded in these criteria, not only explains the interrelated efforts within the CORS ecosystem across countries but also affirms its usefulness as a viable model for assessing technological success. Ultimately, this framework helps encapsulate both the causes and outcomes of implementation efforts and provides a structured way to evaluate the overall effectiveness of technology management.

This research question respectively agrees with the research objective:

To develop a sensible evaluation framework for this technology management based on the literature

The designed success evaluation framework serves as a critical foundation for initiating the analytical process and provides a primary basis for justifying the research findings.

RQ 2 How has GNSS CORS technology management between government organisations in Australia been done?

The Australian case study was conducted in a timely manner to examine how GNSS CORS technology has been managed across government organisations. This investigation utilised secondary data to assess the Australian government's capacity to implement GNSS base stations. Given the similarity of challenges faced in both Australia and Thailand, the study explored not only the nature of these issues but also the pathways leading to successful outcomes. The proposed success evaluation framework was applied to assess the implementation of GNSS reference stations in Australia. Findings were drawn from the systematic collection, collation, and synthesis of relevant documents. These findings were then evaluated using four innovation-specific elements to determine the effectiveness of CORS operations. The analysis provided detailed insights into how Australia has effectively advanced its positioning technology. Furthermore, the collaborative framework for managing the GNSS network in Australia aligned well with the evaluation model, reinforcing its credibility.

Building on this, the study progressed to identify the factors underlying Australia's success in GNSS CORS technology management. Emphasis was placed on uncovering the sources of this success, guided by earlier findings that confirmed Australia's favourable outcomes. The link between actions and achievements was substantiated through both qualitative and quantitative justifications, all measured against the established evaluation criteria. These results—positive in both narrative and numerical terms—demonstrated why Australia has successfully achieved the intended solutions.

This set of research questions, in the end, has clear-sighted rejoinders to press ahead with the research objective as written below.

To evaluate Australia's experience based on the developed evaluation framework

RQ 3 How has GNSS CORS technology management between government organisations in Thailand been done?

To assess GNSS CORS technology management in Thailand, this study analysed primary and secondary data from government agencies. Findings reveal fragmented efforts, with agencies independently developing systems for internal use rather than collaboration. Budget constraints later prompted calls for cooperation, but conditions

for effective collaboration were unmet. As of the final data collection, full coordination had not been achieved. Using a success evaluation framework—technology, human resources, finance, and policy—the study found limited station coverage, insufficient expertise, constrained funding, and a lack of legal, strategic, and operational policies. Most data-sharing remains informal and based on bilateral agreements, while financial shortfalls affect both expansion and maintenance.

The study further explored why Thailand has not succeeded in GNSS CORS implementation. Institutional silos, incompatible missions, and authority boundaries limit coordination. Adopting foreign models like Australia's is impractical due to contextual differences in structure, policy, and capacity. Technologically, the base network remains incomplete. Human resources are lacking in both numbers and specialisation. Financial support is inadequate, and there is no unified policy or legislative framework to guide implementation. Business models suffer from low returns and ongoing deficits. External factors—such as political instability, limited infrastructure prioritisation, and weak economic capacity—exacerbate these issues. The COVID-19 pandemic further disrupted progress. Collectively, these challenges explain Thailand's limited success in GNSS CORS development and highlight the need for stronger policy direction and effective leadership to drive collaboration, ensure resource allocation, and achieve institutional alignment.

To evaluate Thailand's experience based on the developed evaluation framework

RQ 4 How does collaborative innovation alleviate the lack of GNSS CORS technology sharing between government organisations in Thailand problem?

The central research question of this study explores how collaborative innovation can address the lack of GNSS CORS technology sharing among Thai government organisations. A key research aim is to identify effective strategies for fostering collaboration and forming partnerships. The study uses interview data from various government agencies and GNSS specialists in Thai universities to investigate this. The findings support the relevance of Collaborative Innovation, Innovation Ecosystems, Networked Innovation, and Stakeholder Theory. Cross-case analysis with Australia further highlights how these frameworks can inform CORS sharing strategies in Thailand.

An important aspect of collaboration is the management tool for GNSS CORS coordination. Location-Based Services (LBS), a positioning technology compatible with CORS, was evaluated for its potential as a management platform. Respondents gave mixed feedback. Many rejected the idea due to security and necessity concerns—worries about data protection, user accountability, and redundancy with existing computer-based systems. They doubted the need for mobile access in CORS management. Conversely, respondents from agencies already using mobile tools expressed strong support. They use LBS for system structuring, data access, user management, and facility monitoring. They emphasised the importance of real-time

access and control in managing a nationwide shared CORS network. Overall, while LBS received both support and scepticism, the research suggests it has potential value. However, successful implementation would require addressing security, functionality, and user accountability to make it a viable tool for managing collaborative GNSS networks in Thailand.

The differentiation of case analysis between Australia and Thailand on the evolvement of the CORS has been prepared for answering those research questions. It has also been conceived to expand on the conclusion to the research objective below.

To compare the different experiences between Thailand and Australia based on the developed evaluation framework

RQ 5 What guidance should have been recommended for managing the GNSS CORS technology in Thailand?

This purposive study aims to establish best practices in policy and implementation for unifying GNSS CORS technology in Thailand. The key research question—what guidance should be recommended for managing GNSS CORS—has led to a series of strategic suggestions tailored to Thailand’s context. Drawing from within-case and cross-case analyses, particularly lessons from Australia, the study evaluates how functional characteristics of CORS systems can be adapted to Thailand’s institutional environment. The recommendations are grounded in Collaborative Innovation, Innovation Ecosystems, Networked Innovation, and Stakeholder Theory. These frameworks guided the evaluation of previous findings and their alignment with Thailand’s current conditions. As a result, a set of guidelines has been proposed to enhance coordination, efficiency, and shared infrastructure in CORS development.

This question also links to the practical consideration of how the proposed guidance can optimise implementation efforts. The intention is to support the evolution of a joint GNSS network by offering adaptable strategies aligned with the country’s needs and capabilities. By comparing research insights with real-world constraints, the study proposes a model to improve preparedness and coordination among stakeholders. Ultimately, the study integrates research findings with critical literature analysis to develop an actionable plan for advancing Thailand’s CORS network, aiming to strengthen collaboration and support the long-term development of GNSS infrastructure nationwide.

The continued and inspired cogitations on the suggestions about Thailand's CORS administration in the future have, therefore, held to the research objective demonstrated below.

To issue guidance for fitter implementation on GNSS CORS in Thailand

8.2 FINDINGS – THEORIES CONCLUSION

The theories presented in this study have a similar direction to innovation in the public sector that gathers a number of stakeholders. Notably, the Innovation Ecosystem theory that links to the ecosystem of CORS technology led to the generation of codes for data analysis. Eventually, the research findings reaffirm the fitness of these theories and the collected data.

Within this study, two cases were taken into account, and then the outcomes of the case studies analysis were compared. The pattern-matching and content analysis on the outlooks and documents towards the union between the CORS-related organisations in Thailand came up with the unavailing resort. Both the research findings are evident in the mismatch between the happenings in Thailand and the theory. The following section will then consider the suitability of the workings of the CORS-related organisations in concert with other partners that conform to the theories.

8.2.1 Suitability of Theories Explanation

This section will explain how each theory underpins the congruency or discrepancies between the observed data and the theoretical framework elements.

1. Collaborative Innovation

Based on research findings, how the data confirms or refutes Collaborative Innovation.

According to the findings, it can be concluded that Collaborative Innovation is a theory in which conceptual grounds appropriately support the congruency or discrepancy investigation between the theoretical framework and the data gathered for this study, as can be seen in the following research results.

- 1.1. What circumstances led to the absence of inter-organisational collaboration on GNSS CORS implementation between government organisations in Thailand and between Thailand and foreign countries?

Interview participants indicated that GNSS CORS installations in Thailand were driven by each organisation's internal goals, varying knowledge levels, and distinct scopes of work. This fragmented approach stemmed from a lack of awareness and trust between CORS owners, who were unaware of each other's assets and uncertain about the reliability of others' systems. As a result, they submitted separate budget requests, leading to overlapping installations and inefficient coverage. The absence of coordination meetings further hindered collaboration. Crucially, no central authority oversees CORS planning or grants legal permission for data sharing or network integration. Organisations operate under different regulations and receive varying levels of political support, limiting their ability to align efforts. This lack of unified governance has obstructed both domestic and international cooperation in CORS development, highlighting the urgent need for a coordinated

management framework and authoritative leadership to promote efficient, collaborative use of GNSS infrastructure in Thailand.

1.2. Why is collaboration on GNSS CORS implementation not happening in Thailand?

The lack of collaboration in GNSS CORS implementation in Thailand stems from differing requirements, goals, conceptual frameworks, and limited scopes of work among organisations. These disparities highlight the need for open discussion to establish a unified direction. Variations in knowledge levels have led to an unequal understanding of CORS's utility and a lack of awareness of other agencies' installations. Due to limited trust and openness, some organisations prefer to build their own CORS, doubting the quality of others' systems. Moreover, there is no national infrastructure or funding plan, as no central authority oversees CORS development. The government responds reactively to agency requests rather than through coordinated planning. The absence of intermediaries, co-working mechanisms, and meeting opportunities has further restricted collaboration. Unequal organisational power, political support, and differing work cultures also hinder joint efforts. These factors collectively explain why effective CORS collaboration among Thai government agencies remains elusive.

1.3. How could Thailand achieve success in the GNSS CORS implementation?

To successfully implement CORS technology in Thailand, the government should leverage diverse CORS networks across organisations for idea generation, creation, and implementation. This requires openness in both creativity and connectivity. National CORS should accept data from various agencies to enhance the speed and quality of innovation. Collaboration must also involve the ICT sector to support cross-organisational data exchange. Clear work scopes and well-defined responsibilities are essential. Additionally, policies and regulations must promote inter-organisational cooperation, addressing cultural and institutional barriers while encouraging socio-political support. The national CORS should also back initiatives that foster creativity, improve selection processes, enhance implementation, and support effective delivery.

2. Networked Innovation

Based on research findings, how does the data confirm or refute Networked Innovation?

As shown in the context below, the findings present that Networked Innovation encourages the exploration of the congruency or discrepancy between the theoretical framework and the empirical data.

2.1. What environment impacts the establishment of networking on GNSS CORS implementation in Thailand

Key factors hindering GNSS CORS network development in Thailand include fragmented investment and management, leading to uncoordinated actions among CORS owners. Government agencies vary in their understanding of CORS technology and are often unaware of existing systems managed by others. Many lack the necessary technology, skilled personnel, and readiness for implementation. Existing government-owned CORS services fall short in quality and reliability, primarily due to limited funding and a lack of recognition of CORS as critical national infrastructure. Cultural and organisational barriers further restrict cross-sector collaboration and technology exchange. Moreover, CORS-owning organisations lack the authority to share or profit from their systems. Government support is uneven, with some agencies receiving preferential backing due to closer ties with decision-makers. These challenges highlight the need for coordinated policy, unified infrastructure planning, and recognition of CORS technology as vital to national development.

2.2. Why networking does not work for GNSS CORS implementation in Thailand

CORS network development in Thailand has been fragmented due to the absence of a shared goal, coordinated site planning, and a structured co-working programme. Key barriers include limited technological knowledge, unequal awareness of applied technologies, and a lack of continuous adaptation to evolving innovations. Additionally, there is no clear technological development plan or recognition of CORS as a public service, particularly for sectors like agriculture. Readiness gaps in resources, recruitment, and internal capacity, combined with budget constraints and inconsistent service quality, further hinder progress. Cultural differences in work behaviour, lack of strategic vision, and weak understanding of CORS's national importance also contribute to the disconnect. Most critically, the lack of authority to foster collaboration and disparities in political support significantly impede network formation. These issues collectively obstruct the creation of a unified and effective GNSS CORS network in Thailand.

2.3. How networking underpins the achievement of GNSS CORS implementation in Thailand

Data analysis confirms that networking significantly supports GNSS CORS development in Thailand. By leveraging reference stations, the government can build collaborative networks across public, private, civil, non-profit, and research sectors to drive innovation and improve CORS application quality. Through such cooperation, national CORS can

integrate data from member systems to create value within the production process. Partnering with the ICT sector also enables knowledge exchange and idea-sharing across organisations. Moreover, a diverse network provides multiple perspectives, helping reduce decision-making bias and enhancing objectivity. Networking further aids in resource assessment, allowing national CORS to evaluate human and material resources and clarify their roles within and between organisations. This networking framework strengthens the foundation for sustainable, efficient CORS implementation in Thailand.

3. Innovation Ecosystem

Based on the research findings, how does the data confirm or refute the Innovation Ecosystem?

The findings based upon the examination of information gathered for this study describe how the Innovation Ecosystem endorses the congruence and incongruence between empirical information and the theoretical model. The conclusion given below is related to these research outcomes.

3.1. What key factors are influential in the development of GNSS CORS implementation in Thailand?

Thailand's innovation ecosystem for CORS development lacks coordinated support from the government, limiting knowledge exchange and technology sharing among stakeholders. This has led to poor functionality, the absence of standard protocols, and no clear national development plan for GNSS CORS. Due to financial constraints, government support is limited to well-resourced organisations. Internally, CORS-owning organisations operate independently, with distinct missions, experience levels, and conceptual designs, which hinders collaboration and trust. These differences also result in limited awareness of other organisations' CORS assets and efforts. Resource-sharing is further blocked by varying levels of technical knowledge, capacity, and recruitment power. Additionally, inconsistencies in authority and oversight prevent cohesive management of CORS operations. To address these issues, a national CORS framework must grant clear, practical authority to relevant units, ensuring alignment of policies, responsibilities, and legal regulations for effective implementation.

3.2. Why do key factors affect GNSS CORS implementation in Thailand?

Several factors hinder the implementation of GNSS CORS technology in Thailand, primarily due to a lack of practical administration across key areas such as site planning, facility management, technical oversight, and innovation management. Contributing issues include the absence of a

unified design, inadequate site selection processes, and the lack of a nationwide infrastructure and technological development plan. Budget constraints and unequal financial distribution further limit progress. Additionally, imbalances between cultural work practices and technology, combined with limited trust, openness, and awareness, create barriers to collaboration. Disparities in knowledge, conceptual alignment, organisational potential, and resource allocation also affect implementation. Moreover, unclear authority structures, inconsistencies in administrative control, and lack of effective governance frameworks undermine coordinated efforts. Addressing these interconnected issues is essential to enabling a cohesive and sustainable national CORS strategy.

3.3. How do CORS ecosystems encourage the success of GNSS CORS implementation in Thailand?

The CORS ecosystem in Thailand involves various components essential to its development. To support this, the government must foster interdependence among stakeholders within a collaborative CORS framework. The National CORS Data Center should emphasise the importance of collaboration by coordinating complementors, complementary assets, and roles. It should also support partnerships and programme completion across involved organisations. Simultaneously, the government should enhance the ecosystem's appeal by ensuring access to CORS infrastructure, supporting technologies, funding, skilled personnel, and clear organisational roles. This includes implementing practical business models, strategic plans, national policies, standards, and legal frameworks. Additionally, the government must facilitate resource sharing and empower stakeholders with clear authority to drive and sustain CORS initiatives effectively.

These are the aspects that CORS ecosystems can assist in succeeding in Thailand's CORS progression.

4. Stakeholder Theory

Based on the research findings, does the data confirm or refute Stakeholder Theory?

Stakeholder Theory involves multiple entities that have relevance to CORS development in Thailand. The research findings draw the conclusion from the investigation that Stakeholder Theory underpins the congruency and incongruity between the theoretical framework and collected data evaluation. Details, as described below, provide support for this resolution.

4.1. What challenges did stakeholders encounter with GNSS CORS implementation in Thailand?

CORS implementation in Thailand faces several challenges. Due to limited legal authority, the stakeholders believed the partnership could be effective if Thailand adopted a military-style approach to managing it. They expressed a need for clear, stable, and transparent authority to guide CORS development—unaffected by changes in leadership or government. Support for organisations involved in the national CORS programme varied, based on reputation, experience, asset ownership, or political ties. Additionally, differences in educational backgrounds, expertise, resources, and management capabilities created further barriers. Government agencies involved in CORS initiatives have unequal access to resources and human capital. Site planning and design decisions were made internally by individual organisations, with little cross-agency coordination. This led to a lack of awareness of parallel CORS projects, service overlaps, coverage gaps, and disruptions in operations. A coordinated, authoritative, and inclusive approach is essential for seamless CORS integration and long-term sustainability in Thailand.

4.2. Why can the stakeholders not collaborate on GNSS CORS implementation in Thailand?

Implementing GNSS CORS technology in Thailand affects various stakeholders, especially government organisations. However, effective cooperation remains unachieved due to several key issues. These include unequal control and inspection authority, lack of clear administrative structures, and absence of cooperation mandates. Additionally, unclear, ineffective, and unstable authority further hinders progress. Disparities in organisational priorities, influence, and preparedness, as well as unequal access to internal resources and recruitment capabilities, also obstruct collaboration. Furthermore, poor coordination in CORS site planning adds complexity to joint efforts and weakens the potential for unified action.

4.3. How do stakeholders influence the success of GNSS CORS implementation in Thailand?

Stakeholders play a vital role in advancing Thailand's CORS programme. To maximise its potential, the government should foster an active, inclusive environment that engages diverse actors with CORS-related assets—such as infrastructure, funding, knowledge, or ideas. Clear roles and responsibilities should be assigned based on each stakeholder's readiness and resources. Key actors, especially those in the Information and Communication Technologies (ICT) sector, should be empowered to

support knowledge exchange and innovation. It is also essential for the national CORS programme to define the scope of stakeholder involvement and specify which actors should engage at each development stage. This structured, collaborative approach can significantly enhance the effectiveness and success of CORS implementation in Thailand.

8.2.2 Suitability of Theories Evaluation

In this section, the researcher will justify the appropriateness of the approaches taken to explain the research development, both in terms of collected data and analysed results.

1. Collaborative Innovation

This study on GNSS CORS management has a focus on innovation management in the public sector. An examination of whether Collaborative Innovation provides a satisfactory explanation for the data sources and analysis conducted can be done by contemplating whether a new pattern of public sector innovation is required in general (Bommert, 2010).

- Whether there are challenges that are not achieved

CORS management in Thailand faces persistent and emerging challenges, particularly when new or existing organisations build or expand their stations. Organisations unaware of or unable to use existing networks, lacking their own systems, or unable to meet internal needs often invest in separate CORS systems. Without a centralised national network, this leads to repeated investments, redundant budget allocations, and overlapping or incomplete coverage. Leadership and coordination remain weak, despite the RTSD being appointed as the National CORS Data Center by the NGB. Progress has stalled due to insufficient funding, and the absence of structured plans, policies, standards, and legislative enforcement. As a result, authority and responsibilities remain unclear. These ongoing issues highlight unmet challenges in CORS management. Therefore, adopting a collaborative public sector innovation approach is a logical and necessary step forward.

- Whether there are deficiencies in public sector innovation

This section evaluates whether current practices are sufficient for GNSS CORS implementation in Thailand. Findings from case studies and data analysis highlight key weaknesses: lack of collaboration, unequal power dynamics, poor implementation, and absence of clear policy and direction. These deficiencies hinder the government's ability to effectively manage the fragmented CORS installations and address broader economic, institutional, and technological challenges related to GNSS infrastructure.

In conclusion, the research suggests that the lack of a strategic innovation approach hinders efforts to reduce duplication in CORS site selection and budget allocation, as well as the inefficiency in facility sharing. As a result, the government struggles to provide centralised CORS services for the private, public, and research sectors. These issues stem from bureaucratic constraints, cultural barriers, and limited socio-political support. Adopting a collaborative innovation approach could help overcome these challenges, address organisational and cultural limitations, and enhance the effectiveness and potential of CORS development in Thailand.

2. Networked Innovation

Networked innovation connects multiple actors to share resources, ideas, and technologies, fostering collaborative innovation and knowledge exchange. In Thailand, fragmented CORS systems across government organisations present a major challenge, with limited internal resources hindering progress. To overcome this, asset owners require additional data, funding, personnel, and technical expertise—needs that networking can help meet. This study found that some CORS owners are open to external collaboration, supporting data and knowledge sharing. For example, the RTSD and DOL have established a partnership where RTSD uses DOL data to enhance national coverage, while DOL leverages RTSD data to improve land surveying services. Such partnerships highlight the value of a networked approach. Therefore, networked innovation offers a practical and effective solution for strengthening CORS development in Thailand by enabling cooperation, resource sharing, and improved system integration across organisations.

3. Innovation Ecosystem

This study highlights key causes of Thailand's challenges in governing GNSS CORS stations, stressing the importance of understanding governance failures. The innovation ecosystem framework provides a useful lens to examine the roles, relationships, and power dynamics among actors across the value chain, from upstream to downstream innovation. It helps identify interdependencies and external challenges such as technological uncertainty and limited organisational capacity. Applying this framework to the Thai GNSS CORS context is logical, as the transition from internal resources to shared environments involves multiple stakeholders. Fragmented ownership and government budget constraints have hindered progress. Inter-organisational cooperation is proposed as a solution. Research findings identify four critical elements for building a successful collaborative environment: CORS and related technologies, human resources and leadership, financial capacity, and supportive policies and regulations. The alignment between theoretical and observed elements affirms the relevance of the innovation ecosystem approach in advancing GNSS CORS development in Thailand.

4. Stakeholder Theory

CORS owners are central to this study due to their role in the fragmented investment and development of GNSS base stations in Thailand. Government organisations have independently sought fiscal budgets to install CORS systems for internal purposes, leading to duplication and inefficiency. A shift toward a centralised, multi-organisational CORS system requires these entities to collaborate as key stakeholders. Stakeholder Theory explains how individuals, groups, or organisations pursue benefits and influence over ideas, resources, and outcomes. Stakeholders shape decision-making, implementation, and results. In public sector innovation, differences in stakeholder roles and perspectives become more apparent, as organisations often view innovation through their own institutional lens. This study's findings align with the principles of Stakeholder Theory, particularly in highlighting the differing expectations and power dynamics among stakeholders. The theory effectively supports the analysis of CORS development in Thailand and confirms its relevance in guiding collaborative innovation efforts in the public sector.

The theories underpinning this study—Collaborative Innovation, Networked Innovation, Innovation Ecosystem, and Stakeholder Theory—collectively support the development of CORS collaboration among Thai government organisations and validate parallels with the Australian context.

This research prioritised GNSS CORS development in Thailand, focusing on the challenges of managing multiple government asset owners. Collaborative Innovation most effectively explains the inter-organisational relationships and responses to Thailand's specific challenges, especially the need for shared resources and reduced redundancy. Networked Innovation complements this by promoting cross-boundary cooperation through intergovernmental networking. The Innovation Ecosystem framework highlights the importance of interdependencies, roles, and power dynamics, reinforcing the collaborative innovation model. Meanwhile, Stakeholder Theory underscores the importance of engaging influential actors and maintaining balanced stakeholder relationships to ensure system-wide cooperation. In sum, all four theories provide a solid foundation for understanding and improving GNSS CORS management in Thailand, particularly in fostering coordination and centralisation across government sectors.

In comparison with the theoretical framework developed from these theories, several factors have impeded successful CORS collaboration in Thailand. However, the study identifies the core issue as the lack of a clear strategic direction for collaboration, exacerbated by weak leadership. Insights from the successful Australian case further emphasise that these deficiencies are key barriers to Thailand's CORS implementation. Effectively addressing these challenges is crucial for advancing collaborative efforts and ensuring long-term success.

8.3 RECOMMENDATIONS FOR CORS POLICY FRAMEWORK

This study's research design, data collection, and analysis produced findings that closely aligned theoretical frameworks with empirical observations. The interrelationships among key components informed the development of a proposed structure to support Thailand's GNSS CORS policy framework, detailed in the Appendix. This framework addresses core barriers to effective CORS implementation, offering a path toward enhanced multi-stakeholder coordination. It aims to mitigate issues of fragmented investment, redundant operations, and inefficiencies across Thailand's GNSS CORS network.

Drawing on the theoretical framework, particularly the roles of strategic direction and leadership, this study emphasises that successful technological development depends not only on high-level vision (outer layer) but also on practical implementation factors (inner layer). A viable business model, strengthened organisational capabilities, sustained technology investment, and tangible returns are essential. Equally important is the effective management of technological ownership, stakeholder influence, inter-organisational interaction, and governance structures. Proper alignment of these factors ensures that collaborative initiatives move in the right direction for sustainable success.

This study offers a foundation for more effective multi-stakeholder governance of CORS in Thailand. By adopting the proposed framework, the country could move toward a unified GNSS CORS network management, minimising fragmented investment and isolated operations. While the implementation of a national GNSS CORS policy depends on political will and stakeholder consensus, this research underscores the importance of a foundational draft. The proposed structure serves as a starting point for refinement through collaborative input from relevant stakeholders. Ultimately, the study aspires to contribute to the development of a comprehensive national CORS policy for Thailand, offering guidance for achieving more coordinated and sustainable CORS network management in the future.

8.4 CONTRIBUTION OF THIS STUDY

This study offers contributions in two key areas: theoretical and practical. These contributions range from developing a framework based on the literature, applying it for empirical testing, and demonstrating its practical applicability. Together, these contributions aim to support the development of a coordinated, efficient CORS network in Thailand.

8.4.1 Theoretical Contribution of This Research

This study's contribution to the literature lies in the development of a novel theoretical framework, represented by a series of interconnected circles, which integrates both inner- and outer-layer factors influencing GNSS CORS implementation. This framework appears to be effective in terms of explaining why the Thai experience differs greatly from the Australian experience. It provides a set of explanations for why Thailand has performed less well than Australia. In Thailand, the absence of clear strategic direction and leadership, inefficient interaction among key stakeholders, imbalanced power

dynamics, and lack of consensus on ownership and management ultimately resulted in suboptimal outcomes. The framework illustrates that when these factors are neglected, critical issues—such as misaligned business models, inadequate supporting technologies, uneven budget allocation, insufficient capacity building, and ineffective collaboration—become more pronounced. In contrast, Australia’s experience proves that addressing these elements can effectively mitigate such challenges.

The study’s main theoretical contribution is founded on combining perspectives from collaborative innovation in the public sector (outer layer), where government roles influence each factor, with factors critical to complex technology implementation (inner layer)—an integration not previously presented in existing research. This framework moves beyond isolated factors, offering a systemic and multifactorial view of success and failure in collaborative technological projects. Applied empirically to the Thailand and Australia cases, the framework exhibited strong explanatory power, validating its practical relevance. Multiple factors influence the success or failure of technology implementation, and a key finding of this study is that elements from both the outer and inner layers of the framework are interrelated and must function cohesively. While the factors were effectively addressed in Australia, contributing to its success, they remain underdeveloped in Thailand, hindering comparable outcomes. Thus, the study not only develops an original framework but also applies it effectively to real-world cases, demonstrating how systemic alignment between the collaborative strategy and its associated outer-layer components and the implementation components in the inner layer determines the success of GNSS CORS implementation. This integrated understanding advances the theoretical discourse on collaborative innovation and technology management while providing practical guidance for future multi-stakeholder technology initiatives involving government participation.

8.4.2 Practical Contribution of This Research

This research makes valuable contributions to the body of knowledge through its theoretical foundations and empirical findings. It presents an integrated framework for CORS technology, drawing on literature to identify interconnected elements that enhance the understanding of the field. Additionally, the practical insights derived from this study offer actionable guidance for effective CORS technology management. The study makes original contributions in five key areas. First, it introduces an evaluation framework, developed from existing literature, to assess the success of technology implementation in general contexts. Second, it applies this framework to analyse Australia’s historical experience in CORS administration, utilising secondary data gathered from a variety of Australian sources. Third, it examines Thailand’s ongoing CORS implementation, identifying key influencing factors through primary and secondary data collected from various Thai government organisations. Fourth, it conducts a cross-case analysis between Thailand and Australia, highlighting critical aspects of technology management and offering insights into effective governance. Finally, the study proposes recommendations to improve GNSS CORS arrangements in

Thailand. These include practical guidelines for cooperation, with suggested conditions and procedures to support effective collaboration among stakeholders.

The practical contribution of this research is grounded in the theoretical framework developed herein. Its applied elements are designed to guide senior policymakers in Thailand on the implementation of complex, multi-stakeholder technologies. The outcomes provide valuable advice for government officials, identifying crucial factors for successful collaborative innovation and underscoring specific areas that require close attention. This guidance is intended to enhance the viability and success of projects within this domain.

8.4.3 Practical Recommendations for the Thai Government

Although the theoretical framework was developed through research in Thailand's GNSS CORS context, its design is broadly applicable. In principle, it can be adapted for use in other countries and with different technologies, particularly in cases where implementation involves the technology that is suitably complex and requires multi-stakeholder engagement under government influence. By integrating collaborative innovation theories with factors critical to technology implementation, the framework offers a flexible tool for analysing and guiding multi-stakeholder technology initiatives beyond the Thai context.

The ultimate contribution of this study is the advisement on completing Thailand's national GNSS CORS system. Through an in-depth investigation of GNSS CORS management practices, particularly in Australia and Thailand, the research identifies strategies for sustainable administration. These strategies are based on lessons drawn from well-regulated systems and rational management approaches observed internationally. Careful selection and adaptation of these practices ensure that the proposed solutions are tailored to Thailand's specific institutional, technical, and administrative context.

Recommendations for Thailand's GNSS CORS management policy have been developed and are detailed in the "Recommendations for Thailand" section of the Appendix. The policy framework is structured into five key categories—collaboration, finance, roles, plans, and technologies—each linked to components of the theoretical framework. For each category, policy definition, target, advantage, and implementation mechanism are proposed. These recommendations are designed not only to address current challenges but also to provide a dynamic foundation for future refinement, ensuring that Thailand's GNSS CORS system evolves toward greater efficiency, sustainability, and coordination across sectors.

The insights generated from this research have been articulated through both theoretical and practical dimensions. Theoretically, the study contributes by integrating broader perspectives of collaborative innovation in the public sector with the critical factors influencing success and failure. These theoretical contributions address existing research gaps through a novel

approach that enhances understanding of how collaborative innovation in the public sector can be applied to resolve issues of duplicated GNSS CORS investments and the uncoordinated management of CORS technology in Thailand. In parallel, the study provides practical contributions that bridge the transition from theory to practice. These contributions address the empirical gap concerning the relationship between collaborative innovation in the public sector and GNSS CORS management among Thai government organisations—an area that has not been comprehensively explored. The interrelation between the research problems, gaps, and contributions is summarised in the TABLE 33 below.

TABLE 33 Research problems, research gaps, and research contributions of this study
(Source: Author's own research)

Research Problems	Research Gaps	Research Contributions
1. The nature of the inter-organisational collaboration on GNSS CORS implementation between government organisations in Thailand. 2. The nature of the international collaboration on GNSS CORS implementation between Thailand and foreign countries. 3. The nature of the data sharing and central network of GNSS CORS in Thailand. 4. The nature of the central unit for GNSS CORS management in Thailand. 5. The nature of the futuristic technology as an administration tool for GNSS CORS management in Thailand. 6. The nature of the policy framework for GNSS CORS management in Thailand.	Theoretical gap: A collaborative innovation in the public sector approach has not yet been adopted to resolve the issues of duplicated GNSS CORS investments and the fragmented coordination of CORS technology in Thailand.	Theoretical contributions: The theoretical framework, which integrates the concept of collaborative innovation in the public sector with critical success factors, is structured into two interrelated components: Outer layer 1. Ownership and governance 2. Power asymmetries 3. Interaction processes and supporting technologies 4. Setting direction of collaboration Inner layer 1. Technology 2. Human resources 3. Finance 4. Policy
	Empirical gap: The linkage between collaborative innovation in the public sector and the management of GNSS CORS among government organisations in Thailand remains insufficiently explored.	Practical contributions: 1. Theoretical evaluation framework 2. Case study of Australia using secondary data 3. Case study of Thailand using primary and secondary data 4. Cross-case analysis between Thailand and Australia 5. Practical recommendations for Thailand

This study offers five key practical contributions aligned with its research questions. First, addressing Research Question 1, it develops a generalisable theoretical evaluation framework for assessing technology management success, extending beyond the specific case of Thailand

or GNSS CORS. In response to Research Questions 2 and 3, the framework is applied to case studies in Australia and Thailand, respectively, to evaluate the effectiveness of GNSS CORS management in each country. Addressing Research Question 4, the study conducts a comparative analysis to examine how collaborative innovation influenced outcomes in both contexts, thereby demonstrating the framework's relevance and practical applicability. Finally, in response to Research Question 5, the framework informs a set of practical policy recommendations tailored to improving Thailand's GNSS CORS implementation. These contributions collectively bridge theory and practice, offering both a conceptual tool and actionable guidance for managing complex, multi-stakeholder technologies under government influence.

The relationships between the research questions, the research objectives, and the research contribution can be seen in TABLE 34 below.

TABLE 34 Research questions, research objectives, and research contributions of this study (Source: Author's own research)

Research Questions	Research Objectives	Research Contributions
RQ1. How can we evaluate the success of technology management?	To develop a sensible evaluation framework for this technology management based on the literature.	Provide a theoretical evaluation framework developed from the literature for measuring the success of technology implementation in a general background.
RQ2. How has GNSS CORS technology management between government organisations in Australia been done?	To evaluate Australia's experience based on the developed evaluation framework.	Provide a case study of Australia's experience by applying the evaluation framework to the secondary data that has been collected.
RQ3. How has GNSS CORS technology management between government organisations in Thailand been done?	To evaluate Thailand's experience based on the developed evaluation framework.	Provide a case study of Thailand's undertakings by applying the evaluation framework to the primary and secondary data that have been collected.
RQ4. How does collaborative innovation alleviate the lack of GNSS CORS technology sharing between government organisations in Thailand problem?	To compare the different experiences between Thailand and Australia based on the developed evaluation framework.	Provide the critical factors generated from the cross-case analysis that make things have gone well or not well on a broader technology.
RQ5. What guidance should have been recommended for managing the GNSS CORS technology in Thailand?	To issue guidance for fitter implementation on GNSS CORS in Thailand.	Provide practical recommendations for the proper implementation of GNSS CORS in Thailand.

8.5 LIMITATIONS OF THE STUDY

The achievements and limits of this study are subject to the research design. This induction concerns various features: the logical assumption of the missing pieces in the literature addressing the research gaps, a clear explanation of the research problem, the clarity of the research questions, the reasonable adoption of the theoretical framework leading to a justifiable evaluation framework, appropriate data collection methods, expedient data analysis approaches, and sensible interpretation of the findings.

8.5.1 Research Design

1. *Limited Generalisability of Qualitative Design:* This abductive qualitative study may lack generalisability, but its design was purposefully aligned with Thailand's context to address research gaps and explore government involvement in CORS technology.
2. *Methodological Constraints from External Factors:* Research methods were shaped by constraints within Thailand and global disruptions such as the COVID-19 pandemic.

8.5.2 Data Collection

1. *Incomplete Participation in Focus Groups:* Although most key GNSS CORS actors in Thailand joined the focus groups, some dominant agency representatives were absent, limiting the diversity of perspectives.
2. *Influence and Hierarchical Constraints:* Hierarchical dynamics affected the openness of discussions, as subordinates were potentially restricted in expressing differing views from their superiors.
3. *Moderator Limitations and Data Gaps:* The dual role of the researcher as moderator and note-taker may have led to missed details, especially nonverbal cues and simultaneous participant interactions.
4. *COVID-19 Disruptions to Data Collection:* The pandemic forced a shift to online follow-up interviews, which caused delays, reduced access to participants, and limited supplementary data collection.
5. *Changes in Domestic Inter-Agency Collaboration:* Disruptions and restructuring in CORS-related inter-agency cooperation altered partnership forms and affected the scope of co-working arrangements.
6. *Interrupted International Support:* Global pandemic-related delays halted foreign support for Thailand's CORS, shifting the focus from financial aid to knowledge sharing, which hindered business model research.
7. *Impact of Operational Program Changes:* Adjustments to CORS programs due to budget cuts affected all framework aspects—technology, finance, policy, and human resources—leading to project delays and incomplete data from re-assigned personnel.

8.5.3 Data Transcription and Translation

1. *Potential Transcription Errors:* Some content may have been missed due to overlapping speech or distant, low-volume participants during interviews.
2. *Language Barriers in Data Translation:* Interviews were conducted in Thai, and although the researcher is fluent, translation into English may have introduced minor errors. Thai transcripts were used primarily to ensure analytical accuracy.

8.5.4 Case Studies Research

1. *Case Selection Limitation:* Selecting Australia and Thailand was relevant to the study's goals but may restrict the broader applicability of findings.
2. *Use of Authoritative Government Sources:* While the researcher accessed extensive internal documents as a government officer, only approved, credible sources were used in the study.
3. *Exclusion of Additional Case (Japan):* Although Japan was considered to be a third case, it was excluded due to time constraints and contextual dissimilarity with Australia and Thailand.

8.5.5 Data Analysis

1. *Technology and Context Specificity:* The study focuses exclusively on Thailand's CORS technology using data from Thai government agencies, limiting the generalisability of its findings to other technologies or countries.
2. *Scope of Analysis:* The analysis is based only on explicit textual and conversational evidence, potentially overlooking unspoken or undocumented factors.
3. *Framework Limitations:* The evaluation model highlights key factors but does not cover all possible criteria, which may result in overlooked aspects.

8.5.6 Other Challenges

1. *Implementation Challenges:* Applying the study's recommendations in Thailand may face challenges in terms of acceptance, readiness, or implementation capacity.
2. *Limited Transferability:* The proposed guidance may not be suitable for some technologies, sectors, or international contexts.
3. *Contextual Dependence:* Findings may become less relevant if key influencing factors in Thailand change over time.
4. *Generalisation Limits:* While the data is rich, generalising findings to different contexts remains limited.
5. *Researcher Bias:* As a government satellite engineer, the researcher may have unintentionally introduced bias; triangulation is used to enhance validity.

6. *COVID-19 Impact:* The pandemic significantly delayed the research and affected the researcher's mental well-being.

Although there are a lot of limits and barriers against the progress of research, it has been eventually attained. Many tactics have been used to overcome those limitations. However, the paramount importance of the investigation is to learn and realise them. This research might not be able to succeed in dealing with all challenges due to the scope of work and restraint of timespan. However, it is a starting point for further exploration.

8.6 RECOMMENDATIONS FOR FURTHER STUDIES

This study employs a qualitative approach to examine GNSS CORS management in Thailand and Australia, focusing on the implementation of a specific technology within a defined context. The developed theoretical framework has proven effective in identifying and addressing key challenges associated with CORS implementation, offering practical recommendations tailored to Thailand's environment. While the study centres on a highly specific case, the framework holds broader relevance for similar technologies or for the same technology applied in other countries.

From a theoretical perspective, the model's broader applicability warrants further exploration. It may prove useful in contexts involving complex and advanced technologies, multi-stakeholder dynamics, and significant government involvement—especially in cases where project outcomes fall short of expectations within a set timeframe. Future research could apply the framework to different technologies or countries with varying socio-political and economic conditions to test its generalisability. Key contextual factors include stakeholder power imbalances, the role of political dynamics, governance structures, and national economic performance. These elements underscore the need for effective coordination to ensure successful technology implementation.

The framework developed in this study—grounded in Collaborative Innovation Theory and supported by Networked Innovation, Innovation Ecosystem, and Stakeholder Theory—provides a structured lens through which these dynamics can be analysed. Ultimately, applying this model across diverse technological domains and distinct cultural contexts could enhance understanding of the conditions that foster or hinder success in multi-stakeholder technology projects. Doing so would not only validate the framework's broader applicability but also contribute to more effective governance and strategic coordination in complex technological initiatives.

8.7 CHAPTER CONCLUSION

This study explores key elements of GNSS CORS collaboration in Thailand through the lens of Collaborative Innovation Theory. Drawing on insights from an Australian case study, expert interviews, and focus groups, it supports the development of a policy framework for national CORS management. Location-Based Services technology is proposed as a strategic tool to

guide this system. In response to fragmented collaboration and duplicated efforts among Thai government agencies, the study also incorporates Networked Innovation, Innovation Ecosystem, and Stakeholder Theory to highlight the role of CORS asset owners and validate the need for coordinated action. A central finding is the urgent need for a clearly defined direction for collaboration, guided by strong leadership. Without a unified vision and empowered leadership to align stakeholder efforts, cooperative management risks remaining ineffective. As a consequence, both setting shared goals and assigning clear authority are essential to unify efforts across sectors.

Future research is recommended to assess the policy framework's impact and guide its practical implementation. Additionally, multinational collaboration on GNSS networks is encouraged to enhance service coverage, meet user demands, and stimulate growth in the positioning technology sector, benefiting both system providers and product manufacturers.

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ABBREVIATIONS

AEROTHAI	Aeronautical Radio of Thailand Ltd.
ANZLIC, the Spatial Information Council	Australian and New Zealand Land Information Council
APREF	Asia-Pacific Reference Frame
CU	Chulalongkorn University
DDPM	Department of Disaster Prevention and Mitigation
DOL	The Department of Lands
DPT	The Department of Public Works and Town & Country Planning
GA	Geoscience Australia
GISTDA	The Geo-Informatics and Space Technology Development Agency
GNSS	Global Navigation Satellite Systems
HAII	The Hydro and Agro Informatics Institute
IGS	International GNSS Service
KMITL	King Mongkut's Institute of Technology Ladkrabang
KU	Kasetsart University
LDD	Land Development Department
MD	Marine Department
MFA	The Ministry of Foreign Affairs
NBTC	Office of The National Broadcasting and Telecommunications Commission
NCRIS	National Collaborative Research Infrastructure Strategy
NGB	The National Geo-Informatics Board
NIMT	The National Institute of Metrology (Thailand)
NOAA	National Oceanic and Atmospheric Administration
NPI	National Positioning Infrastructure
NPI Plan	National Positioning Infrastructure Plan
NPI-AB	National Positioning Infrastructure Advisory Board
NPIPE	NPI Project Executive

PNT	Positioning, Navigation & Timing
RFD	Royal Forest Department
RID	Royal Irrigation Department
RTSD	The Royal Thai Survey Department
RU	Ramkhamhaeng University
TWG	Technical Working Groups

APPENDICES

A. DATA SOURCES

A.1 Interview Participants

TABLE A - 1 The first interview participant and interview data details (Source: Author's own research)

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TABLE A - 2 The first interview participant details (Source: Author's own research)

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TABLE A - 3 The follow-up interview participant and interview data details (Source: Author's own research)

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A.2 Interview Transcripts

Interview Questions

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B. LITERATURE REVIEW OUTCOMES

TABLE A - 4 A summary of a literature review on the innovation ecosystem (Source: Author's own research)

System Component	System Structure	System Process	System Requirement	System Evaluation	System Development
• innovation (Jackson, 2011) • straightforward innovation process, upstream components and downstream complements (Adner and Kapoor, 2010; Smith, 2006) • organisations and invigorated organisational culture (Adner and Kapoor, 2010; Smith, 2006) • actors, representatives and competent human resources (Adner and Kapoor, 2010; Jackson, 2011; Smith, 2006)	• innovation networks (technology and infrastructure) • knowledge clusters (knowledge stocks and knowledge flows) (Carayannis and Campbell, 2009)	• flows of inputs and outputs (Adner and Kapoor, 2010)	• business model (Adner, 2006) • financial management (Adner, 2006; Carayannis and Campbell, 2009) • innovation and knowledge society (Carayannis and Campbell, 2009; Jackson, 2011) • materials and resources (Adner, 2006; Carayannis and Campbell, 2009) • actors and human capital (Carayannis and Campbell, 2009; Jackson, 2011) • logistics (Adner, 2006)	• business area (Adner, 2006; Adner and Kapoor, 2010) • risk assessment (initiative risks, interdependence risks, and integration risks) (Adner, 2006; Adner and Kapoor, 2010) • position of a focal firm (Adner and Kapoor, 2010) • bottleneck (Adner and Kapoor, 2010) • role of personnel and responsibility to the system (allogenic and autogenic engineering) (Adner and Kapoor, 2010; Jones <i>et al.</i>, 1994)	• ecological succession (social forming process, environment change, ecosystem equilibrium) (Odum, 1969)

TABLE A - 5 A summary of a literature review on the CORS ecosystem (Source: Author's own research)

Infrastructure	Human resources	Policy	Standards	Financial resources	Business model
communication links material resources (Abidin <i>et al.</i> , 2010)	staff resources; experts; human resources; personnel training programme (Abidin <i>et al.</i> , 2010)	governmental endorsement of infrastructure and professionals (Abidin <i>et al.</i> , 2010)	require authentic infrastructure (Abidin <i>et al.</i> , 2010)	revenue generation (Abidin <i>et al.</i> , 2010)	require a further business model and master plan (Abidin <i>et al.</i> , 2010)
observation station, data transmission, central facility, and data distribution (Strange and Weston, 1995)			CORS supports the quality and standard of products (Strange and Weston, 1995)		
CORS network and CORS data chain; technology and relevant infrastructures (Supinajaroen and Van Loenen, 2019)	human element (Supinajaroen and Van Loenen, 2019)	policies and institutional framework (Supinajaroen and Van Loenen, 2019)	standards (Supinajaroen and Van Loenen, 2019)	financial resources (Supinajaroen and Van Loenen, 2019)	SDI framework (Supinajaroen and Van Loenen, 2019)

TABLE A - 6 A summary of a literature review on the CORS business model (Source: Author's own research)

Technology & Infrastructure	Strategy	Financial resources	Benefits	Human relations	Policy, Legal, Standard	Business models
CORS technology, in terms of communication, security, and technique (Bakici <i>et al.</i> , 2017)		installation and operation costs: equipment, software, maintenance, promotion, and communication (Bakici <i>et al.</i> , 2017)	revenues and service charges supervised by the Board and categorised by the service types (Bakici <i>et al.</i> , 2017)	user (Bakici <i>et al.</i> , 2017)		a business strategy, i.e., administrative structure, technical infrastructure, financial structure for CORS- TR System in Turkey (Bakici <i>et al.</i> , 2017)

Technology & Infrastructure	Strategy	Financial resources	Benefits	Human relations	Policy, Legal, Standard	Business models
- technical design: structure, infrastructure, obtainability (Bouwman <i>et al.</i>, 2008) - product innovation, infrastructure management (Donker, 2009)	- cooperative organisations (Bouwman <i>et al.</i>, 2008) - product and profit (Osterwalder and Pigneur, 2002) - value-added resellers (VARs) (Donker, 2009)	- invested capital (Bouwman <i>et al.</i>, 2008) - financial aspect (Osterwalder and Pigneur, 2002)	be mindful of: - payment mechanisms (Bouwman <i>et al.</i>, 2008) pay regard to: - service type and value - revenue and market strategy (Osterwalder and Pigneur, 2002) strategies: - free for the public, tax revenue from the VARs (Donker, 2009)	- actors and their connections (Bouwman <i>et al.</i>, 2008) - customer relationship (Osterwalder and Pigneur, 2002)	the encouragement of policy and announcement (Donker, 2009)	PSGI web services (Bouwman <i>et al.</i> , 2008; Donker, 2009; Osterwalder and Pigneur, 2002)
	commercially or non-commercially operation by the government, public and private organisations and society (Janssen <i>et al.</i> , 2016)		mainly from the land management and surveying sector (Janssen <i>et al.</i> , 2016)		CORS to service to the best practice (Janssen <i>et al.</i> , 2016)	the National Positioning Infrastructure (NPI) (Janssen <i>et al.</i> , 2016)
GNSS infrastructure in emerging		time and costs saving (Moegen <i>et al.</i> , 2018)	beneficial gain possibility (Moegen <i>et al.</i> , 2018)		traceability regulations adoption	viability of GNSS infrastructure in emerging countries

Technology & Infrastructure	Strategy	Financial resources	Benefits	Human relations	Policy, Legal, Standard	Business models
countries (Moegen <i>et al.</i> , 2018)					(Moegen <i>et al.</i> , 2018)	(Moegen <i>et al.</i> , 2018)
public infrastructure (Ojigi, 2015)	minimisation of cost and expense (Ojigi, 2015)	cost and expense in the possible applications and local businesses (Ojigi, 2015)	unnecessary to concentrate on the financial return only, less expense is the benefit (Ojigi, 2015)			Network RTK Service Model in Nigeria (Ojigi, 2015) was developed based on the Client-Server approach (Rizos and Cranenbroeck, 2006)
• CORS infrastructure model for infrastructure and service generation • Client-Server approach for reducing the burden on users' device (Rizos and Cranenbroeck, 2006)	CORS infrastructure model: • <i>Govt network adequate model</i> - licensed data to multiple companies (GSI's GEONET - Japan's network) • <i>VAR augments network model</i> - companies improve service capability (OS - Britain's organisation) • <i>100% private sector</i> - activate further VA services		commercialisation • charges on CORS service • may not be commercialised by the government (Rizos and Cranenbroeck, 2006)	Relevant persons: • users • operators • middleman (Rizos and Cranenbroeck, 2006)		GNSS-RTK business models (Rizos and Cranenbroeck, 2006)

Technology & Infrastructure	Strategy	Financial resources	Benefits	Human relations	Policy, Legal, Standard	Business models
	and/or business models Customer charges models: • <i>Starbucks model</i> – invest in the infrastructure and provide free service to sell the instrument • <i>Mobile Telephony model</i> – provide free instruments to get service subscription GNSS-RTK value-added model: • <i>Client-Server approach</i> – reduce the burden on users' device GNSS broker model: • Data/Service Broker – a middleman who operates the					

Technology & Infrastructure	Strategy	Financial resources	Benefits	Human relations	Policy, Legal, Standard	Business models
	services and facilitates the users (Rizos and Cranenbroeck, 2006)					
• public infrastructure viewpoint • web-based services technology (Rizos, 2013)	• potential users and service fees evaluation • CORS network as a public infrastructure concept • preventable costs model (Rizos, 2013)		consider: • RTK services payment • ROI • preventable costs (Rizos, 2013)	the service providers and users mainly focus on technology rather than commercial (Rizos, 2013)		Client-Server based model (Rizos, 2013)
• multi-tier CORS stations (Rizos, 2008a) • precision agriculture technology (Roberts, 2009)	Precision farming: • Controlled Traffic Farming • Inter-row sowing (Roberts, 2009)	• Australian CORS investments by the Federal government and the State governments, and private-owned CORS • how to reduce costs and unfavourable conditions (Roberts, 2009)	increase productivity and profits (Roberts, 2009)	get more users other than the surveying and machine guidance sector (Roberts, 2009)		GNSS CORS for agriculture businesses (Roberts, 2009)
• system of systems concept (Rizos, 2007)	• system of systems concept (Rizos, 2007)	duplication of CORS investment	commercialisation model (Rizos, 2007;	CORS infrastructure owner (Rizos and Satirapod, 2011)	Plan for inter-organisational collaboration on	Thailand's CORS collaboration model

Technology & Infrastructure	Strategy	Financial resources	Benefits	Human relations	Policy, Legal, Standard	Business models
- multi-tier CORS stations concept (Rizos, 2008a) - CORS network development in Thailand (Rizos and Satirapod, 2011)	- multi-tier CORS stations concept (Rizos, 2008a) - collaboration on CORS network sharing (Rizos and Satirapod, 2011)	challenge (Rizos and Satirapod, 2011)	Rizos and Satirapod, 2011)		CORS (Rizos and Satirapod, 2011)	(Rizos and Satirapod, 2011)
various types of GNSS service (Tsuji <i>et al.</i> 2017)	- GEONET provides a variety of service types - private companies sell value-added solutions (Tsuji <i>et al.</i> 2017)		generate high revenue from the public surveying market (Tsuji <i>et al.</i> 2017)	user group: surveying, innovative construction, farm mechanism, and others (Tsuji <i>et al.</i> 2017)		GSI's GEONET model (Tsuji <i>et al.</i> 2017)

TABLE A - 7 The links between the innovation ecosystem and the CORS system (Source: Author's own research)

CORS System Component	CORS System Structure	CORS System Process	CORS System Requirement	CORS System Evaluation	CORS System Development
Innovation that is GNSS CORS technology (Jackson, 2011; Strange and Weston, 1995; Supinajaroen and Van Loenen, 2019) Innovation process including upstream components and	Innovation networks , including technology and infrastructure (Carayannis and Campbell, 2009; Jackson, 2011) CORS station (Strange and Weston, 1995; Supinajaroen and Van Loenen, 2019)	Flows of inputs and outputs, straightforward innovation process and logistics (Adner, 2006; Adner and Kapoor, 2010; Smith, 2006) data flow (Strange and Weston, 1995;	Business model and policies and other institutional frameworks supporting CORS activities, including CORS infrastructure and professionals (Abidin <i>et al.</i>, 2010; Adner, 2006;	Business areas are in the positioning field, including surveying, construction, farming and other areas (Abidin <i>et al.</i>, 2010; Adner, 2006; Adner and Kapoor, 2010; Strange and Weston, 1995; Supinajaroen	Ecological succession (Odum, 1969) - CORS network forming process (Abidin <i>et al.</i>, 2010; Strange and Weston, 1995; Supinajaroen and Van Loenen, 2019) - change of the CORS environment,

CORS System Component	CORS System Structure	CORS System Process	CORS System Requirement	CORS System Evaluation	CORS System Development
downstream complements for GNSS data chain (Adner and Kapoor, 2010; Smith, 2006; Strange and Weston, 1995; Supinajaroen and Van Loenen, 2019) • Organisation and invigorated organisational culture supporting CORS network management (Abidin <i>et al.</i>, 2010; Adner and Kapoor, 2010; Smith, 2006; Supinajaroen and Van Loenen, 2019) • Actors including representatives, experts, competent human resources, and general staff for CORS network operation and data communication (Abidin <i>et al.</i>, 2010; Adner and Kapoor,	• material resources (Abidin <i>et al.</i>, 2010) • communication links (Abidin <i>et al.</i>, 2010) Knowledge clusters, including knowledge stocks and knowledge flows (Carayannis and Campbell, 2009) • professionals in CORS technology supported by the government (Abidin <i>et al.</i>, 2010; Supinajaroen and Van Loenen, 2019) • knowledge transfer through a training programme (Abidin <i>et al.</i>, 2010; Supinajaroen and Van Loenen, 2019)	Supinajaroen and Van Loenen, 2019) • service diffusion (Strange and Weston, 1995; Supinajaroen and Van Loenen, 2019)	Supinajaroen and Van Loenen, 2019) • Financial management, including CORS network funding and revenue generation from CORS (Abidin <i>et al.</i>, 2010; Adner, 2006; Carayannis and Campbell, 2009; Supinajaroen and Van Loenen, 2019) • Innovation and knowledge management, including CORS infrastructure and CORS society (Abidin <i>et al.</i>, 2010; Carayannis and Campbell, 2009; Jackson, 2011) • Resources management, including materials, instruments, communication links and relevant	and Van Loenen, 2019) • Risk assessment including initiative risks, interdependence risks, and integration risks in establishing and operating the CORS network (Adner, 2006; Adner and Kapoor, 2010) • Position of CORS owner (Abidin <i>et al.</i>, 2010; Adner and Kapoor, 2010; Supinajaroen and Van Loenen, 2019) • The bottleneck of establishing, linking and benefiting the CORS network due to the lack of resources, business model, policies and essential framework (Abidin <i>et al.</i>, 2010; Adner and Kapoor, 2010;	including addition and disruption of the CORS network (Abidin <i>et al.</i>, 2010; Strange and Weston, 1995; Supinajaroen and Van Loenen, 2019) • ecosystem equilibrium to sustain the CORS network system require support and endorsement in terms of resources, business plan and policies from the government (Abidin <i>et al.</i>, 2010; Supinajaroen and Van Loenen, 2019)

CORS System Component	CORS System Structure	CORS System Process	CORS System Requirement	CORS System Evaluation	CORS System Development
2010; Jackson, 2011; Smith, 2006; Supinajaroen and Van Loenen, 2019)			resources needed for the CORS network (Abidin <i>et al.</i>, 2010; Adner, 2006; Carayannis and Campbell, 2009; Strange and Weston, 1995; Supinajaroen and Van Loenen, 2019) • Human resources management, including actors, experts, and human capital (Abidin <i>et al.</i>, 2010; Carayannis and Campbell, 2009; Jackson, 2011; Supinajaroen and Van Loenen, 2019) • Logistics management, including GNSS data flow and data diffusion (Adner, 2006; Strange and Weston, 1995; Supinajaroen and Van Loenen, 2019)	Supinajaroen and Van Loenen, 2019) • Role of personnel in the CORS network management (Abidin <i>et al.</i>, 2010; Adner and Kapoor, 2010; Jones <i>et al.</i>, 1994; Supinajaroen and Van Loenen, 2019)	

TABLE A - 8 The links between the innovation ecosystem, CORS system and CORS business model (Source: Author's own research)

CORS System Component	CORS System Structure	CORS System Process	CORS System Requirement	CORS System Evaluation	CORS System Development
• Innovation in the GNSS CORS technology and relevant technical design (Bakici <i>et al.</i>, 2017; Bouwman <i>et al.</i>, 2008; Donker, 2009; Jackson, 2011; Moegen <i>et al.</i>, 2018; Ojigi, 2015; Rizos, 2007; 2008a; 2013; Rizos and Cranenbroeck, 2006; Rizos and Satirapod, 2011; Roberts, 2009; Strange and Weston, 1995; Supinajaroen and Van Loenen, 2019; Tsuji <i>et al.</i> 2017) • Innovation process of upstream and downstream GNSS CORS development and data chain (Adner and Kapoor, 2010; Bakici <i>et al.</i>, 2017; Bouwman <i>et al.</i>, 2008; Donker, 2009; Rizos, 2013; Rizos and Cranenbroeck, 2006; Roberts, 2009; Smith, 2006; Strange and Weston, 1995; Supinajaroen and Van Loenen, 2019; Tsuji <i>et al.</i> 2017)	Innovation networks, including technology and infrastructure (Carayannis and Campbell, 2009; Jackson, 2011) • CORS station, including power supply and other subsystems (Bakici <i>et al.</i>, 2017; Bouwman <i>et al.</i>, 2008; Donker, 2009; Moegen <i>et al.</i>, 2018; Ojigi, 2015; Rizos and Cranenbroeck, 2006; Rizos, 2007; 2008a; 2013; Rizos and Satirapod, 2011; Roberts, 2009; Strange and Weston, 1995; Supinajaroen and Van Loenen, 2019; Tsuji <i>et al.</i> 2017) • material resources (Abidin <i>et al.</i>, 2010; Bakici <i>et al.</i>, 2017; Bouwman <i>et al.</i>, 2008) • communication links (Abidin <i>et al.</i>, 2010; Bakici <i>et al.</i>, 2017; Bouwman <i>et al.</i>, 2008; Rizos, 2013) Knowledge clusters, including knowledge stocks and knowledge	Flows of inputs and outputs, straightforward innovation process and logistics (Adner, 2006; Adner and Kapoor, 2010; Smith, 2006) • data flow (Bakici <i>et al.</i>, 2017; Bouwman <i>et al.</i>, 2008; Rizos, 2013; Rizos and Cranenbroeck, 2006; Strange and Weston, 1995; Supinajaroen and Van Loenen, 2019) • service diffusion (Bakici <i>et al.</i>, 2017; Bouwman <i>et al.</i>, 2008; Rizos, 2013; Rizos and Cranenbroeck, 2006; Roberts, 2009; Strange and Weston, 1995; Supinajaroen and Van Loenen, 2019; Tsuji <i>et al.</i> 2017)	• Business model and policies and other institutional frameworks supporting CORS activities, including CORS infrastructure and professionals (Abidin <i>et al.</i>, 2010; Adner, 2006; Bakici <i>et al.</i>, 2017; Bouwman <i>et al.</i>, 2008; Donker, 2009; Janssen <i>et al.</i>, 2016; Moegen <i>et al.</i>, 2018; Ojigi, 2015; Osterwalder and Pigneur, 2002; Rizos, 2013; Rizos and Cranenbroeck, 2006; Rizos and Satirapod, 2011; Roberts, 2009; Supinajaroen and Van Loenen, 2019; Tsuji <i>et al.</i> 2017) • Financial management, including CORS network funding and revenue generation from CORS (Abidin <i>et al.</i>, 2010; Adner, 2006; Bakici <i>et al.</i>, 2017; Bouwman <i>et al.</i>, 2008; Carayannis and Campbell, 2009; Donker, 2009;	• Business areas are in the positioning field, including surveying, construction, farming and other areas (Abidin <i>et al.</i>, 2010; Adner, 2006; Adner and Kapoor, 2010; Donker, 2009; (Rizos, 2013; Rizos and Cranenbroeck, 2006; Roberts, 2009; Strange and Weston, 1995; Supinajaroen and Van Loenen, 2019; Tsuji <i>et al.</i> 2017) • Risk assessment including initiative risks, interdependence risks, and integration risks in establishing and operating the CORS network (Adner, 2006; Adner and Kapoor, 2010; Donker, 2009; Moegen <i>et al.</i>, 2018; Ojigi, 2015; Rizos, 2013; Rizos and Cranenbroeck, 2006; Roberts, 2009) • Position of CORS owner in the	Ecological succession (Odum, 1969) • CORS network forming process (Abidin <i>et al.</i>, 2010; Bakici <i>et al.</i>, 2017; Bouwman <i>et al.</i>, 2008; Donker, 2009; Moegen <i>et al.</i>, 2018; Ojigi, 2015; Rizos, 2007; 2008a; 2013; Rizos and Cranenbroeck, 2006; Rizos and Satirapod, 2011; Roberts, 2009; Strange and Weston, 1995; Supinajaroen and Van Loenen, 2019; Tsuji <i>et al.</i> 2017) • change of the CORS environment, including addition and disruption of the CORS network (Abidin <i>et al.</i>, 2010; Bakici <i>et al.</i>, 2017; Rizos, 2007; Strange and Weston, 1995; Supinajaroen and Van Loenen, 2019) • ecosystem equilibrium to sustain the CORS network system require support and endorsement in

CORS System Component	CORS System Structure	CORS System Process	CORS System Requirement	CORS System Evaluation	CORS System Development
• Organisations associated with GNSS CORS network management and incentivised organisational culture building (Abidin <i>et al.</i>, 2010; Adner and Kapoor, 2010; Bouwman <i>et al.</i>, 2008; Smith, 2006; Supinajaroen and Van Loenen, 2019) • Actors within CORS network operation, data communication and customer relations, including representatives, experts, competent human resources, and general staff (Abidin <i>et al.</i>, 2010; Adner and Kapoor, 2010; Bakici <i>et al.</i>, 2017; Bouwman <i>et al.</i>, 2008; Jackson, 2011; Osterwalder and Pigneur, 2002; Rizos, 2013; Rizos and Cranenbroeck, 2006; Smith, 2006; Supinajaroen and Van Loenen, 2019; Tsuji <i>et al.</i> 2017)	flows (Carayannis and Campbell, 2009) • professionals in CORS technology and CORS application businesses may need support from the government (Abidin <i>et al.</i>, 2010; Bouwman <i>et al.</i>, 2008; Rizos and Satirapod, 2011; Supinajaroen and Van Loenen, 2019; Tsuji <i>et al.</i> 2017) • knowledge transfer through a training programme (Abidin <i>et al.</i>, 2010; Supinajaroen and Van Loenen, 2019)		Janssen <i>et al.</i>, 2016; Moegen <i>et al.</i>, 2018; Ojigi, 2015; Osterwalder and Pigneur, 2002; Rizos, 2007; Rizos, 2013; Rizos and Cranenbroeck, 2006; Rizos and Satirapod, 2011; Roberts, 2009; Supinajaroen and Van Loenen, 2019; Tsuji <i>et al.</i> 2017) • Innovation and knowledge management, including CORS infrastructure and CORS society (Abidin <i>et al.</i>, 2010; Bakici <i>et al.</i>, 2017; Bouwman <i>et al.</i>, 2008; Carayannis and Campbell, 2009; Donker, 2009; Jackson, 2011; Moegen <i>et al.</i>, 2018; Ojigi, 2015; Osterwalder and Pigneur, 2002; Rizos, 2008a; Rizos, 2013; Rizos and Cranenbroeck, 2006; Rizos and Satirapod, 2011; Roberts, 2009; Tsuji <i>et al.</i> 2017) • Resources management, including materials, instruments,	collaboration, position of the authorised organisation in the business model (Abidin <i>et al.</i>, 2010; Adner and Kapoor, 2010; Rizos, 2013; Rizos and Cranenbroeck, 2006; Rizos and Satirapod, 2011; Supinajaroen and Van Loenen, 2019) • The bottleneck of establishing, linking and benefiting the CORS network is due to the lack of resources, business model, policies and essential framework and the limitation on gaining the broader markets due to business strategy and policy framework challenge (Abidin <i>et al.</i>, 2010; Adner and Kapoor, 2010; Bakici <i>et al.</i>, 2017; Donker, 2009; Janssen <i>et al.</i>, 2016; Rizos, 2013; Rizos and Cranenbroeck, 2006; Rizos and Satirapod, 2011; Supinajaroen and Van Loenen, 2019)	terms of resources, business plan and policies from the government (Abidin <i>et al.</i>, 2010; Bakici <i>et al.</i>, 2017; Rizos, 2007; 2008a; 2013; Rizos and Cranenbroeck, 2006; Rizos and Satirapod, 2011; Supinajaroen and Van Loenen, 2019; Tsuji <i>et al.</i> 2017)

CORS System Component	CORS System Structure	CORS System Process	CORS System Requirement	CORS System Evaluation	CORS System Development
			communication links and relevant resources needed for the CORS network (Abidin <i>et al.</i>, 2010; Adner, 2006; Bakici <i>et al.</i>, 2017; Bouwman <i>et al.</i>, 2008; Carayannis and Campbell, 2009; Donker, 2009; Rizos, 2007; 2008a; 2013; Rizos and Cranenbroeck, 2006; Rizos and Satirapod, 2011; Roberts, 2009; Strange and Weston, 1995; Supinajaroen and Van Loenen, 2019) • Human resources management, including actors, experts, human capital (Abidin <i>et al.</i>, 2010; Bouwman <i>et al.</i>, 2008; Carayannis and Campbell, 2009; Jackson, 2011; Osterwalder and Pigneur, 2002; Rizos and Cranenbroeck, 2006; Rizos and Satirapod, 2011; Roberts, 2009; Supinajaroen and Van Loenen, 2019; Tsuji <i>et al.</i> 2017) • Logistics management,	• Role of personnel in the CORS network management (Abidin <i>et al.</i>, 2010; Adner and Kapoor, 2010; Bakici <i>et al.</i>, 2017; Bouwman <i>et al.</i>, 2008; Donker, 2009; Janssen <i>et al.</i>, 2016; Jones <i>et al.</i>, 1994; Rizos and Cranenbroeck, 2006; Rizos and Satirapod, 2011; Supinajaroen and Van Loenen, 2019)	

CORS System Component	CORS System Structure	CORS System Process	CORS System Requirement	CORS System Evaluation	CORS System Development
			including GNSS data flow and data diffusion (Adner, 2006; Bakici <i>et al.</i> , 2017; Bouwman <i>et al.</i> , 2008; Rizos, 2013; Rizos and Cranenbroeck, 2006; Strange and Weston, 1995; Supinajaroen and Van Loenen, 2019)		

C. CASE STUDIES

Each of the cases has represented the evidence that supported its circumstance towards the conceptual ideas. These arrangements can be inferred that Australia and Thailand both have particular characteristics in the context of CORS management. The ensuing section will be an investigation of the Australia and Thailand cases and the interrelations between these two cases.

C.1 Australia

Technology

Equipment and technical issues on this account have been taken into consideration to handle the technology component by many vital drivers (Feng *et al.*, 2007; Rizos, 2010). During the growth of CORS networks, a number of papers and discussions on CORS techniques advancement have been raised to engage the attention of the users in the survey and construction group, boost agriculture, and stimulate industries (Feng and Rizos, 2005; Hausler and Collier, 2013b; Higgins, 2007; Rizos, 2007a; Rizos and Han, 2003; Rizos *et al.*, 2000; Rizos *et al.*, 2005; Wanninger, 2004).

Lim and Rizos (2008b) elucidated that the "generation 1" CORS networks could not receive new satellite signals and produce up-to-date products, so they needed to upgrade the receivers, algorithms, and IT components. As per the shortage of "thick infrastructure" – the eminent communication networks including mobile and internet – due to the denseness of metropolitan in Australia, particularly south-east Queensland, Feng *et al.* (2007) urged the Three Carrier Ambiguity Resolution (TCAR) method to lighten a load on the user's instrument. TCAR approach has been proffered in varied alternatives to suit best the receiver types and other conditions (Feng, 2007; 2008; Feng and Rizos, 2005; Feng and Rizos, 2009). Meanwhile, Lim and Rizos (2007; 2008a; 2008b) submitted a new framework, a server-based and thin-client platform, to improve service solutions and reduce the arduous task of users. They claimed that their proposed "out-of-the-box" services, compared with conventional criteria, would benefit the GNSS end-users more in terms of competence and productiveness. With such a concept, they conveyed the idea of forming manifold Virtual Reference Station (VRS) clusters, which could work comparably to the Flächen Korrektur Parameter (FKP) technique. Besides, Heo *et al.* (2009) drew a significant feature of SNAPper – a software invented regarding the notion elaborated by Lim and Rizos – that it is versatile, extendable, suitable for complicated correction generators without adverse effects, and nearly as accurate as other Network-RTK (NRTK) approaches. Later, Feng *et al.* (2013) concluded with a recommendation that the reference station-based processing model they gave could outstrip the traditional computation of the CORS networks. It increases the performance of the unified services, but it also imparts a flexible, ease-of-use processing system that could save costs. After a fashion in Australia, the techniques and models above kept coming to prevail over the CORS

operative functions. The varieties of CORS networks became a tough assignment to NPI in manoeuvring the separate signals into an identical service (Rizos, 2010).

In connection with data and service dealing, numerous ideas had been put out, principally the web tool. According to Rizos *et al.* (2003), web-based service has been used for CORS support in Australia for many years, such as AUSPOS, which allows users to upload and download some kinds of positioning services. The 'second generation' CORS network infrastructure that they expressed then came with the idea of 'active control stations'. Lim and Rizos (2007) subscribed to the employment of web servers and web map servers as the portal for clients to request data and for the CORS administrator to observe the networks. With this proposal, they unveiled the web-based data quality monitoring system, which can simultaneously serve diverse types of services and render real-time statistics for the observers. More details about web and database components and architecture are illustrated in FIGURE A – 1 below (Lim *et al.*, 2008).

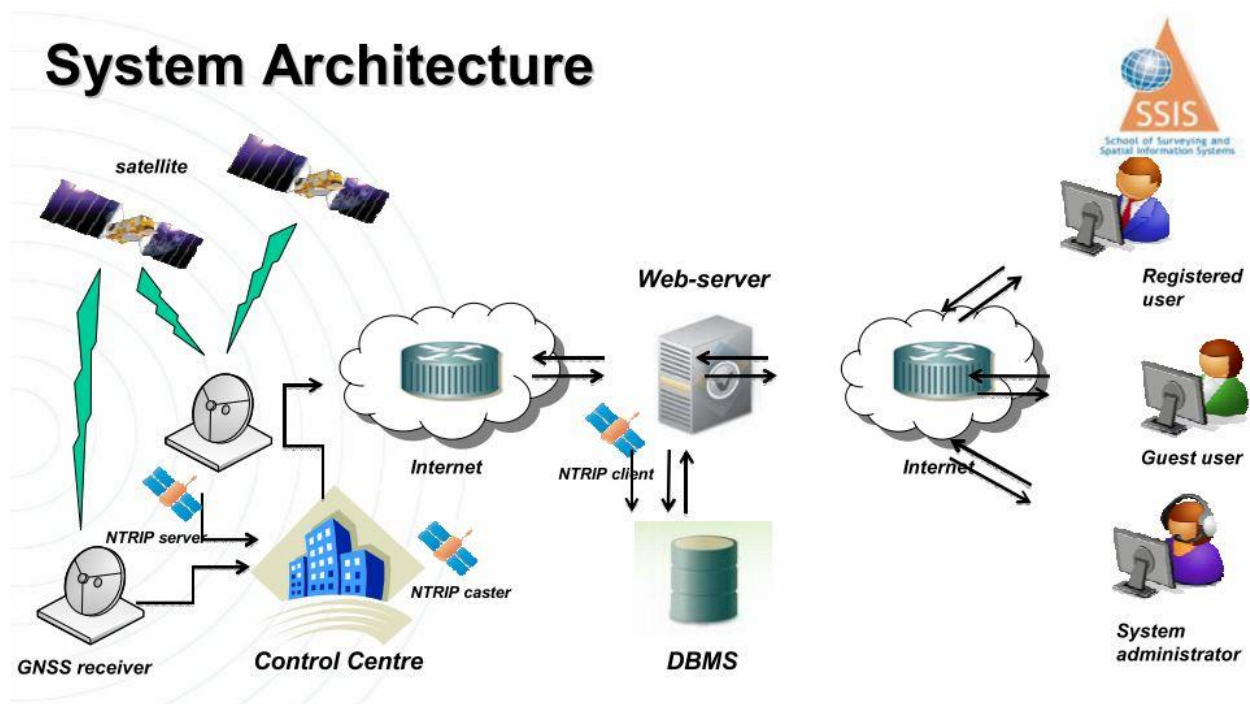


FIGURE A - 1 Web-based GNSS data monitoring system by Lim *et al.* (2008)

In light of the web-based service matters, the National Geospatial Reference System (NGRS) was created as a centre of geospatial learning, data, infrastructure, and software (Johnston and Morgan, 2010). Despite the stations and databases being operated and sustained by multiple authorities, this portal is governed by the Intergovernmental Committee on Surveying and Mappings' Permanent Committee on Geodesy. In response to the Standard for the Australian Survey Control Network Special Publication 1 (SP1), the NGRS is a web map service encompassing all sectors of geospatial data composed of data, infrastructure, models, and standards. Australia's authoritative referencing system is made up of two primary databases: the National Geodetic Data Base (NGDB) and the GNSS database. The NGDB collects data from

roughly 27,000 geodetic stations located in Australia, covering offshore jurisdictions and Antarctica. Likewise, the GNSS database contains metadata of the CORS sites across Australian jurisdictions and the South Pacific and their data quality statistics to assist the geodetic framework in Australia and earth observation processability. Though such a database combines the databases maintained by the State and Territories, which some information may not be included in the National Geodetic Control Point (NCGP) database, all the reference stations are under Geoscience Australia organising. Moreover, there are a lot of tools and models developed by Geoscience Australia to facilitate utilisation of the NGRS, for instance, datum transformation, geoid conversion, vertical conversion, projection conversion, coordinate system conversion, plate motion model, geoid model, gravity model (ANZLIC, 2010; Geoscience Australia, 2020c; 2020b; ICSM, 2014). Aside from that, Australia's NGRS was raised to collaborate with New Zealand and the Asia Pacific countries associated with the APREF regional reference frame project by Johnston and Morgan (2010) for dynamic datum generation.

The Asia-Pacific Reference Frame (APREF) project was initiated for the perpetual regional monitoring of the Australian CORS site's motion (ICSM, 2014). This project has a concentrated interest in establishing and retaining a reliable geodetic framework for distinctive variations of the location-based application revolution in the Asia-Pacific zone (Geoscience Australia, 2020a). Notwithstanding, there were some complications relating to a homogenisation of multi-owner GNSS reference stations that had been addressed: network density, accuracy and accessibility issues, network connection issues, and data sharing and analysis issues. Consequently, in 2015, a rigorous set of rules gave rise to guide the CORS operators in devising their systems corresponding to the Asia-Pacific Reference Frame (APREF) GNSS network (Geoscience Australia, 2015c; Johnston and Morgan, 2010). Concerning the interrelation centre, the Central Bureau – an authority within Geoscience Australia, acts as a 'day-to-day' APREF coordinator. But even so, this ongoing project has another three Local Analysis Centres (LACs), namely Geoscience Australia, Office of Surveyor-General Victoria, Australia, and the Institute of Geodesy and Geophysics, Chinese Academy of Sciences. APREF data products, both horizontal and vertical, can be retrieved via the internet under an open access data policy from either CORS operators FTP or web server (Blick and Sarib, 2010). Nonetheless, Hausler and Collier (2013b) premised that APREF data could be presented, discovered, and interfaced through the NGCI web map.

As concluded by Hausler and Collier (2013b) and Hausler (2014), each of the CORS operators evolved their service portals peculiarly to their uses, the lack of a centralised source to visualise Australian CORS data (AuScope Geospatial Team, 2008) has led to the duplication of the network details. Hence, the National GNSS CORS Infrastructure (NGCI) web map, an interactive tool to represent the whole picture of CORS locations and their metadata and the service custodian classification, has been created on an online basis to resolve this problem. This tool primarily targeted aggregating the CORS site location and information in Australia entirely. All of the relevant content of the government-owned and individual CORS will be available in one place. Plus, this

website will also be capable of total SPs records querying and reviewing. Both government and commercial SPs will be counselled for site investment, either the new installation or upgrade, while the clients will be informed about service suppliers in a given area. The web map was predominantly instigated in regard to the ANZLIC's NPI Policy (2010) and positioned to foster the ASC's Strategic Plan for GNSS (2012), which is markedly concerned about the national economy and the positioning infrastructure plan. It named a dynamic database to be a requisite for the real-time tendency support of the CORS administration. The National GNSS CORS Infrastructure (NGCI) database has thus concomitantly been set up as the CORS site update and management source. As a public resource, the database can diagnose each node in the third-party SPs, which are licensed by the CORS operators, and get involved by compiling the metadata for the custodian and client inputs. Such a communication tool gives authorisation to the exchanging of information by the public to rectify duplication. This feedback will be of assistance to the government and industry SPs in terms of public and commercial demand confirmation by zone. The NGCI web map and NGCI database are influenceable systems to ascertain demand and standardise the deployment of prospective CORS. The overlapping areas and low accuracy regions needing handleability, such as more site insertion, are the keys for quality control and economic planning in investing and licensing. These kits have been advanced by a partner of the CRCSI, a private company known as ThinkSpatial Pty Ltd. The company also hosts the NGCI web service and provides access.

The Foundation Spatial Data Framework (FSDF) is the scheme introduced by ANZLIC to control and make uniform spatial data quality in Australia and New Zealand. It has commenced delivering up-to-date and most fitting authentic countrywide coverage datasets to support the evolution of information models and the National Spatial Data Infrastructure (SDI) (Box *et al.*, 2015). The FSDF was implemented respecting the ANZLIC Strategic Plan, which highlighted the issues of supply chain enhancement, competence realisation, and duplicate endeavours of the Australian jurisdiction's reduction (ANZLIC, 2014a; 2014b). Additionally, the FSDF theme was set to serve the full, most recent, continual NGRS coverage with prompt, trustworthy, applicable positioning and time services for the whole of Australia (ANZLIC, 2018). Despite the spread of data, existing software and platforms have generally been exercised by the spatial society; FSDF had devised paradigms for data distribution over multiform online platforms to accelerate data usage. This conception had been engineered to suit user needs in accessing, querying, and understanding the datasets from different sources assembled. At last, the spatial data from multiple domains, which were presumed to be concatenated together under standard data format, will be enabled access in the semantic Web formats in practice. The models formed to generate an application schema for FSDF products are shown in FIGURE A – 2.

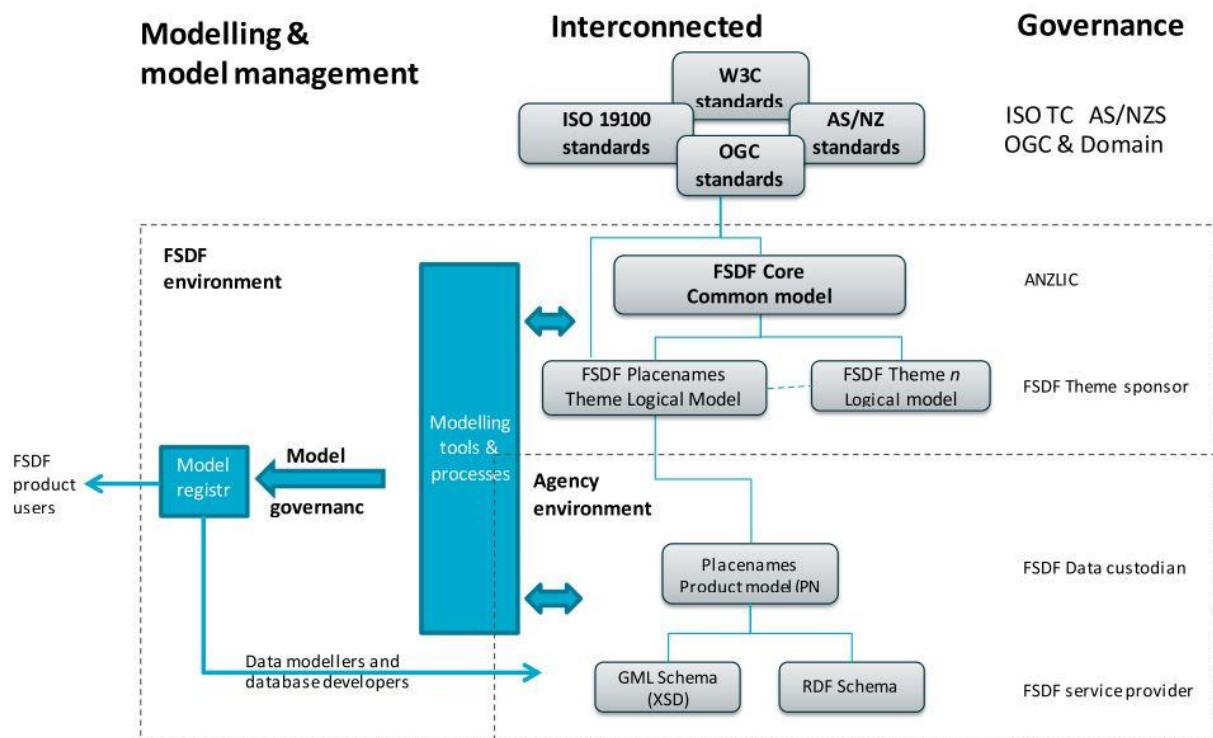


FIGURE A - 2 Overview of the FSDf model framework by Box *et al.* (2015)

In the transition to the Spatial Knowledge Infrastructure (SKI), the focal point of the spatial domain had been shifted from "data" to "knowledge". Therefore, four prime knowledge-creation processes – sharing, versatility, process, and usability – were employed to maximise the SDI value (Duckham *et al.*, 2017). In spite of the technical processes, the parallel procedures that had been spotlighted were national and international policy and research revision, as well as road maps for a 'cross-cutting theme' generation. These can be seen in the FSDf development plan progress, in view of the Summary Program Status Report by Tranche that had manifested multifaceted FSDf tasks. The events' status was indicated green in most cases in May 2016; they had wholly attained these objectives in October 2016 and persisted in action for years (ANZLIC, 2016).

Further to the aforementioned tools, there was an interesting implement that had been brought into being, the LBS. The Location-Based Services (LBS) technology, especially a mobile guide that uses the benefit of portable devices, positioning data, and relative location information to give users hints on the surrounding area, can exploit the client-server approach (Raper *et al.*, 2007b). It has been shown in the study that the utilisation of the client-server environment on mobile spatial data organisation is suitable for web-based LBS as it is flexible, scalable, and able to minimise the network unavailability problem (Raper *et al.*, 2007a). In Australia, the LBS Positioning System project was taken to perform a network of an Internet-based system all through Victoria in 2004 (Roberts *et al.*, 2004). Moreover, the Australian Strategic Plan for GNSS had privileged a spawn of the LBS industry coupled with high-

accuracy products and services as they could gain additional gross benefit from CORS up to AUD\$58 Billion (ASC, 2012). It was noticeable that the modern positioning service demand had grown in LBS technology in company with other industries in Australia and worldwide; as a consequence, Hausler (2014) and Hausler and Collier (2013a) commended that the NPI should satisfy the GNSS market with optimum CORS data performance.

Collaboration

The applications of positioning data continued to flourish in Australia and the Commonwealth; they had been used in counter-terrorism activities in the Melbourne 2006 Commonwealth Games. In consequence, the management of the Australian State and Territory Government CORS networks ensued afterwards (Hale *et al.*, 2006). Together with state and territory jurisdictions, the Australian Federal Government funded additional CORS in the AuScope project under the National Collaborative Research Infrastructure Strategy (NCRIS) to seamlessly provide countrywide service (Hausler and Collier, 2013b; Hale, 2007). The formation of these extra GNSS reference stations had been underway, paralleling the Very Long Baseline Interferometry (VLBI) and Satellite Laser Ranging (SLR) stations to strengthen the National Geospatial Reference Framework (NGRF) (Rizos, 2007b). This project has fostered joint working groups on CORS data sharing between the Australian Inter Governmental Committee on Surveying and Mapping (ICSM) members and enterprises (Johnston and Morgan, 2010). At the same time, the CRCSI project has also driven the collaboration on positioning services between the public sector and private sector (Higgins, 2008). Apart from the state and territory governments' partnership, Higgins advised on the unified CORS model that the third party should be endorsed to build subsidiary GNSS base stations within the confines of the National Measurement Act.

The Cooperative Research Centre for Spatial Information (CRCSI)

The Cooperative Research Centre for Spatial Information (CRCSI) progression has ascended over the decades. It had been subsidised by the Australian Government to discharge the duties of this user-led research program. The work has been phased on the subject of the period and cooperativeness.

CRCSI-1 got going in July 2003 as a solo effort. It was situated and had financial resources granted by the Cooperative Research Centres (CRC) Program – an Australian Government Initiative. This cross-holding entity had the ambition to elevate the creative greatness in research liaison between researchers and end-users, capitalising on the fundamental spatial technologies inclusive of GNSS. The successfulness of this operation opened CRCSI-2, which had an alliance with the principal collaborators. Either the governments, academies, above 50 companies in the SME consortium 43 Pty Ltd (43pl), or over 30 internal and international partners. The backbone of the confluence of Australian and New Zealand activities was academia which had been based in many cities. The research fellowship had been structured under a college pattern. The CRSCI colleges covered the Government College headed by ANZLIC, the

Research and Education College, and 43pl. The CRCSI-2 had stood with more than 110 partners from January 2010 to July 2018 (CRCSI, 2012; 2020).

The CRCSI later moved to another form of strategic partnership and operation. In July 2019, CRCSI became known as FrontierSI – a not-for-profit company with a distinctive operating model. Its mission is to harness its spatial expertise under the link-up across government, university and spatial and private industry boundaries to better societal and environmental welfare (FrontierSI, 2019; 2020). Consistently, ANZLIC and the associates had pinpointed business failures and viable options. FrontierSI, analogous to that of the CRCSI, gives the resources respectively, the research and local spatial industry community consecutively leverage them to embark on those matters from ANZLIC (ANZLIC, 2020b).

Significantly, as for Australian CORS stewardship, CRCSI had endowed with tremendous means to researchers for the contributions, which counting the SydNET CORS infrastructure management (Rizos *et al.*, 2003; 2004), a model for CORS network management (Hale *et al.*, 2006), standards and practices for GNSS CORS infrastructure (Burns and Sarib, 2010), NPI infrastructure management and operations (Geoscience Australia, 2015c), national geoid model (Geoscience Australia, 2017), and noticeably more.

Australia's Satellite Utilisation Policy

The Space Policy Unit (SPU) was assigned in 2010 by the Australian Government to be a subsidiary of the Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education (DIICCS RTE) (Space Policy Unit, 2012). A mandate to forge ahead with Australian space policy intervention had the upshot on the sequel to Australia's Satellite Utilisation Policy in 2013. The concentric stress of Principle one of the Policy unveiled the space technology weightiness in pushing forward the country. It subsumed the elaboration of the NPI Plan in a bid to ground infrastructure investment deliberation. DIICCS RTE was colluding with various opportunities, including the CRCSI project, and later renamed the Department of Industry (DoI) (Choy *et al.*, 2017; CRCSI, 2013; Hausler and Collier, 2013a; 2013b; Hausler, 2014).

ANZLIC – The Spatial Information Council (ANZLIC)

"ANZLIC, the Spatial Information Council, is the peak inter-governmental council responsible for the coordination of spatial information management in Australia and New Zealand" (ANZLIC, 2001). Initially, in 1986, ANZLIC originated as the Australian Land Information Council (ALIC) by agreeing on negotiations between the Australian Prime Minister and the governors of the State and Territory governments. It was intentionally brought into existence with relevance to correlate land-linked information gathering and transmitting between the governments and promulgate the serviceability of particulars. After a while, all Australian States, Territories, and New Zealand joined ALIC; for this reason, the Council re-entitled ANZLIC in 1991 with different intentions. The vision of ANZLIC is that "Spatially referenced information that

is current, complete, accurate, affordable and accessible is used to inform decision making for economic, social and environmental outcomes." (ANZLIC, 2018).

ANZLIC has catalysed the foundation of spatial data theming in Australia by launching a Foundation Spatial Data Framework (FSDF) to ratify the transmission of geographic information and the transfer of knowledge between organisations, sectors, and jurisdictions. ANZLIC, combined with other government and non-government sectors, ultimately revealed ten data themes in accord with each of the national foundation dataset communities. The themes are Geocoded Addressing; Administrative Boundaries; Positioning; Place Names; Land Parcel and Property; Imagery; Transport; Water; Elevation and Depth; Land Cover. The conceptual view of the FSDF can be seen in FIGURE A – 3 below. As announced by the Chair of ANZLIC, ANZLIC purported to bring national spatial data and services to commerce. FDSF, under the lead of ANZLIC and the sponsors of Australian states and territories, has been obligated to carry the national foundation dataset from diverse dataset custodians to the government, academia, research, industry and the generic public users, which are premier user groups. These users can be a member of a theme leadership group through application or invitation (ANZLIC, 2001; 2014a).

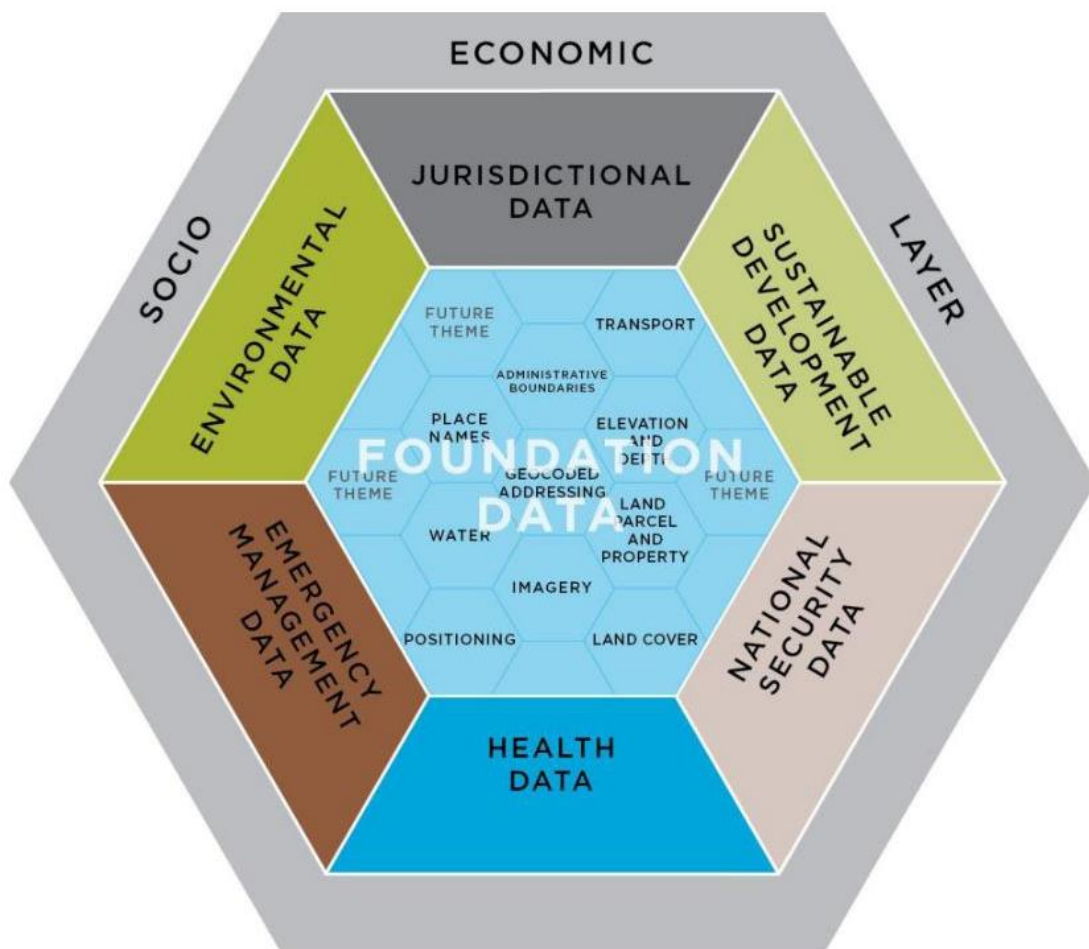


FIGURE A - 3 Conceptual view of the FSDF by ANZLIC (2014a)

Conjointly, ANZLIC had contemplated action for the national spatial policy effectuation by instating the Intergovernmental Committee on Survey and Mapping (ICSM) as a permanent committee of ANZLIC to tackle the national equipment puzzle by constructing the technical standards (ANZLIC, 2014a). As ANZLIC members, the jurisdictions can sit in ICSM permanent sub-committees and working groups. In respect of Higgins's (2008) explanation, the unified Australian GNSS network required an intermixture of actions via ICSM withal. The assumption embodied in the interaction between ICSM and FSDF is that the ICSM will arrange professionals, models, and standards for the FSDF, and the FSDF will go ahead with the retrieval of the ICSM working groups.

On top of that, ANZLIC has collaborated with sundry partners. Either a not-for-profit company named FrontierSI; an unlisted public company called PSMA Australia Limited (PSMA); the Spatial Industries Business Association (SIBA) and Geospatial Information & Technology Association ANZ (GITA), which consist of more than 500 private enterprises; the Surveying & Spatial Sciences Institute (SSSI) – a peak body in Australia and New Zealand. The Council also presents a membership of the Centre for Spatial Law and Policy (ANZLIC, 2020b).

Equivalently, ANZLIC, as the dominant Australian authority, has taken a cardinal role in starting up a national positioning infrastructure (NPI) (ANZLIC, 2010).

National Positioning Infrastructure (NPI)

Positioning infrastructure, in the sense of Australia, refers to the component of position-connective technologies. It is comprised of ground-based survey marks, GNSS space segment, GNSS ground control segment, Space Based Augmentation Systems (SBAS), Ground Based Augmentation Systems (GBAS), and Non-GNSS location devices (ANZLIC, 2010). Contradictorily, the lack of uniqueness of infrastructure control and management had magnified the barriers to economic, technical and administrative furtherance. Adversely, these barriers had been escalated by an absence of official infrastructure standards and a Service Level Management (SLM) traceability for fitting, enhancing, tracking, and notifying. Consequently, the Australian government, in association with industry and scholarly part, pioneered the National Positioning Infrastructure (NPI) for organising infrastructure in harvesting the fruitfulness of multi-GNSS. To be closely bound up with the manifold policy, production, and supply chain nationwide, the NPI would plant a coming positioning infrastructure conforming with the solid SLM standards. The contribution of NPI had manifested the governments, industry and research section associateship in the possible eventuality of GNSS infrastructure by addressing: CORS Infrastructure and Positioning Services in Australia; Commercial Business Models; Tiered Infrastructure – Standards and Best Practice Guidelines; ANZLIC NPI Policy; National GNSS CORS Infrastructure Web Map. By that token, some projects and activities had backed the instigation of NPI: ASIA-PACIFIC REFERENCE FRAME (APREF); Australian Spatial Consortium (ASC) – Australian Strategic Plan For GNSS; International GNSS Service (IGS); Australia's Satellite Utilisation Policy and the NPI Infrastructure Plan. With these, axiomatically, the ANZLIC, ICSM, ASC,

CRCSI, GA, and DIICCS RTE had conveyed the stipulations that make compliance mandatory for implementing NPI in the matter of technical, organisational, and economical (Hausler and Collier, 2013b). Details as TABLE A – 9 below.

TABLE A - 9 Technical, organisational, and economic considerations for NPI by Hausler and Collier, 2013b

Technical Considerations	Organisational Considerations	Economic Considerations
• Datum – Dynamic (4-dimensional) – Legally traceable • CORS – Multi-GNSS enabled receivers/antennas – High bandwidth/low latency communications (dual streaming via independent systems) – Mains power with backup (e.g. Uninterruptable Power Supply) – Site specifications (Tier) and site security – Co-located sensors (e.g. meteorological) • Network Architecture – Station density – Network redundancy – Data archives – Servers/firewalls – Data centres – Control centres – Analysis centres – Virtual Private Networks (VPNs) • Data Formats – Proprietary vs open source – RTCM 3.x – RINEX11 – HP-MSM • Processing Methodologies – Proprietary vs open source – VRS12/FKP13/MAC14/PPP • Non-GNSS Technology – Locata – Ultra-Wide Band – Signals-of-Opportunity – Wi-Fi and cell towers – Long Range Navigation (eLORAN) • Quality Control (QC)	• Governance – National steering committee(s) – National advisory committee(s) – Implementation teams – Technical working groups – Cross-sector information sharing and reporting mechanisms across all tiers of Government and industry through an appropriate Secretariat – National policy development – Single point of contact – International engagement and collaboration to secure access to positioning and communications systems (e.g. through SPU) • Infrastructure and Data Standards – Endorsement of technical standards and guidelines – Spatial integration across jurisdictions to adopt the national GRS – Alignment with international best practice standards (e.g. IGS) – Legal traceability and compliance • Data Access – Data access and pricing policies (competitive pricing guidelines) – Data custodianship arrangements – Data privacy – Revenue and royalty-sharing arrangements – Legal traceability and compliance – Wholesale and retail terms and conditions (VARs, DSPs, other vendors?)	• Fixed Costs – Capital expenditure – Hardware/equipment – Rent and property – Wages – Software and data licenses – Insurance – Utilities – Maintenance contracts – Data, Control and Analysis Centres • Variable Costs – Operational expenditure – Communications/power – Data usage – Disk (cloud) storage – Maintenance – Marketing • Pricing Strategies – Public goods (free) – Cost neutral (cost recovery) – Profit-making – Differentiation strategies (e.g. product versioning/bundling) • Productivity: – Economies of scale (production efficiencies) – Network effects (e.g. interoperable products and services) – Gross Domestic Product (GDP) – Gross State Product (GSP) – Supply and demand elasticity – Levels of competition – Industrial vs information goods • Costs/Benefit – External benefits – education, public safety, innovation – External costs – radio spectrum restrictions, aesthetic disturbances from CORS monument

Technical Considerations	Organisational Considerations	Economic Considerations
– ICSM/APREF/IGS/NPI infrastructure and SLM standards – Service Level Objectives and Operational Level Agreements that specify accuracy, availability and reliability criteria – Systems testing – Monitoring and alert systems – Proprietary and independent (e.g. RTQC15) QC programs – Disaster recovery procedures	• Service Level Agreements (SLAs) – Responsibilities, guarantees, compensation – Third-party SLAs – Locations and timelines – Warranties and emergency management procedures – User feedback and continuous system improvement – Staffing and training – Information privacy/security – Entitlements and liabilities – Intellectual property rights	– Internal and external transaction costs (i.e. 'the cost of participation') – Marginal costs and marginal utility (benefits) • Government Regulation and Taxes – Pricing, access and service standards

The NPI was considered a well-suited approach for infrastructure investment and functioning management by Hausler and Collier (2013b). In readiness, the Australian Government had been forging interconnections between responsibilities and procedures and a cross-party platform for NPI, as it turned out, the NPI Plan.

The evolution of the National Positioning Infrastructure (NPI) Plan began with a series of sequential steps. After the Australian Government mandate to commit the Space Policy Unit (SPU) to Australia's space policy in 2010, Australia's Satellite Utilisation Policy emerged in 2013 (Australian Government, 2013). This policy mentioned the need for an NPI Plan for assessing the worth of ground infrastructure investment and its dependable solution provision in Australia. The preceding occurrence in 2012, Hausler (2014) – a PhD candidate – in a cooperative relationship with Geoscience Australia had prepared a draft NPI Plan and given consultations for the governments, industry and academic sectors. His certified thesis, for that reason, was made public.

The idea to create the co-working environment was that the uncoordinated reference networks should be combined into a single authoritative dataset. The future installed base stations should be merged with the existence, and all should be available for access through the NPI. These would not only expand service coverage but also reaffirm the quality of services (Hausler, 2014). As a result, an NPI Plan was put in place in 2013 by Geoscience Australia – an Australian government organisation obligated to take action in national geology and geography (Geoscience Australia, 2018a). NPI Plan was designed to analyse inland investment in location-related infrastructure and provision authentic Positioning, Navigation & Timing (PNT) products Australia-wide (Hausler, 2014).

NPI has played a markedly vitalising role in the PNT matter in Australia. On account of this, Geoscience Australia commissioned the National Positioning Infrastructure Advisory Board (NPI-AB) in December 2014 (Geoscience Australia, 2018a). The Board, which has been consolidated from the assorted separate bodies in Australia and New Zealand, aspired to supervise NPI direction. As the Chair and Secretariat of NPI-AB, in

collaboration with ten fixed representatives from government, research and industry domains, Geoscience Australia has grown their attentiveness to the NPI governing and consequences. The reports generated by NPI-AB will be submitted to the NPI Project Executive (NPIPE), which is under Geoscience Australia. As the NPI-AB Chair, Geoscience Australia will ally with the Australian Government PNT Working Group (PNT-WG) on the NPI-AB work. Consonantly, the NPI planning will be examined by NPI-AB incorporated with the Technical Working Groups (TWG).

Policy and Business Model

Concurrently, the policies and frameworks of CORS have been taken into account in terms of service, infrastructure, and management (Lim and Rizos, 2007; Rizos, 2007a). Several models have been taken with deliberation at the national level; one of them is the "GNSS CORS Network Management Model" (FIGURE A – 4), which was put forward by Hale *et al.* (2006). The model focused on the unification of CORS networks in Australia to maintain the sustainability of CORS infrastructure and service of the state and territory. Its targets are the management frame of the CORS institution, network operation, marketing and legal, and the profit from the government investment. As a result, the data service providers (DSPs) were recommended to be licensed under a competitive pricing policy, and value-added resellers (VARs) were suggested to be supplementary.

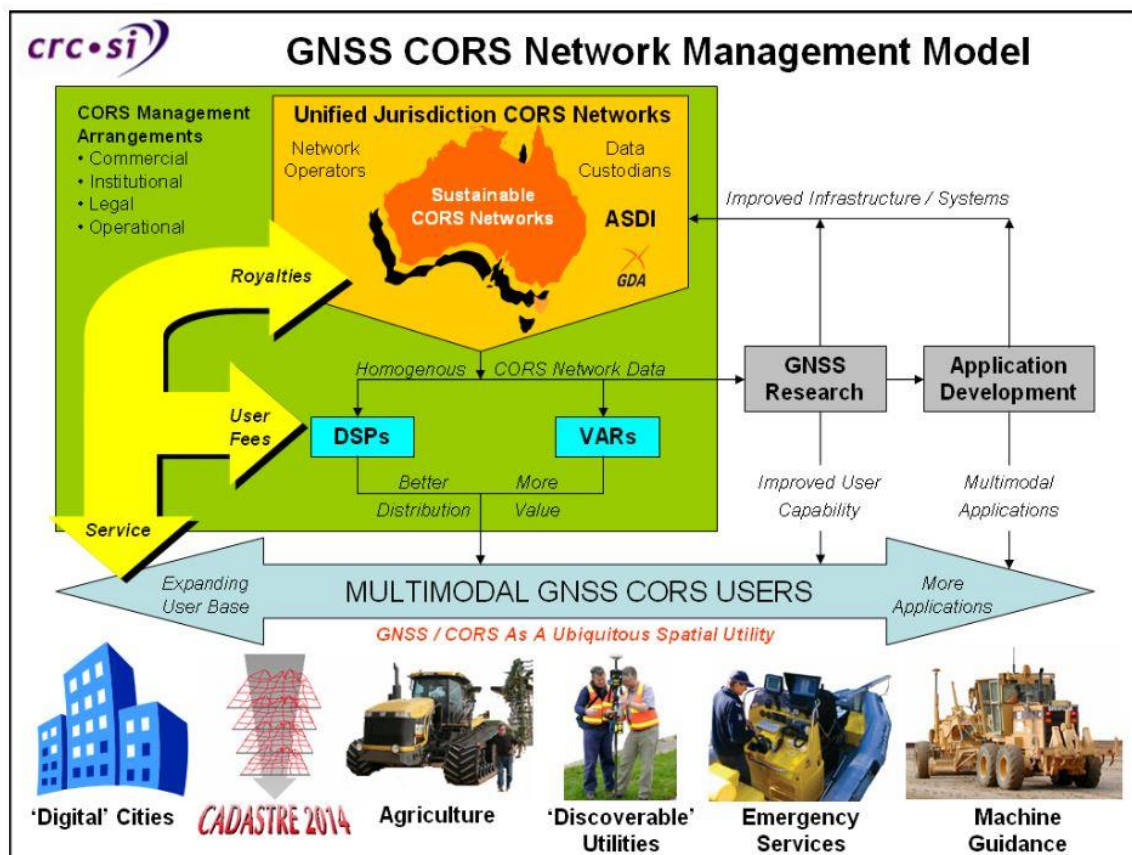


FIGURE A - 4 GNSS CORS Network Management Model by Hale *et al.* (2006)

Multi-Tier and technical models

Rizos and Cranenbroeck (2006) formulated some new business models to explore the possible ways to reap the advantages of CORS networks. They initiated the "client-server based model" to facilitate the users and service providers in delivering data and commercialising. This technique will allocate an onerous data processing burden on the control centre side, then send the final reliable solutions to users. It will result in the service payment calculation, and the service providers can control their product quality and product value-added. Also, they inaugurated business models for profit-oriented purposes based on mobile telephony and quality assurance notions. A service broker concept can validate these ideas that premise both standard RTK services and value-added products.

In 2007, a new Queensland Geospatial Reference Framework Policy was released by the Department of Natural Resources and Water (NRW), an authority whose role is under the Surveying and Mapping Infrastructure Act (QNRW, 2007 in Higgins, 2008). This movement showed the effort to define the functions ranging from "Specify System" to "Deliver Service" and the prominent role of the NRW. In addition, the AuScope (2007 in Higgins, 2008) project encouraged the model that the state and territory governments should generate revenue from their CORS solutions and provide free public services simultaneously to repair, renew, and expand their resources pauselessly. Although the service providers in Australia were both from the public and private sectors, the project presented that the combination of inter-operator for unifying the GNSS reference station network is worthwhile to move forward (Higgins, 2008).

Further, according to Lim and Rizos (2007), there was a discussion about a new framework of next-generation CORS infrastructure plan and management to overcome conventional limitations and enhance the productivity and capability of GNSS technology in Australia. Hence, the CORS structures and services implementation models were identified to categorise the CORS owner groups and service license types using a private service provider (SP) licensing strategy. The following models have been placed in the Rizos (2007a) framework:

"Model 1: Institutional CORS infrastructure, no commercial services

Model 2: Government CORS infrastructure, operates commercial services

Model 3: Government CORS infrastructure, licenses data to private sector

Model 4: Cooperative privately-owned CORS infrastructure, operating commercial services

Model 5: Privately-owned CORS infrastructure, operating commercial services"

Rizos described his "client-server" concept as that it would prevent undesirable things and contribute to the system's structural integrity. This "legal traceability" process and "total quality assured coordinate service" could attract "The GNSS service broker" just like it has been done in Japan. In his subsequent publication, he also laid the first stone of the Multi-Tier hierarchical system of the CORS networks (Rizos, 2007b). The

initiative was intended to rank the permanent base stations in order of their installation, precision, and exploitation. The payments for services will be calculated differently; however, some of the stations have to offer free service abiding by the Commonwealth government's open data policy.

From the earlier ideas in 2007, Rizo (2008a; 2008b) introduced the "System of Systems Reference Station Infrastructure" framework which the hierarchy of base stations was classified into three tiers according to the possible business models in Australia. Those tiers can be seen below:

"Tier 1 are the CORS to be used by IGS, or equivalent ultra-high accuracy networks to support geoscientific research and global reference frame definition.

Tier 2 are the high accuracy CORS networks operated by national geodetic agencies such as Geoscience Australia (2008) for the purpose of maintaining national geodetic datums and providing the fundamental backbone of the national geospatial reference frame.

Tier 3 are the CORS that densify the national CORS networks, operated by agencies such as state governments, or private companies providing commercial DGNS services."

This conceptual scheme was further discussed by Higgins (2008). He advocated the partnership model to specify key actor roles in undertaking GNSS high precision services distribution throughout the country. This model included not only views on cooperation but also technique, market, and payment. It clarified the motives for the unified reference network as follows: "...

- meet public good needs such as underpinning Australia's geodetic infrastructure;*
- enable the science opportunities from the AuScope stations to be fully realised;*
- conform to well defined standards in relation to issues such geodetic reference frame and data transmission;*
- allow for a revenue stream for the states and territories to recover operating costs through commercial services and;*
- encourage participation by other parties in the private and public sectors; ..."*

The model classed the organisation's commitment into five categories; "...

- Specify the network and services;*
- Own reference stations;*
- Network the data;*
- Process the network;*

- *Deliver services. ..."*

Each of the sections outlined the roles for each organisation confining to a particular activity, as illustrated in FIGURE A – 5. The policy involving the campaign was conducted within this boundary. When the model is applied, the government-owned CORS networks will be organised collaboratively through the ICSM.

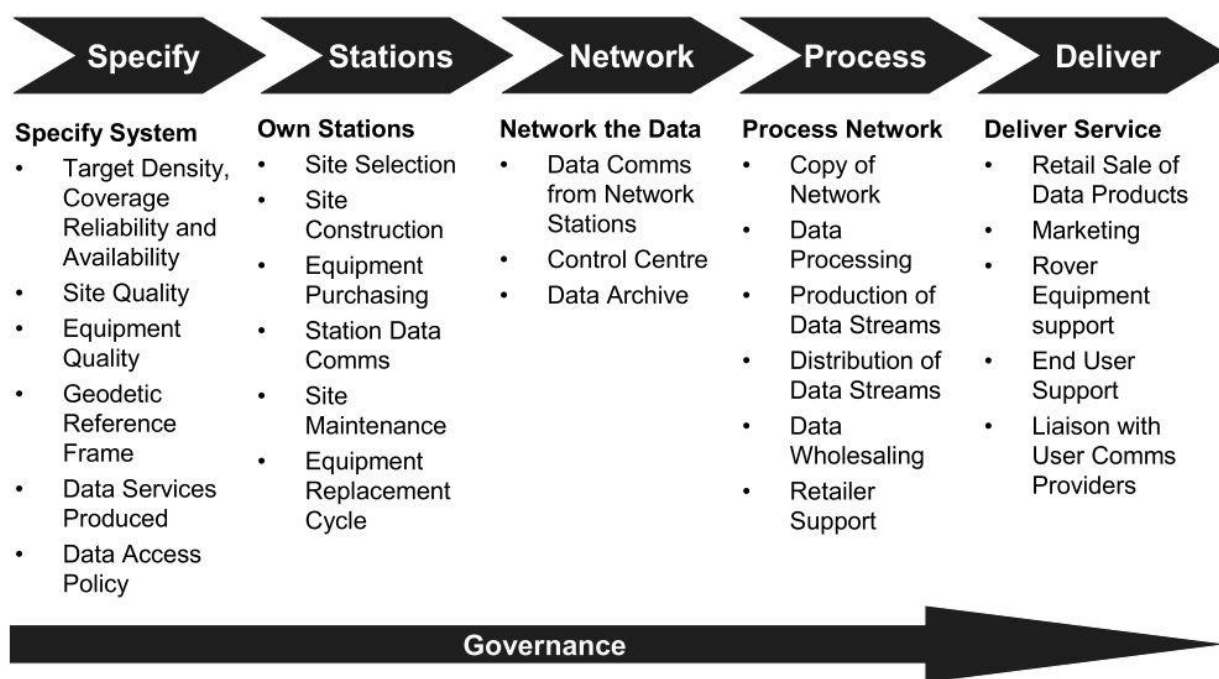


FIGURE A - 5 A Model for describing organisational roles in Precise Positioning by Higgins (2008)

As recapitulated by Burns and Sarib (2010), Australia's Permanent Committee on Geodesy (PCG), under the supervision of the ICSM, had issued guidelines for the CORS infrastructure building and functioning. Some parts of these procedures had been developed from the Tiers initiated by Rizos (2008a); the procedures were outlined as seen below:

1. Base station institution:

Tier 1 and 2 CORS are high-stability monuments. Their locations should be distanced from the risk of factors that could harm them, either living things or meteorological conditions.

Tier 3 CORS are stable monuments. Their sites could be on existing buildings or any appropriate structures requiring access permission.

2. System operation:

Tier 1 CORS are monitored apropos of the International GNSS Service (IGS).

Tier 2 CORS are monitored apropos of Tier 1 CORS.

Tier 3 CORS are monitored apropos of Tier 2 CORS.

Furthermore, the Land and Property Information (LPI) Division within the NSW Government had publicised the guidelines purposed to give guidance on the specification of the GNSS network that would fit CORSnet-NSW expectations (LPI, 2012). These guidelines were constructed to express LPI's responsibility to the NPI policy and reinforce the CORS infrastructure implementation mission (Hausler, 2014; Hausler and Collier, 2013a; 2013b; Janssen *et al.*, 2010; 2011b). Similarly, the server-based and thin-client RTK services framework had been put into practice on Sydney Network (SydNET) and looked forward to enacting wider (Lim and Rizos, 2007; 2008a). The use of database and web technologies has been striving for data analysis and management as well as solution delivery and network monitoring.

National Positioning Infrastructure (NPI)

As the national authority, ANZLIC inaugurated the National Positioning Infrastructure (NPI) Policy for delivering the positioning infrastructure guidelines that would fit the requirements of Australia in terms of the economy, society, and environment (ANZLIC, 2010). NPI Policy is a set of principles that had been indicated for a national positioning infrastructure (NPI) preparation to sustain and ascertain the compatibility of the GNSS Continuously Operating Reference Stations (CORS) infrastructure placement in Australia (ANZLIC, 2010). It strives to contribute a multiplex capability of CORS from multifarious owners across Australia to multiple groups of users for multipurpose exploitation. Positioning infrastructure, in the context of the NPI Plan, typically means the CORS networks, which are in the Ground Based Augmentation Systems (GBAS) element. Non-GNSS location devices are thus beyond the scope of this scheme. There are outcomes supposed to be produced if the NPI has internal consistency and reliability and achieves countrywide unified cooperative effort construction. Specifically, national GNSS positioning capability strengthening; National Geospatial Reference System (NGRS) reinforcement; unified framework intensification; duplicated positioning infrastructure handling and supply chain encouragement; positioning infrastructure benefit realisation; positioning data access management; positioning solution productiveness escalation.

The NPI Policy followed the role model originated by Higgins (2008) with an exceptional focus on Specify, Stations and Network sections. It had been concentrated on the Purpose, Interoperability, Performance, Governance, and Privacy issues. And, thereon, ANZLIC had entrusted the policy enactment by laying the foundations of the Intergovernmental Committee on Surveying and Mapping (ICSM) as its Standing Committee. ICSM then founded a permanent sub-committee of ICSM, namely the ICSM GNSS CORS Coordination Group, working as a coordination body for policy implementation. The ICSM GNSS CORS Coordination Group had a crucial position in developing and promulgating the CORS networks, performance, standards, and instructions, and the inauguration of the Australian program for the locations and facilities of current and new investment infrastructure. It also had to structure a framework for NPI direction over business and technology and create a relationship between NPI and telecommunication organisations and between NPI and non-CORS

network providers. This Coordination Group was responsible for learning materials about the privacy risks composition as well.

After that, in 2013, Geoscience Australia activated an internal- to-Government NPI Plan to assess the existing and succeeding investments engaged with PNT in Australia (Geoscience Australia, 2018a). The stakeholders had come across with NPI Plan were from both the public and private sectors, and the NPI Plan had been used to underpin Australia's Satellite Utilisation Policy (Space Coordination Office, 2013). The NPI Plan realised the uniqueness of Australia concerning its superior GNSS field of vision, which had stipulated the NPI in making available PNT information anywhere and anytime across the Australian landscape and its maritime jurisdictions. And on this account, it suggested a National Positioning Infrastructure Advisory Board (NPI-AB) formation to outline the rules and recommendations for the implementation of the NPI. The NPI-AB has been working on the NPI Plan under the identified functions and authorities to privilege four domains – administration and directorship, infrastructure advancement, product refinement, and service delivery. The NPI-AB member has been nominally set made up of four representatives from industry groups; two representatives from State/Territory Governments; two representatives from non-Geoscience Australia Governments related to PNT; one representative from New Zealand Government; one representative from Australian academic. The membership will be reconsidered every three years by the Chair (Geoscience Australia, 2018a). The NPI-AB outcomes had been narrated in the NPI-AB meeting reports were that they had entered the Technical Working Groups (TWG) in 2015 to unitise notable stakeholders to prioritise the contentions noted down by the Advisory Board (Geoscience Australia, 2015a; 2015b). The first TWG – NPI Business Model Subcommittee (BMSC) was imminently attached to the NPI-AB. It was induced to pro-and-con the rolling supply chain; confer rights and impose duties to the government and non-government network suppliers; and seek authoritative guidance for time to come (Geoscience Australia, 2016a; 2016b). Added to that, some Working Groups had counted in the NPI-AB Work Plan, such as the Australian Government – Positioning, Timing & Navigation Working Group (PNT-WG) and the SBAS Interoperability Working Group (IWG) (Geoscience Australia, 2017). The NPI-AB chaired by Geoscience Australia had thereupon recommended the National Positioning Infrastructure (NPI) Capability (Geoscience Australia, 2018b).

The NPI Capability is a government-led project in control of Geoscience Australia to optimise the ultimate value from GNSS satellite signals for Australia (Geoscience Australia, 2018b). Australia can plentifully obtain fruitful positioning utilities due to its high visibility situation. That apparent usefulness lies in surveying and mapping, construction, navigation, machine control, international air traffic management, and many more, which is advantageous to both scientific and commercial substances. In a similar manner, the Space Coordination Committee (SCC), which enacts responding to Australia's Satellite Utilisation Policy to foster civil space endeavours for the Australian Government, denotes another national PNT-involved body chaired by Geoscience Australia. Represented as a standing committee under the SCC, the PNT Working Group deals with several NPT issues, which include NPI Capability planning.

Foundation Spatial Data Framework (FSDF)

The Foundation Spatial Data Framework (FSDF) presents a common framework for the Australian and New Zealand foundation geospatial data homogenising and conserving since 2010 (Bastrakova *et al.*, 2019). The framework focalises "open, accessible, affordable and usable a national coverage foundation spatial data" dispersion. As the ANZLIC initiative, the FSDF has dedicated itself to completing the national foundation spatial data standard and quality assurance (Box *et al.*, 2015). It implies data and user-driven based outlook in a bid for national Spatial Data Infrastructure (SDI) genesis. SDI enables the National Map, one of the web mapping portals of the National Map initiative led by the Australian Government, for geospatial data retrieval through web services. By contrast, the FSDF found that transforming and putting together the matched national solutions of valid geospatial data from Australian Governments are intangibles. The Location Information Knowledge Platform (LINK) – an active, web-based, cloud-based resolving and query tool was, in that case, disclosed in 2016 by FSDF (ANZLIC, 2020a). The FSDF-LINK envisions FSDF-related knowledge spreads and markets by purveying a framework for policy induction, supply chain forethought, and data discovery. The FSDF-LINK is an online tool containing more than 1200 individual datasets that are utilised by over 73 Australian government agencies and industry organisations (Bastrakova *et al.*, 2019). The impending convention of FSDF-LINK is the automated collaborative data dissemination infrastructure.

Finance

For the financial aspect of the CORS project, Rizos (2007a) pointed out that the critical question is whether the market size is sufficient for the expected return, which is an insistent demand for the CORS system maintenance and improvement. So the earlier mentioned five business models had been developed to let the service providers justify their investment. With respect to the Return on Investment (ROI), the governments have paid particular attention to the "preventable costs" strategy, which aims to maintain public expenses on the chosen decision less than other scenarios rather than raising revenue. Regarding Higgins (2007; 2008), the benefits of economic growth in Queensland were estimated to rise 30 per cent in the mining operations productiveness and decrease 40 per cent of physical harm idle time, 30 per cent of the construction time span, 10-20 per cent of agricultural expenditure, and 10 per cent in transportation economising. Contrastingly, CORSnet-NSW service by the LPI, in alliance with other authorities, such as the Victorian Department of Sustainability and Environment and the ACT Planning and Land Authority, has tariffed since 1 July 2009 to allocate for the network overheads (Janssen *et al.*, 2010; 2011b). As anticipated, Australia could reap further gross benefits from GNSS CORS around \$58 Billion (ASC, 2012). The economy of the high-precision CORS network only in the construction, farming, and mining sectors could be worth \$800 Million to \$1.5 Billion per year (Allen Consulting, 2008; Geoscience Australia, 2018b). With consistent sponsorship on precise positioning, this industry could have profited financially from AUD\$73 Billion to AUD\$134 Billion by 2030 (ASC, 2012). Particularly, solely in the economic sectors,

namely agriculture, mining, and civil, it could yield between \$32 Billion and \$58 Billion (Allen Consulting, 2008; Geoscience Australia, 2018b). The expectancy of financial growth had come with the accompanying conviction on NPI power. Anyhow, the CORS element composed for constantly providing positioning service should be based on the essentials to cope with technical challenges, product reliability, user device budget, and network denseness. These components and circumstances had been confronted under the NPI perspective within the context of the Australian GNSS Strategic Plan.

National Positioning Infrastructure (NPI)

The NPI has a significant role in addressing the failure of Australian CORS marketing. Minimising fixed costs both by lessening investments, either by governments or businesses and expanding effectively on such a system ideal for a unified service performed by NPI were critical to policy adoption and investment decision-making development made by NPI (Hausler, 2014). Nonetheless, the important implication that has led to service coverage limitation was cost barriers. The CORS site distribution has been placed sparsely and remotely due to an insufficient budget. As a result, they cannot produce high-precision solutions throughout Australia; the profit returns were then expected to be obtained for service area expansion purposes. Anyway, the SPs cannot supply these services in all areas and hence cannot charge for use. The NPI accordingly planned to promote their products more advantageous if the network is extended to attract more users.

In order to consider Australian CORS profit-making institutions, divergent suggestions have been set forth. A "Client-Server" approach was believed could be adapted to manoeuvring the production process to make a profit from the CORS network. Contrariwise, substantial essentialities, including infrastructure employment, marketing research, and cost-benefit analysis, were prerequisites to be accomplished (Cranenbroek *et al.*, 2006). Thereby, the CORS services could be distributed by government and industry service providers (SPs) – the operator of GNSS reference stations covering government authorities and individuals like GNSS manufacturers and partner companies (Hausler, 2014). The private-public partnerships strategy was another attainable initiative for achieving a profitable return by placing data licence fees as wholesale under the competition-based pricing method (Hale, 2007). Besides, private sector data service providers (DSPs) would be more capable than the public sector in marketing to reachable targets. Contemporaneously, the value-added resellers (VARs), which have consolidated the original signals and creative complementaries as their solutions, could be the paramount players in the supply chain. Even so, the service brokers could also be appraised to reinforce the CORS commercialism (Rizos and Cranenbroek, 2006).

The average total cost (ATC) theory – the proportion of the total cost of manufacturing to the quantity of out-turn – was drawn as a decisive strategy to evaluate monopolies and economies of scale. While the operators compete by pricing at ATC, data licensing

gives third-party SPs permission to sell value-added products so it can reduce the fixed cost of processing services (Hausler, 2014).

Legal

The CORS development in Australia has been supported by the state and territory government juridical significance and market demand (Higgins, 2008). The unified model proposed by Higgins subsequently emphasised that all the actions should be legislatively done and coexist within the public-good requirement. In the case of Queensland (QNRW, 2007 in Higgins, 2008), they adopted a policy that complied with the Act mandated by the State Control Survey so that they had absolute confidence in their roles. As a consequence, Higgins alluded to the notion that Australia should proceed with the national CORS network unification along the lines of the Queensland approach.

As a crucial part of the CORS management pushes, multiple Acts have been invoked to authorise the moves. These can be seen in the PhD thesis of Hausler (2014), who listed the legislation relevant to the Australian GNSS network management as below:

- *Australian Competition and Consumer Act 2010*, one of the Antitrust Laws, was assigned to public policy development as regards information goods supervision.
- *Broadcasting Services Act 1992* was assigned to legislate the regulations that will come into force over the service providers' control as well as telecommunications carrier manipulation.
- *National Electricity (South Australia) Act 1996* was assigned to safeguard the electricity transmission synchronicity between the states and territories.
- *National Electricity (Victoria) Act 2005* was applied together with the National Electricity Law (NEL) and the National Electricity Rules (NER) to govern electricity transmission within the jurisdiction.
- *National Measurement Act 1960* was assigned for the verification of the coordinate uncertainty in the coordinate traceability process.
- *National Measurement Regulations 1999* was assigned for the verification of the coordinate uncertainty in the coordinate traceability process.
- *Telecommunications Act 1997* was assigned to legislate the regulations which will come into force over the service providers' control as well as telecommunications carrier manipulation.

International Collaboration

Activities, as above-mentioned, are the endeavours to create resolutions to fix technical challenges and end entanglement in running the CORS network throughout

Australia. On the other hand, the attempt to establish a collaboration on the CORS services between Australia and the foreign country has also been carried through.

The university-led CORS system functioning in Singapore was a beneficial source for researchers from both Singapore and Australia in the co-creation of data processing algorithms and data management techniques, as well as the evolution of communication systems (Rizos, 2002). The defining process in these contributions had been jointly prepared by the researchers from these two countries for a specific target. The outcome called SNAPper was put to use for the University of New South Wales (UNSW) CORS system (Heo *et al.*, 2009). In comparison, other co-experiments on CORS networks were between Australia, Europe, New Zealand, the USA, Japan and China. For example, the joint effort between Australia and Japan to mitigate the natural hazard using low-cost permanent GPS networks was arranged by the University and the Geographical Survey Institute (GSI) (Rizos *et al.*, 2000).

ANZLIC – The Spatial Information Council (ANZLIC) is the peak government organisation in a harmonious union of Australian jurisdictions and New Zealand (ANZLIC, 2014a). ANZLIC is a predominant driver of spatial information projects in Australia and New Zealand and influences the ASIA-Pacific region (ANZLIC, 2018; Hausler and Collier, 2013b). It has coordinated with the Surveying & Spatial Sciences Institute (SSSI), an inter-governmental peak body in Australia and New Zealand harmony, to assist the expert community on surveying and spatial science disciplines (ANZLIC, 2020b). Australia has emerged numerousness of geospatial policies and standards via ANZLIC companionship. Not only that, Australia has joined the events taking account of GNSS base stations.

Australia became a member of the International Committee on GNSS (ICG), an organisation founded in 2005 by the United Nations Office of Outer Space Affairs (UNOOSA) to direct the IGS activities. The association comprises active players from worldwide organisations which are both related and non-relative to the governments (Dow *et al.*, 2007). ICG formed multiple working groups and pilot projects, Australia by Geoscience Australia (GA), and the associated partners have cooperated with them in the Real Time Pilot Project (RT-PP) to evolve data streaming potentiality (Rizos, 2007b). With the succeeding change in the GNSS landscape, international coordination on IGS had been asked to upraise (Dow *et al.*, 2009). As the project leader, GA participates in the ASIA-Pacific Reference Frame (APREF) – the intercontinental project under the direction of the CRCSI to determine the future generation of geodetic datum over Asia and the Pacific region. APREF was mandated in 2009 by the United Nations Regional Cartographic Conference (UNRCC) for Asia and the Pacific under the endorsement of IGS, UNOOSA, and the Federation of International Surveyors (FIG). The APREF objectives, in respect of the ANZLIC and ICSM policies and guidelines, are to spur the cooperative sharing of CORS data. In particular, it will be supportive for site selection to situate GNSS stations of high calibre (Geoscience Australia, 2015c; 2020a; Hausler and Collier, 2013b).

TABLE A - 10 The cooperativeness in GNSS CORS development in Australia (Source: Author's own research)

Cooperativeness	Activity	Achievement
Inter-organisational Collaboration	• The Melbourne 2006 Commonwealth Games (Hale <i>et al.</i>, 2006)	• The advantage of GNSS reference stations was discovered at the state level.
	• The NCRIS (Hausler and Collier, 2013b; Hale, 2007; AuScope Geospatial Team, 2008)	• NCRIS is an initiative for geospatial research infrastructure development funded by the Australian Federal Government. (November 2006)
	• The AuScope (Hausler and Collier, 2013b; Rizos, 2007b)	• AuScope was instituted at the Federal level under NCRIS to manage the Australia-wide CORS installation supporting geospatial research. (2006)
	• The NGRF (Rizos, 2007b)	• AuScope allocated funds to CORS's establishment in the NGRF geodetic infrastructure improvement.
	• The CRC project (Higgins, 2008)	• The CRC project was created to address problems concerning CORS.
	• The CRCSI (Higgins, 2008)	• CRCSI started off Project 1.04, built on the CRC project for inquiry of CORS expansion to a regional extent. (July 2007)
	• The ANZLIC (ANZLIC, 2001)	• ANZLIC, the peak government body in Australia and New Zealand, is responsible for developing spatial information policies and strategies. (1986)
	• The NPI (ANZLIC, 2010; Hausler and Collier, 2013b)	• The NPI was established to ensure national and international collaboration on GNSS infrastructure.
	• The ANZLIC's NPI Policy (ANZLIC, 2010)	• ANZLIC's NPI Policy is a policy framework proposed by ANZLIC to implement GNSS CORS standards and guidelines within the Australian Government. (Late 2010)
	▪ The ICSM (ANZLIC, 2014a; ICSM, 2018)	▪ ICSM, a Standing Committee of ANZLIC, is responsible for implementing ANZLIC's NPI Policy

Cooperativeness	Activity	Achievement
		regarding technical standards and information models. (2002)
	▪ The ICSM permanent sub-committees (ANZLIC, 2014a)	▪ ICSM permanent sub-committees, the representatives of the ANZLIC member jurisdictions, are based coordination body established by ICSM for devising ANZLIC's NPI Policy implementation plan. ○ ICSM GNSS CORS Coordination Group is responsible for delivering optimum network design and station performance. ○ Other Permanent Committees: PCA, PCPN, PCC, PCG, PCTMSL, PCTI
	▪ The ICSM working groups (ANZLIC, 2014a)	▪ ICSM working groups, the representatives of the ANZLIC member jurisdictions, are responsible for compiling all plans to improve dataset quality. ○ Two working groups under PCC ○ GDA Modernisation Implementation Working Group ○ Metadata Working Group
	▪ The FSDF (ANZLIC, 2014a)	▪ The FSDF, an ANZLIC-sponsored initiative, served the ANZLIC's prospects in making the best use of the ICSM working groups and preparing project proposals aligned with the 1SDI roadmap.
	• The SPU (Hausler and Collier, 2013b; Space Policy Unit, 2012)	• The Australian Government assigned SPU to undertake the development of Australia's space policy. (2010)
	• The NPI Plan (Australian Government, 2013)	• Australia's Satellite Utilisation Policy developed by SPU initiated the NPI Plan for supervising the positioning ground infrastructure investment throughout Australia. (April 2013)
	• The NPI-AB (Geoscience Australia, 2018a)	• NPI-AB was instituted by ten government, industry and research

Cooperativeness	Activity	Achievement
		sector members for advising about the NPI development and implementation to GA. (December 2014)
	▪ The NPIPE (Geoscience Australia, 2018a)	▪ NPIPE has a major responsibility to receive the reports from NPI-AB for establishing within GA.
	▪ The PNT-WG (Geoscience Australia, 2018a)	▪ PNT-WG is a working group chaired by GA in association with Australian Government Departments involving PNT to advise the SCC on NPI planning. (March 2015)
	▪ The TWG (Geoscience Australia, 2018a)	▪ Technical Working Groups, permanent and temporary working groups, were commissioned by the NPI-AB to address the NPI planning issues.
	▪ The BMSC (Geoscience Australia, 2016b)	▪ NPI Business Model Subcommittee, the first TWG founded by NPI-AB, is responsible for sales and support of high-precision technology. (2016)
International Collaboration	• Singapore	• Data processing algorithms, data management techniques and communication systems (Rizos, 2002) • SNAPper – a research outcome used in the UNSW CORS system (Heo <i>et al.</i>, 2009)
	• Japan	• The natural hazard mitigation research (Rizos <i>et al.</i> , 2000)
	• China	• GNSS CORS joint research with China (Rizos <i>et al.</i> , 2000)
	• Europe, New Zealand, the USA	• GNSS CORS joint research with Europe, New Zealand, and the USA (Rizos <i>et al.</i> , 2000)
	• ANZLIC	• Spatial information projects in Australia, New Zealand, and the ASIA-Pacific (ANZLIC, 2018)
	• ICG	• An international committee was established for the IGS activities governing (Dow <i>et al.</i> , 2007)

Cooperativeness	Activity	Achievement
	• APREF	• The intercontinental project of geodetic datum over Asia and the Pacific region (Geoscience Australia, 2015c; 2020a)

TABLE A - 11 The achievement in GNSS CORS development in Australia (Source: Author's own research)

Key term	Key element regarding theory	Australia
Technology		
CORS Infrastructure	Innovation ecosystems have a great link with technology platforms and economic or social circumstances (Gobble, 2014).	• Thick infrastructure (Lim and Rizos, 2008b)
Techniques		• The NGDB (Johnston and Morgan, 2010)
		• The APREF monitoring system (ICSM, 2014)
		• The NGCI database (Hausler and Collier, 2013b)
		• TCAR approach (Feng <i>et al.</i>, 2007)
Tools		• Server-based and thin-client platform (Lim and Rizos, 2007; 2008a; 2008b)
		• SNAPper software (Heo <i>et al.</i>, 2009)
		• The FSDF unified spatial data (ANZLIC, 2018)
		• Web server and web map server (Lim and Rizos, 2007)
		• The NGRS (Johnston and Morgan, 2010)
		• The APREF web service (ICSM, 2014)
		• The NGCI web map (Hausler and Collier, 2013b)
		• The SKI (Duckham <i>et al.</i>, 2017)
Delivery		• The FSDF services (ANZLIC, 2018)
		• The LBS Positioning System (Roberts <i>et al.</i>, 2004)
	• ANZLIC’s Metadata Working Group reviewed the contact position for spatial service delivery in the ANZLIC Metadata Guidelines V.2 (ANZLIC, 2001).	
	• Dow <i>et al.</i> (2002) introduced the use of LBS and the data service delivery barriers due to the limited bandwidth of mobile networks.	

Key term	Key element regarding theory	Australia
		• Hale (2007) advised the development of multi-mode service delivery to GPSnet Commercial Requirements. • Rizos (2007) initiated using the internet as another channel for real-time GNSS service delivery. • Rizos (2008) introduced a service delivery strategy complying with the IGS scheme in the System of Systems Reference Station Infrastructure initiative. • Higgins (2008) highlighted the partnership and business models that defining organisational roles in service delivery will enable their power and legitimacy to market. • Hale <i>et al.</i> (2008) underlined mobile internet as a priority for GPSnet's real-time service delivery. • AuScope Geospatial Team (2008) has designed the service delivery of positioning infrastructure, including CORS networks. • Heo <i>et al.</i> (2009) proposed a data delivery strategy in terms of transmission procedure, communication link, and the structure, types, format, and content of data. • Service delivery was one of the major concerns in the NGRS databases and systems management (Johnston and Morgan, 2010). • Janssen <i>et al.</i> (2010) expanded the LPI's delivery mechanisms to enhance the quality and extent of services. • Guidelines for CORSnet-NSW CORS V. 1.1 considered GNSS CORS Network Design regarding service reliability and delivery (LPI, 2012). • The SydNet communication link and service delivery were discussed to support multiple programmes and

Key term	Key element regarding theory	Australia
		commercialise the network (Rizos <i>et al.</i>, 2013). • Hausler and Collier (2013a) concluded service delivery challenges addressed by the NPI Plan. • Program 4.1 created a practical strategy for delivering the CRC's outputs to agriculture, natural resources and climate change experts via applicable media (CRCSI, 2013) • The guideline for CORS SP.1 mentioned the key parameters for NGRS service delivery and the effect when equipment is closed down (ICSM, 2014). • Hausler (2014) summarised the role of government for commercial drivers in service delivery to the market and the limitation regarding broadband services. • The NPI-AB assigned one of the TWG to prioritise delivery mechanisms (Geoscience Australia, 2015a). • GA discussed data and service delivery in the development of the Australian NPI Strategic Planning Framework (Geoscience Australia, 2015) • Janssen <i>et al.</i> (2016) emphasised the enhancement of service delivery to support LPI's business. • Spatial Data Infrastructures service delivery was arranged within the federated system of government underpinned by the CRCSI (CRCSI, 2017). • The FSDF strengthened service delivery to improve transport data and location address data (Queensland, 2018) • Service delivery issues lie in the ten themes of the FSDF (FSDF, 2019). • The research and innovation development partnership led by

Key term	Key element regarding theory	Australia
		FrontierSI focuses on three prime areas, inclusive of service delivery improvement (FrontierSI, 2019).
Access	Access to spatial data infrastructures and other information is essential for the government, industry, academic, public, and non-profit sectors (Van Loenen and Kok, 2004).	• ANZLIC (2001) listed core metadata elements for geospatial data, including access category, based on the US FGDC. • Roberts <i>et al.</i> (2004) recommended the use of CORS networks in Australia via internet access. • Rizos <i>et al.</i> (2005) studied the SydNET performance and its limitations, including the accessibility of services. • Hale (2006) discussed service access for traditional and non-traditional spatial users. • In presenting a client-server-based model concept, Rizos and Van Cranenbroeck (2006) were concerned about the high-speed internet and wireless connection necessary for infrastructure link and service access. • Hale (2007) recommended the requirement for multiple modes of access. • Rizos (2007) brought about the models for infrastructure and services establishment. • Hale <i>et al.</i> (2008) described GPSnet management in terms of technical standards and access. • Rizos (2008) offered the data access approaches to multi-tier CORS networks conforming to the models in 2007. • Higgins (2008) spotlighted a data access policy in the specification of each organisation's role play. • Lim <i>et al.</i> (2008) advised the implementation system of CORS in terms of access ability. • Data access mechanisms were included in the SDI concepts to employ geospatial data for geodetic

Key term	Key element regarding theory	Australia
		datum and land governance (Higgins, 2009). • Roberts (2009) recommended a protocol for service access in rural and regional areas. • Rizos (2010) proposed adopting a data access policy to define the organisations' roles in a multi-tier infrastructure joint movement. • Blick and Sarib (2010) instigated the geodetic infrastructure in Australia and New Zealand, including data access mechanisms. • LPI has an essential role in delivering positioning infrastructure products statewide by offering ease-of-access services (Janssen <i>et al.</i>, 2010). • NGRS used the geospatial data for national datum updates and required available access to data (Johnston and Morgan, 2010). • Janssen <i>et al.</i> (2011) enlightened CORSnet-NSW products access to improve the reliability of the expanding network. • Hausler and Collier (2013a) identified and evaluated CORS infrastructure accessibility and the DSP offer access. • Hausler and Collier (2013b) summarised the policies and arrangements for data access supporting the NPI Plan. • Hausler (2014) underlined the service access strategies both a public good and a private good. • The guideline for CORS SP.1 determined the site and data access arrangements regarding the hierarchy of CORS (ICSM, 2014). • The FSDF presented a national SDI approach to enable user access (Box <i>et al.</i>, 2015). • NPI-AB commissioned TWG to prioritise the NPI management and

Key term	Key element regarding theory	Australia
		standards and control access quality (Higgins, 2015). • Dawson (2017) highlighted accessibility as one of the critical concerns in the NPI Capability. • Woodgate <i>et al.</i> (2017) marked NPI development as a vital strategy for establishing homogeneous positioning data access. • ANZLIC (2018) stated its role in encouraging spatial data accessibility and utilisation. • The FSDF identified essential requirements of foundation spatial data for Queensland, inclusive of accessibility (Queensland, 2018). • FrontierSI focuses on enhancing spatial data accessibility and service delivery for research and development (FrontierSI, 2019). • The FSDF supported numerous of Australia's spatial benefits, including countrywide seamless access (Bastrakova <i>et al.</i>, 2019). • CORSnet-NSW provided statewide access to data services supporting NSW farmers (DCS Spatial Services, 2020).
Human Resources		
Professional	It is necessary to engage the tasks and practices with competent actors (Diener, 2014).	• ICSM support the specialists for standards and information modelling development to the ANZLIC expectation (ANZLIC, 2014a; ICSM, 2018). • ICSM Executive Officer provides secretariat and project assistance to both the Committee and Working Groups (ICSM, 2018). • GA delivers the Chair and Secretariat to the NPI-AB (Geoscience Australia, 2018a). • CRCSI has funded the researchers and supervisors for the project about the GPSnet™ CORS network (Hale, 2007).

Key term	Key element regarding theory	Australia
General Staff	The intermediary typology development in the innovation ecosystem is based on the roles and responsibilities (Diener, 2014).	• CORSnet-NSW has been controlled by multi-disciplinary specialists in technical and customer support teams (Janssen <i>et al.</i>, 2011). • The IT managers associated with support staff could have critical functionality in sustaining the CORS network (Hale, 2006). • The joint investment and co-working through the AuScope project paid attention to personnel as well as instrument and operating cost (AuScope Geospatial Team, 2008). • Higgins (2008) described the role model for data distribution that the field staff would receive the correction derived from the hybrid methods. • Hale <i>et al.</i> (2008) specified the GPSNet staff role as a personal contact for offline data access. • The report on the economic benefits of positioning services outlined the advantage of land surveying in terms of labour savings in that non-survey staff can do a job without skill (Allen Consulting, 2008). • CORSnet-NSW set up operating teams as technical and customer support staff (Janssen <i>et al.</i>, 2011). • The NPC staff was expected to calibrate and link the tide gauge BM and the CORS BM together (Janssen <i>et al.</i>, 2013). • The requirements for an NPI Plan considered staffing and training issues as part of organisational concerns (Hausler and Collier, 2013b). • The inappropriateness of staff replacement and assignment impacted the end-users, particularly government partners, maximising resource capacity. The Applications Program could improve staff

Key term	Key element regarding theory	Australia
		competence with \$8 M savings (CRCSI, 2014). • As the leader of the mutual relationship in the spatial information research community, FrontierSI (2019) has functioned on staff recruitment and training to ascertain the implementation of the Strategy.
Improvement Organisational design	Organisational social capital (OSC) development is an investment to facilitate relationships between organisational members and inter-organisations in terms of motivation and capability enhancement (Chuang <i>et al.</i>, 2013).	Institution of key bodies in the CORS implementation movements • FSDF PMO is the coordinator for ANZLIC's projects establishment (ANZLIC, 2019; Geoscience Australia, 2016c). • ICSM Chair and Executive Officer are appointed to support the Committee and Working Groups (ICSM, 2018). • NPIPE has received advisory issues from the NPI-AB Chair for GA planning (Geoscience Australia, 2018a). • ICSM Permanent Committees and Working Groups comprise the members from the ANZLIC fellowship in governmental, academic, and private sectors to conduct projects and research (ANZLIC, 2014a). • NPI-AB is composed of ten representatives from governments, research communities, and industries in Australia and New Zealand aimed at NPI creation (Geoscience Australia, 2018a). • NPI Working Groups was commissioned by NPI-AB to carry out the work of the NPI-AB (Geoscience Australia, 2016b; 2018a). • NCRIS, which was funded by the Australian Federal Government, had announced geospatial research infrastructure (AuScope Geospatial Team, 2008).

Key term	Key element regarding theory	Australia
		• AuScope is a joint public funding project of the Federal Government to manage the CORS investment supporting scientific purposes (AuScope, 2007 in Higgins, 2008).
		• CRCSI was initiated by the CRC Program and partnered with various sectors to conduct activities in Australia and New Zealand (Hale, 2007).
		Specification of the various roles of the players • The organisational roles model was created to specify the characteristics of each organisation in the partnership movements ranging from the system to service delivery (Higgins, 2008).
Training ○ Limitation ○ Plan	Human resources management practices take a significant role play in facilitating, accumulating, and utilising the OSC to reinforce the organisation's member mutual relationships (Chuang <i>et al.</i>, 2013).	Human capital training and education • The CORS model validation mentioned the lack of proper training as a barrier to the CORS operation and service for non-traditional spatial users (Hale, 2006; 2007) • The profit-making recommendation suggested service support training for new organisations and possible users (Cranenbroek <i>et al.</i>, 2006). • The Australian Government will provide training in space capabilities to support innovation, science and skills development (Australian Government, 2013). • Human resources allocation for training staff in GPSnet Team and user training should have specialised training and regular training (Hale, 2007). • The CRCSI developed training programs for the non-exclusive,

Key term	Key element regarding theory	Australia
		royalty-free CRCSI IP's Essential Participant (CRCSI, 2013). • The CRCSI arranged education or training for the university, the government, and the private and vocational training sectors in the National Spatial Education Leadership Group (CRCSI, 2013). • CRCSI set up a local staff training programme (CRCSI, 2013). • FrontierSI provided professional development training (FrontierSI, 2019). • Hausler (2014) recommended training in Service Level Agreements to fulfil the NPI Plan. • Technical training for controlled traffic farming was suggested as the typical package for a farming system (Allen Consulting, 2008).
Finance		
Investment	Economic issues are involved in the enhancement of spatial data infrastructures, so the costs and loss could be problematic (Van Loenen and Kok, 2004).	• It was estimated to cost over \$70M for thousands of CORS sites across Australia (AuScope Geospatial Team, 2008). • The LPI funded AUD7.25M in capital investment for the CORS network in the Survey Infrastructure Improvement Program, of which CORSnet-NSW is the central part (Janssen <i>et al.</i>, 2011). • The LPI funded AUD1M in software (Janssen <i>et al.</i>, 2011). • The CRCSI has been funded by the CRC Program and partners for investment and research (CRCSI, 2020). ▪ \$78M and \$13.3M in 2003 ▪ \$15M and \$2.7M in 2009 ▪ \$160M and \$32.2M in 2010 • The AuScope project was funded for \$15.4M, \$4.5M, and \$23M for the geospatial part, with 123 new CORS

Key term	Key element regarding theory	Australia
		stations (AuScope Geospatial Team, 2008). • The VIC Government's GPSnet has \$650,000 yearly operational costs and \$13.25M in 5 years of fixed investment (Hausler, 2014). • The New Zealand Government and the Australian Government jointly funded \$14M for the positioning capability improvement (Geoscience Australia, 2017).
Maintenance and renewal		• \$120M replacement cost by City of Greater Dandenong Council (Allen Consulting, 2008)
Loss		• \$13.5M on capital and operation (Hausler and Collier, 2013a) • \$8.4M of over-investment in AuScope and ARGN sites (Hausler and Collier, 2013a)
Return on Investment (ROI)		• Preventable costs strategy (Rizos, 2007a) • \$435M to \$870M per year operating cost savings and \$2.3B per year capital cost savings in using asset mapping (Allen Consulting, 2008) • \$120M per year Queensland's economic growth (Higgins, 2007; 2008) • \$152M – \$206M in 2008 for the agricultural sector (Roberts, 2009) • CORSnet-NSW service package (Janssen <i>et al.</i>, 2010; 2011b)
Prospect		• \$800M to \$1.5B per year in the sector of construction, farming, and mining (Allen Consulting, 2008) • AUD73B to AUD134B by 2030 (ASC, 2012) • \$32B and \$58B in the economic sectors of agriculture, mining, and civil (Allen Consulting, 2008) • \$1005M – \$1357M in 2030 for the agricultural industry (Roberts, 2009)
Policy and Business Model		

Key term	Key element regarding theory	Australia
Policy	Legal and policy issues are parts of the Spatial Data Infrastructure settings (Van Loenen and Kok, 2004).	• The Queensland Geospatial Reference Framework Policy (QNRW, 2007 in Higgins, 2008) • The National Positioning Infrastructure (NPI) Policy (ANZLIC, 2010) ▪ The NPI Plan ▪ The Intergovernmental Committee on Surveying and Mapping (ICSM) as a Standing Committee ▪ The ICSM GNSS CORS Coordination Group ▪ The National Positioning Infrastructure Advisory Board (NPI-AB) ▪ The Technical Working Groups (TWG) ▪ The Positioning, Timing & Navigation Working Group (PNT-WG) ▪ The SBAS Interoperability Working Group (IWG)
Business Model	Alternative and innovative business models are chosen to sustain the public sector data providers (Donker and Van Loenen, 2016).	• GNSS CORS Network Management Model (Hale <i>et al.</i>, 2006) ▪ The data service provider (DSP) ▪ The value-added reseller (VAR) • The service provider (SP) licensing strategy (Lim and Rizos, 2007) • The CORS infrastructure and service models for commercialising GPS-RTK (Rizos, 2007a) • The client-server based model (Rizos and Cranenbroeck, 2006) • The AuScope project (AuScope, 2007 in Higgins, 2008) • The data service provider (DSP) (Hausler and Collier, 2013a) <i>Current:</i> 8.4% service coverage by independent DSPs <i>Expect:</i> - 11.5% service coverage by independent DSPs when the fundamental geodetic infrastructure is fixed

Key term	Key element regarding theory	Australia
Model and Strategy	The strategic focus areas are inclusive of collaborative work, communication, digital spatial discussion, and the technology ecosystem (ANZLIC, 2016).	- 14.8% service coverage by joint working DSPs • The initial Multi-Tier hierarchical system (Rizos, 2007b) • Legal traceability process • The GNSS service broker ▪ The System of Systems Reference Station Infrastructure framework – three tiers (Rizos, 2008a; 2008b) ▪ The Organisational Roles in Precise Positioning partnership model (Higgins, 2008) • The server-based and thin client RTK services framework for Sydney Network (SydNET) (Lim and Rizos, 2007; 2008a) • The National Positioning Infrastructure (NPI) Policy (ANZLIC, 2010) • The TWG – NPI Business Model Subcommittee (BMSC) • The National Positioning Infrastructure (NPI) Capability
Plan	Work plans and activities to encourage and deliver spatial data development are within the strategic focus areas (ANZLIC, 2016).	• The ANZLIC Strategic Plan (ANZLIC, 2001; 2014; 2016; 2018; 2020) • The Australian Strategic Plan for GNSS (ASC, 2012) • The CRCSI Strategic Plan (CRCSI, 2012; 2013; 2014) • The NPI Plan (Choy <i>et al.</i>, 2017; Dawson <i>et al.</i>, 2014; Hausler and Collier, 2013a; 2013b; Hausler, 2014; Higgins, 2015; Janssen <i>et al.</i>, 2016; LPI, 2012; Geoscience Australia, 2015; 2018a) • The ICSM Strategic Plan (ICSM, 2018; 2019)
Guideline/ Standard	National standards are created in harmony with requirements, data aggregations, and policies to reach optimum satisfaction (Van Loenen and Kok, 2004).	• The Land and Property Information (LPI) Division guidelines for CORSnet-NSW (LPI, 2012) • The CORS unified model (Higgins, 2008)
Legal Legislation	The data and movements' legal protection relates to national law,	

Key term	Key element regarding theory	Australia
Relevant Act	which harmoniously responds to a mandate of the government (Van Loenen and Kok, 2004).	• The state and territory government CORS (Higgins, 2008) • The Queensland State Control Survey (Higgins, 2008) • Australian Competition and Consumer Act 2010 (Hausler, 2014) • Broadcasting Services Act 1992 (Hausler, 2014) • National Electricity (South Australia) Act 1996 (Hausler, 2014) • National Electricity (Victoria) Act 2005 (Hausler, 2014) • National Measurement Act 1960 (Hausler, 2014) • National Measurement Regulations 1999 (Hausler, 2014) • Telecommunications Act 1997 (Hausler, 2014)

C.2 Thailand

Technology

Technical issues can be separated into categories: equipment, infrastructure, technique, and service delivery.

The views that have been drawn towards the instrument, such as the receivers, are noticeable. Their efficiency is scarcely problematic; even though they are non-identical, they are comparable. The major apprehensions about the implements are their obsolescence and modernisation. Some of the receivers can obtain the GPS signals merely; they then are unable to acquire the other GNSS information and extract the utmost benefit of the whole GNSS satellites. To contemporise those old-fashioned devices, the operators need to customise or substitute them with new ones. These undertakings harmoniously demand budgetary allotment as well as systematic recommendations to shape the overall instrumental theme. To categorise the class of these tools and define their specifications in appropriating the use of CORS, Rizos and Satirapod (2011) suggested the system-of-systems motion (Rizos, 2007b; 2007b; 2008a; 2008b).

One of the tangible blockages in the GNSS network flow is the CORS facilities. The smoothness of the solution distribution and the connection between CORS sites and control centres lean on the infrastructure. The internet is one of the most imperative features. It is compulsory not only for data transmission but also for administrating

and warning systems. In Thailand, the landline internet is not available throughout the country, especially in the alpine and woody regions or the area near the frontier. Mobile internet is the most feasible alternative; in spite of that, mobile broadband services neglect to transfer data due to the sparsely located cell towers in the coverage. This barrier has not been efficaciously addressed.

There are a great number of approaches that fall under the umbrella of GNSS positioning processing techniques. Despite that, the CORS manoeuvrers are inspired by general manners mounted by hardware companies for basic use. The released research invariably engaged with the applications of GNSS data from the CORS and the investigation of the validity of CORS technology, for example, the studies to evaluate the performance of the CORS in Thailand, precisely the real-time service (Charoenkalunyuta *et al.*, 2012; Niwasanon and Satirapod, 2019). These explorations focused on one of the data processing modes called Virtual Reference Station (VRS) Real-Time Kinematic (RTK) network derived from Thai CORS infrastructure. They alluded to the site spacing that engendered the calculation of positions, notwithstanding the system-by-system proposition in relation to TCAR scenarios (Feng *et al.*, 2007; Feng, 2007; 2008; Feng and Rizos, 2005; Feng and Rizos, 2009; Rizos, 2007a; 2007b; 2008a; 2008b) was recommended to Thailand by Rizos and Satirapod (2011).

The consistent practice of data processing methods is related to service distribution on types of solutions and service transfer style. Some kind of exercise stands in need of instant high-precision results, so they ask for a real-time strategy to produce in-the-flesh coordinates. Whereas a mass of utilisation does not look for the live deliverables, the data archive has been made accessible for post-processing. Nevertheless, a transition to commercialising the competence of the GNSS network necessitates a multitude of constituents, extreme service reliability and an authoritative business plan.

These technical factors are gripped at the outset as a result of the diversity of CORS infrastructure and holders. For that reason, the standards and fundamental guidelines for GNSS CORS establishment should be embraced. Consequently, arranging current assets and laying new infrastructure in regard to these formal agreements will pledge to avoid incidental redundancies and guarantee that the whole-of-nation network will get ready with synchronous values.

The mechanical plan contrived to CORS acknowledgement was compartmented into segments. A service dispensing and knowledge imparting phase was designed to be undertaken via the web portal as a contrivance. As a pilot study, the service would be provided to limited sorts of users at no cost at the early stage. The centre of interest was the Research and Development (R&D) community. This contrivance was then resorted to endorsing the start-ups and SMEs at another time. The GISTDA had introduced this web-based service for national CORS data; for the time being, they had taken control of the National CORS Data Center. And the Chinese organisation

favoured them with this technology. The website was aimed at mainstreaming location-related learning and advancement into industries for the economy drive.

More extensively, the RTSD has drawn up a practical system for the National CORS Data Center with a concentration on the superior accuracy of CORS data and the steadiness of the system. This system will comprise a Virtual Machine, a server that will keep the service supply continuity and network security services alive. The smooth running of services will be held for twenty-four hours a day. In addition to the management system, the Data Centre system would be fitted with data archival and backup systems that will work on a real-time basis and have a ten-year storage capability. The Data Centre system would have the full backing of all sorts of solution formats and be capable of a mass of concurrent users. It should be equal to the tasks of base station querying and other germane subjects. The services provided by this system would be up to the web portal, which the users can approach online. This tool will also have the potential to control and govern the CORS sites, registering system, clustering system, zoning system, screening and managing system, and statistics. In light of the CORS site facilities, the leased lines – the Dedicated Internet Access (DIA) have been put to work; unfortunately, some areas in Thailand are free from internet service or have intermittent internet service.

Collaboration

Uncooperativeness is a foremost deadlock that the Thai government needs to blast out of the blocks. The CORS-related front runners of Thailand are from the varied lines of the public sector, which independently fixed and controlled their properties regarding their areas of activity. A formal teamwork intent has hence been ruminated on with carefulness. In February 2017, the National Geo-Informatics Board hosted a High Level seminar for defining the national geo-informatics movement guidelines. This seminar encompassed dominant CORS proprietors in Thailand – the RTSD, DOL, DPT, HAIL, and GISTDA. By that, the participants had conferred with allies about creating the National CORS Data Center, which will be under the National Subcommittee on GNSS Network. The qualifications required for the National CORS Data Center candidates were that: must be a government organisation; have the ability to provide services to both the public and private sector; the competence in encouraging a diversity of missions; must have skilled staff; must contain the technology to support the national infrastructure.

At the conference, they conversed about the National CORS Data Center in foreign countries. As a result, it uncovered the user groups of those CORS utilities: public sector, private sector, and hybrid organisations. At that point, the CORS has either been taken as a charge on usage or registered as free of charge.

Besides, the national GNSS infrastructure was one of the topics brought to the debate. Under the concept of Network of CORS Networks, the users who are non-CORS owners, either the public or private sector, are the main target. Even so, the

unavailability of a national data centre working as a service provider was an indicative challenge. The seminar was then engrossed in starting the national data centre to service a cluster of applications in the Eastern Economic Corridor (EEC) locality. As a result of this, GISTDA was deputed to act as the leader of the National GNSS Infrastructure project. The GISTDA will be obligated to act in the National CORS Data Center and coordinate with foreign countries like China and, expressly, Japan, which will earmark Thailand's 200 CORS installation programme.

The National Geo-Informatics Board meeting, which thereupon convened in March, had decided to begin the National CORS Data Center to serve the public, private, and civilian sectors. Eventually, in May, the National Geo-Informatics Board appointed the National Subcommittee on GNSS Network to implement the National GNSS Infrastructure project under the Network of CORS Networks concept (National Geo-Informatics Board, 2017). The project was meant to link with five clusters and the organisations that will be held accountable for them:

1. Surveying and cadastral plan mission: DOL
2. Surveying, topographic mapping, and national defence mission: RTSD
3. Town planning and Urban management mission: DPT
4. Water resource and disaster management mission: HII and Japan
5. Research and innovation management mission: GISTDA and Universities

In addition to those clusters, some tasks were connected to GNSS technology as well, such as logistics, transportation, and communication. The authorities that have overtaken these tasks have not had a CORS asset possessively. They conclusively supplicated a mainstay of state GNSS data or a National CORS Data Center to stream whole-of-government engagement data to governmental and non-governmental users.

Another breakthrough was of considerable significance in this companionship in June. The GNSS CORS acquaintance with abroad had led to perceptible changes. The GISTDA was affirmed to hold the National CORS Data Center handler position, and the HAI would take responsibility for CORS infrastructure. For all that, the HAI had deemed their vulnerability and called for teaming up with the RTSD. The conferences and teleconferences between the two countries in Japan - Thailand High Level Joint Commission (HLJC) discovered a series of weak points. To fill this void, the Ministry of Foreign Affairs (MFA) invited the GISTDA to participate in the meeting about an agreement on academic cooperation in HLJC. The GISTDA was committed to arranging a GNSS CORS coordination proposal (Application Form) under the approval of the National Subcommittee on the GNSS Network. A while later, in August, the GISTDA sent the upshot to the Thailand International Cooperation Agency (TICA) – an agency within the MFA.

As the secretariat of the National Subcommittee on GNSS Network, the GISTDA, in co-operated with the associates, had mapped out a guidance for the National CORS Data Center. By enlightening the domestic CORS network ally, they instructed that state-wide inter-organisational CORS data should be integrated. Also, the National CORS Data Center's product distribution is a long-term assignment highly concentrated by the National Geo-Informatics Board. Next, the GISTDA – the temporary manoeuvre of the National CORS Data Center had sided with other organisations to draft the direction of the National CORS Data Center services in regards to technique, equipment, specialist, authority, and economy. They also framed a roadmap for providing CORS solutions with prioritised features like policies, standards, and applications. One of these features, precision farming, had caused the disputation about a fitting operator of the National CORS Data Center due to the capability of the RTSD in preparing a smart map and their readiness of human resources.

In tandem with the government allyship on the CORS network merging, undertakings were thriving on apprising the awareness and stimulating the exploitation of CORS, including enriching the use of them in general and nurturing the cultivating flow of research and development to make the most of GNSS technology for start-ups and SMEs.

Policy and Business Model

The GISTDA proffered an Application Form proposal to the TICA – an organisation under the supervision of the MFA, in August 2017. The proposal contained five brackets of the GNSS CORS support requirements as follows (National Subcommittee on GNSS Network, 2017b):

1. Technical support
2. The National Service Data Centre establishment
3. The National Mapping Data Centre establishment
4. The GNSS CORS expansion
5. Human Resources Development

This proposal was delineated to appeal for the endorsement by listing involved strands: technologies, devices and relevant utilities, experts and workforces, the central bodies of each section, and economic zones and special districts. The appropriate bodies then clinched the Form and tendered it to the supporter in due course.

The GISTDA, in a transitory national data centre position, had conducted a road map for the CORS services. The road map is composed of four elements; for example,

1. The arrangement in moulding the policy and business plan of the National CORS Data Center on the services – *to issue guidelines for the unanimous approval of the product distribution, service regulations, and data security*

Based on the national-scale assessment, the business plan that will be clarified in the future would follow the Japanese configurations. It would be that the governments would preliminarily function the National CORS Data Center. Subsequently, the private corporation would continue the operation.

2. The arrangement in setting out the service standards – *to serve uniform solutions derived from the Thailand-wide pooled ventures*
3. The arrangement in stirring the users to realise the utilisation and application of CORS data – *to drive forward Thailand's economy, particularly in the private sector, such as Precision Farming*

Objectively, the National CORS Data Center was the notion in relation to positioning and geospatial data management. The RTSD had prompted that precision farming required a smart map which will be finished in 2020. Therefore, the road map will be retaken to the interrogation after completing the smart map.

CORS ecosystem conceptual model was prologued by Supinajaroen and Van Loenen (2019) to persevere the CORS data accession and business model upon dependable policy. The Spatial Data Infrastructure (SDI) framework was used to measure this model. Evaluation of the interdependence between the SDI and the model had deliberately sensed six major elements of the CORS: network and data chain, personnel, policy and procedural framework, components, and infrastructures were of relevance to technology, standards, and monetary resources. The out-turn had apprehended the correspondence between the elements that they were not unlinked. Yet, they had an influence, straight or by implication, on each other. Taking up the SDI framework proved the rationality of the ecosystem model. By the comprehensive assemblage of those elements, the model will be actuated by the System Dynamics approach and ultimately altered into a Decision Support System. The final will pursue and perpetuate the access policy of GNSS CORS performance.

Finance

In furtherance of this cooperative idea, the fiscal grant is the preponderant variable. All the allies are from governmental sections; the proceedings have to rely upon the state capital, either budget or human. Previously, the allotment of monetary resources for the CORS technology had been considered for each government organisation. This ration strategy caused the problems of GNSS reference station duplication investment. Each of the agencies that had installed the systems has not obtained enough quota for their demands. More, they had not pooled their assets, so they could not afford the services of high quality nationwide. Even though the governments are not focusing on income-seeking, they desire the working capital from budget allocation. The business plan is pertaining to a lucrative share offer from that place.

In terms of lucrateness, public infrastructure is not aiming for moneymaking. The productions would not be profitable but manifestly have the ability to place at an

advantage over the country. The opening remarks of the CORS technology were for the following missions:

1. Digital information service on town planning and urban administration: *the DPT (2020)*
2. National land information and mapping and land registry and title deed services: *the DOL (2020)*
3. National surveying and mapping in supporting national security: *the RTSD (2020)*
4. National hydro-informatics and disaster management: *the HII (2020)*
5. Innovation Research and Development: *the GISTDA (2020) and universities*

The most prominent objective of this technology adoption is gainful employment on a sustained basis. In connection with this, its main focus is prescribed for minimising cost in public welfare and fundamental infrastructure investment and maximising positioning facilities amelioration. Nearly all government organisations are not profit-making organisations. Rather than making a point of marketing opportunities, the governments pivoted on diminishing reduplicated disbursement of CORS system investment and elevating the chance to apportion the benefit of GNSS network data to other units throughout Thailand.

The beneficial effect on the economy has been concocted with a multisector brainstorm. The public sector has partnered with enterprises and the private sector to hasten the positioning innovation implementation to make a response to economic objectives. The decisive actions that point to initiative and resoluteness have been made for the substantive cities and economic zones, notably the EEC boundary. The remunerative activities might not be in the positioning-related businesses purely; on the other hand, the market linkages that location services could be helpful to them are also within the bounds of possibility.

With the government itself to be the positioning services provider, the clients could varyingly be government organisations, research communities, industries, or the general public. Anyway, the levels of service access rights would be clustered by the type of users and their applications. These matters have linked up with the solution charge. The public domain customers are accustomed to having free public infrastructure. If the National CORS Data Center would like to provide services on an uncharged basis, they should have exchanged with another abetment. Whereas the surveying and mapping and the businesses in connection with construction engineering are currently based markets, the National Subcommittee on GNSS Network has set out the ambition in marketing the logistics and agriculture like precision farming.

In 2020, the National CORS Data Center, in which the RTSD, as the leader, plays an entirely collaborative part, has not yet been ready to serve the CORS solutions. The

work is hampered by a lack of funds for the control centre facilities. This interruption is ascribed to the situation of the virus pandemic crisis, which is a marked influence on not only government budgeting but also external support from Japan. With remarkable tact and skill, the RTSD is proceeding the RTSD data centre as a transient National CORS Data Center. Even some improvisation has been performed to give the fluidity of the coordinated situation; the RTSD could not use the full potentiality of the whole CORS networks. They can form the national network partially due to the deficiency of their control centre facilities capability. But still, they can supply services from this impermanent national data centre under the collaboration between the RTSD and the DOL in the name of the RTSD control centre. The RTSD data centre business plan was conceived to deliver CORS products in various packages. The free-of-charge services are available permanently for the government and academic sectors and in the short term of the trial period for other sectors. After the test session, the clients can select the preferable bundle that suits their needs. The RTSD intends to achieve new groups of users other than surveying, mapping and construction fields presently are the main clients. They have in view of turning their solutions into a cost-effective advantage to gain income for system maintenance, renewal and extension.

Legal

An affirmative climate of legislation and regulation could uphold such collaborative development. Cross-party efforts on GNSS CORS integration have been scarcely carried on without a founding in the concrete authoritative deliverance of inter-organisation openness. Many of the participants from those organisations involving the CORS cooperation have been concerned about the restrictions in favour of CORS data sharing. Each of the authorities has been under the organisation laws that have stern measures for data protection and the crossover between them. Amendments to their policies and regulations would result in the associateship flowing effortlessly to the next level, and colleagues could become increasingly open-minded. As regards their solicitousness, all the works advocate government motions necessitating the government's written declaration in the form of legal structures or statements. CORS data beneficial apportionment on the present legal status of governmental organisations is upon the MOU between organisations. As a focal point of data and services, the National CORS Data Center has thus been anticipated to substitute the MOU relationship.

In spite of that, at the meetings, the National Subcommittee on GNSS Network had not yet sought to legitimise it. The formation of the National CORS Data Center has not been accomplished; when it does, there would be another step to make legitimate expectations at relevant laws. Therefore, the members of the alliance and the operators of the National CORS Data Center would be assured of avoiding facing potential prosecution as a consequence of these movements.

International Collaboration

The non-linked GNSS reference stations have not expressed the uttermost satisfaction with positioning solutions; the Thai governments have sought a collaborative network. The cooperative endeavours between governments, scholars, and industries in Thailand have been organised promisingly. But anyhow, Thai governments set about international joint ventures in the way forward that technical support, knowledge transfer, and system resourcing can happen with either foreign governments or businesses.

One of the official unitedness on CORS encouragement between Thailand and abroad is the Japan - Thailand High Level Joint Commission (HLJC). According to the Joint Press Statement in the third meeting of the HLJC, the Integrated Data Centre of the GNSS CORS Network in Thailand was propelled to turn geospatial data and satellite positioning technologies into good account (MFA, 2017). Both Japan and Thailand concurred in the collective determination to effectuate the Integrated Data Centre in Thailand in order for the futuristic society evolution. In summation, Japan – by the Ministry of Land, Infrastructure, Transport and Tourism and Thailand – by the Ministry of Science and Technology had signed a Memorandum of Cooperation (MOC) on the Establishment of the Integrated Data Centre in June 2017. The MOC has been effected in three modules: the Integrated Data Centre institutional arrangements, the CORS infrastructure enlargement, and the GNSS Innovation Center (GiNNo) construction.

The cooperation between the two countries has been continued variously. Japan has broadened its connections with multiple Thai government organisations in disparate ways to achieve the concerted attempts to accomplish the favourable conditions of CORS in Thailand. They have negotiated with the HAI in regard to the additional support of CORS infrastructure. Japan offered a new 200 CORS station instalment for satellite positioning and time utilisation to ensure safeguards against disaster and steady water management. In response to this, the HAI coexisted with nine pertinent organisations that had co-opted members for the Working Group on Thailand-Japan coordination on water and disaster manipulation. Parallely, the Thai government believed this could impel the CORS operators forward to capture and make alterations to the GNSS technology interests other than the water and disaster. The Japanese government also had committed to the GISTDA for the inception of the National CORS Data Center and technical training program for the data centre discharge. They would foster the organisation in charge of the National CORS Data Center with erudition and substantial funds for founding the integrated data centre. To a certain degree, the Japanese enterprises and top-tier public and private organisations had enjoined the GISTDA to put up the GiNNo – one of the modules written in the MOC. Latterly, the GISTDA had elaborately scoped five components that drew sustenance from Japan:

1. The specialists – to advise on the Integrated Data Centre movement
2. The specialists, hardware, software, and instrument – to encourage the establishment of the National Service Data Centre

3. The specialists, hardware, software, and instrument – to encourage the establishment of the National Mapping Data Centre
4. The CORS infrastructure – to encourage the establishment of the additional CORS
5. The training programme – to advance human resources development

The GISTDA has not reached an agreement yet; nevertheless, a partial list of the treaty has been ongoing.

Comparatively, Japan had discussed the excessive baseline distance and fixing solution barriers with the DOL several times. But they had not promised the additive CORS equipment. Other than this, they have contacted the RTSD to propose the 200 CORS supplement. Owing to the RTSD's steadfast refusal, they have opted for a request for a workspace at the RTSD. They have shown an intention to help the RTSD out with the National CORS Data Center operation, so they will designate a mentor who is skilful in the GNSS field of activity from Japan to coach the stipulated data centre team. This intent has been accepted cordially; however, the military agency has stringent regulations to permit a foreigner to admit to the military unit. The consideration to select the alternatives to review the protocol or revise this concord has been underway. Besides, Japan has associated with other Thai government organisations in the context of positioning resources benefiting, such as the Department of Fisheries (DOF).

The heart of this problem is that the organisations that do not have CORS, either the public or private sector, cannot reach the services. Due to this, Japan has repeatedly urged to service CORS data to the private sector in order to bolster manufacturers' confidence. It was postulated that Thailand could be the prospect of being the focus of the linkages in this region if they have a data centre to supply solutions for a variety of applications. Taking this point as a priority, Japan has recommended a national data centre to support the utilisation of positioning information in the EEC region. Ideally, the federal data centre should be placed in the EEC zone and should not solely dedicate to GNSS or CORS subjects. It should equivalently appertain to supplemental happenings. But despite that, Thailand has changed the manoeuvrer of the National CORS Data Center. This rotation affected the address of the centre as well. Still, Japan insisted on pressing ahead.

Above and beyond, China has given an undertaking of the GNSS network ranging in Thailand. The GISTDA, as the National CORS Data Center, had made ready a system for tethering data and services. The system had been shouldered by Wuhan University from China and designed to put in place and prepare fundamental instruments and human resources time ahead (National Subcommittee on GNSS Network, 2017a). The Chinese team had also offered to station added GNSS CORS to the DOL. Even so, the interactive agreements between China and Thailand have not been settled. And the assistances have not come into being.

Further communal attempts have been based on technology sharing between IGS – the global GNSS network, and the Thai GNSS permanent stations. The organisations in Thailand that have adjoined their CORS to the IGS network are university and government agencies. Chulalongkorn University is the first Thai organisation to make the GNSS base station in line with IGS requirements. This intercontinental network tie-in has been built for pooling resources for teaching and research on purpose. In comparison, the NIMT’s CORS has been linked with the worldwide GNSS system for time synchronisation and standardisation.

The mutual relationship on GNSS CORS can be distinctly accounted for occurrence between Thailand and abroad. Most of them have been taken on the research community by scholars.

The table below presents the series of actions that the Thai government has carried out, either successfully or underway, in line with the theories based on the literature review.

TABLE A - 12 Achievement in GNSS CORS development in Thailand (Source: Author's own research)

Key term	Key element regarding theory	Thailand
Technology		
CORS Infrastructure	Innovation ecosystems have a strong link with technology platforms and economic or social circumstances (Gobble, 2014).	• System-of-systems (Rizos and Satirapod, 2011) • Real-time service (Charoenkalunyuta <i>et al.</i>, 2012)
Techniques		• TCAR approach (Feng <i>et al.</i>, 2007)
Tools		• Web-based service
Delivery	Information and service delivery mechanisms are necessary to enable spatial data management at the global, national and organisational levels (Van Loenen and Kok, 2004).	• Waiting for the decision on service delivery and internet problem resolution • Data format design for the specific types, such as Thaitext, Gtext
Access	Access to spatial data infrastructures and other information is essential for the government, industry, academic, public, and non-profit sectors (Van Loenen and Kok, 2004).	• Waiting for the decision on access and authorisation • Grant access via the RTSD website for temporary National CORS
Human Resources		
Professional	It is necessary to engage the tasks and practices with competent actors (Diener, 2014).	• Require scholars for technical issues and professionals in particular areas. • The RTSD’s Geodesy and Geophysics Division will be a service support team for the temporary National CORS. • Prof. Chalermchon Satirapod, the CU’s professor, will be the team lead for the technical part.

Key term	Key element regarding theory	Thailand
General Staff	The intermediary typology development in the innovation ecosystem is based on the roles and responsibilities (Diener, 2014).	• The technical support operators for the temporary National CORS Data Center are from RTSD. • Require a proper staff allocation strategy.
Improvement <i>Organisational design</i>	Organisational social capital (OSC) development is an investment to facilitate relationships between organisational members and inter-organisations in terms of motivation and capability enhancement (Chuang <i>et al.</i> , 2013).	• Assign the RTSD as a temporary National CORS. • Require an organisation as a National CORS. • Require an organisation as a secretariat to drive the project. • Require a committee comprising representatives from the relevant organisations.
Training	Human resources management practices take a significant role in facilitating, accumulating, and utilising the OSC to reinforce the organisation's member mutual relationships (Chuang <i>et al.</i> , 2013).	
○ Limitation ○ Plan		• Limited knowledge in this field. • Let the institutes reinforce education and training. • Let the organisations that are the experts in the field be responsible for knowledge transfer to others. • Let the research sector improve knowledge and development.
Finance		
Investment	Economic issues are involved in the enhancement of spatial data infrastructures, so the costs and loss could be problematic (Van Loenen and Kok, 2004).	• DOL was allocated ฿1,168.80M in 2017 for the RTK Network implementation (DOL, 2017a; 2018). • RTSD submitted a proposal for ฿420M in 2014 for the GNSS CORS system (RTSD, 2014). • DDPM supported ฿26.49M in 2014 for HII and NIMT jointly installed GNSS CORS (Dailynews, 2017). • Require Preventive Maintenance (PM) and a Maintenance (MA) plan from the National CORS central unit.
Maintenance and renewal		
Lost		-
Return on Investment (ROI)		• Support government organisations' missions as a priority. • The National CORS Data Center service packages by the RTSD • \$2,200-2,800M per year revenue from registering rights and juristic acts benefited GNSS positioning services (DOL, 2017b)

Key term	Key element regarding theory	Thailand
		• More than ten users from government organisations used the services for free, and thirteen clients from the private sector paid for the RTSD (temporary National CORS) services.
Prospect		• The surveying group will be the main client. • Expect the revenue from taxes that the private sector pays from benefiting the CORS services.
Policy and Business Model		
Policy	Legal and policy issues are part of the Spatial Data Infrastructure settings (Van Loenen and Kok, 2004).	• An Application Form suits the GNSS CORS requirements (National Subcommittee on GNSS Network, 2017) • Require an open long-term management plan and policy covering new technology adoption and CORS establishment by the private sector and foreigners. ▪ The National CORS, supported by the National Subcommittee on the GNSS Network, should be responsible for the policy establishment. ▪ All relevant organisations should take part in policy pursuance.
Business Model	Alternative and innovative business models are chosen to sustain the public sector data providers (Donker and Van Loenen, 2016).	• Consider the Japanese business model as a role model. • Consider a contract-based relationship or service license as a CORS business model between the owners (or the National CORS Data Center) and the service providers and agencies. • Consider the development of add-on solutions and co-create applications in the business model. • RTSD, as a temporary National CORS Data Center, provides service packages for governmental organisations' free access and non-governmental user service prices using the Malaysian CORS business model as a role model. • The National CORS services target users will be the surveying group.
Model and Strategy	The strategic focus areas are inclusive of collaborative work, communication, digital spatial discussion, and the technology ecosystem (ANZLIC, 2016).	• Consider appointing GISTDA or RTSD as a National CORS service provider. • Consider appointing GISTDA and RTSD as the National CORS backup sites.

Key term	Key element regarding theory	Thailand
Plan	Work plans and activities to encourage and deliver spatial data development are within the strategic focus areas (ANZLIC, 2016).	• The revenue from the services will be working capital for the National CORS movements. • The CORS owners stream data for internal use concurrently with streaming for the National CORS. • May follow the Japanese model that separates the overall network control centre from the local offices for site care to prevent overlapping actions. • International collaboration will emphasise the National CORS Data Center management, knowledge transfer, and technology support. • The infrastructure plan will focus on managing existing CORS and maintenance rather than establishing a new network. • Additional CORS investment should be under the consideration of the National CORS or the Board.
Guideline/Standard	National standards are created in harmony with requirements, data aggregations, and policies to reach optimum satisfaction (Van Loenen and Kok, 2004).	• May follow the IGS standards for network installation. • Require Thai standards and guidelines for the National CORS system.
Legal Legislation Relevant Act	The data and movements' legal protection relates to national law, which harmoniously responds to a mandate of the government (Van Loenen and Kok, 2004).	• Require the legislation for inter-organisational data sharing. • MOU between government organisations • The Private Surveyor Act 1992 mandated the control of private surveyors on the cadastral survey (DOL, 2017b), and the Land Code (DOL, 2017a) are the exemplars of the National CORS.

C.3 Cross-Case Analysis

The cross-case analysis in qualitative research is a strategy that uses the primary stand-alone case results from the within-case analysis method to make a comparison. It is a secondary technique that makes one aware of essential components for the entirety. The comparison will be conducted to estimate the similarities or dissimilarities of experiences between partakers to categorise the typical expression of facts (Ayres *et al.*, 2003).

The high-level impact factors have been carefully selected through the literature review and contributed to this research's conceptual framework. These influential components have been applied to evaluate the happenings about GNSS CORS occurring in Thailand against the historical moves in Australia. The analysis has been

done by contrasting those pieces of evidence with the theoretical model. Thus, the research outcomes can be seen below.

The table below shows the collation of Australian and Thai information significant to the research to indicate their relevance to the investigation. The criteria were picked to inspect whether the situations in each country adhere to the goal of this study. First of all, *Technology* was highlighted as it is predominantly a matter of this innovation management study. This research prioritises *GNSS CORS*; as a consequence, the differentiation found that there are some identical movements in Australia and Thailand, such as the initiation of CORS stations in these countries that happened in the same decade. Both countries have the same *Administration tool*, namely a web-based portal; however, Thailand mentioned the use of the LBS tool for site control, too. One of the supreme importance of this contribution is to address the source of the *problem* in these countries. Two common points that rationalised how the situations have gone this far are *Duplication* in the network's investment and the *Lack* of sharing for cross-organisational access. Focusing on the experiences of *Problem-solving*, there are different outcomes in the comparison. Shed light on *Collaboration*; Australia has already done this as a resolution, whereas it is thriving in Thailand with no corroboration of success. In addition to this, Australia adopted multiple structured *Plans* and pertinent frameworks to resolve this issue. Contrastingly, Thailand is underway outlining workable plans and requires several components to support CORS implementation. The utmost importance in contrasting these two countries is their credentials. The *Achievement* of the CORS administration in Australia can count on the *Shared* relationship. Australia established an NPI-AB as a central body for CORS development and built FSDF as a web-based, cloud-based resolving and query tool for sharing data. In Thailand, the Subcommittee on National CORS was assigned to institute the National CORS Data Center for performing the capital of data sharing. Nonetheless, the attempts have not yet been fulfilled. Moreover, Thailand has not approved any *Policy and standard* for the CORS endeavours, while Australia has already enforced its policies and settled relevant standards to maintain the sustainability of the system. By comparing the Benefit term, Australia can generate some revenue and ROI prospects as well as keep moving on a preventable costs model. But, Thailand still expects the CORS services to be profitable and aims to make the CORS network a public service.

As the *Current status* shows the *Latest update* of the CORS actions, the complexities in Australia have been fixed, but they exist in Thailand; this study has been proven to move forward.

TABLE A - 13 Case selection criteria for this study (Source: Author's own research)

Theme	Australia	Thailand
Technology		
GNSS CORS	• Implement and operate GNSS CORS technology. • Initiate the CORS station in the 1990s. • Use international standard equipment grade. • Have countrywide service coverage.	• Implement and operate GNSS CORS technology. • Initiate the CORS station in the 1990s. • Use international standard equipment grade. • Have countrywide service coverage.
Administration tool	• Develop web-based administration tool.	• Develop web-based administration tool. • Use LBS for the field operation and maintenance and the membership approval.
Problem		
Duplication	• CORS networks are Australia-wide owned by multiple state and jurisdictions governments and industries. • The network coverage areas are overlapped or have base stations in the same zone. • Over-investment problem.	• CORS networks are Thailand-wide owned by multiple government agencies and universities. • The network coverage areas are overlapped or have base stations in the same zone. • Duplication in budgeting problem.
Lack of sharing	• Build the CORS system for internal utilisation. • Lack of facilities and solutions sharing for cross-organisational access. • Create cooperation between the owner and the user in a separate agreement, such as research purpose.	• Build the CORS system for internal utilisation. • Lack of facilities and solutions sharing for cross-organisational access. • Create cooperation between the owner and the user in a separate agreement, such as MOU with a government organisation.
Problem-solving		
Collaboration	• Develop collaborative endeavour between Australian state and jurisdictions on positioning technology. • Develop international cooperation on the CORS movement.	• Try to develop collaborative endeavour between Thai government organisations on CORS technology. • Try to develop international cooperation on the CORS movement.

Theme	Australia	Thailand
Plan	• Adopt an NPI Plan framework for national positioning move policy. • Establish standards and guidelines for infrastructure and service delivery and service access mechanisms. • Legislate specific rules and laws about CORS implementation. • Pursue strategic plans for further development on CORS and renewal and maintenance plan. • Construct staff training programme and role design. • Do business plans for yielding financial gain.	• Require a practical policy framework for CORS implementation. • Require a standard and guideline for CORS implementation. • Require laws about CORS implementation. • Require a strategic plan for CORS implementation. • Require human resources management for CORS. • Require a feasible business model.
Achievement		
Shared	• Successful in the adoption of uniform CORS network and service sharing. • Have ANZLIC NPI Policy for the overall direction of GNSS CORS and other positioning services. • Have an NPI-AB as a central body for CORS development. • Have ICSM and working groups for implementing the NPI Plan. • Have FSDF as a web-based, cloud-based resolving and query tool for positioning data. • Have NGRS as a national database for spatial data. • Have CRCSI as a joint working programme for research liaison on the fundamental spatial technologies.	• Institute the National Subcommittee on GNSS Network • Try to assign a Subcommittee on National CORS • Appoint Working Group on National CORS Data Center Planning • Appoint Working Group on National CORS Data Center Management • Appoint Working Group on Thailand-Japan High Level Joint Commission
Policy and standard	• Adopt the NPI Policy for national positioning implementation • Have the standards and guidelines for instrument specification, system installation, access, service delivery, staff competence and other technical and management issues.	• Require a national policy for CORS management. • Require a national standard or guideline for CORS implementation.

Theme	Australia	Thailand
Benefit	• Consider the CORS network as a national positioning infrastructure. • Keep moving on a preventable costs model that underlines the lower expense of the selected alternative more than generating income. • Generate some revenue and ROI prospects. • Provide service for farming, engineering, mining and other industries. • Provision of the CORS services to support LBS technology.	• Aim to make the CORS network a public service. • Supply positioning service for the government and academic sectors. • Expect the CORS services to be profitable.
Current status		
Latest update	• Carry on the developed plan through the supervision of NPI-AB. • The complexities have been fixed.	• Wait for the further activity for moving to the next step. • The difficulties still exist.

Considering the difference in the cooperativeness occurrence in the GNSS CORS technology between Australia and Thailand, both domestic and worldwide related motivations, details are displayed in TABLE A – 14 below. The collaboration on GNSS positioning technology has been established for multi-dimensional purposes. Each joint agreement was set up for the particular common points to attain pooled benefits between participants. Besides, the characteristics of communalism that emerge from the study are divergent in terms of approach, target, and degree.

TABLE A - 14 Case comparison regarding the cooperativeness (Source: Author's own research)

Cooperativeness	Australia	Thailand
Inter-organisational Collaboration	• The Melbourne 2006 Commonwealth Games (Hale <i>et al.</i>, 2006)	• The High Level seminar on creating the National CORS Data Center (National Geo-Informatics Board, 2017)
	• The NCRIS (Hausler and Collier, 2013b; Hale, 2007; AuScope Geospatial Team, 2008)	• The National Subcommittee on GNSS Network (National Geo-Informatics Board, 2017)
	• The AuScope (Hausler and Collier, 2013b; Rizos, 2007b)	• The National CORS Data Center (National Subcommittee on GNSS Network, 2017)
	• The NGRF (Rizos, 2007b)	• A roadmap for policies, standards, and applications (National

Cooperativeness		Australia	Thailand
			Subcommittee on GNSS Network, 2017)
	• The CRC project (Higgins, 2008)		• Research and development for the start-ups and SMEs (National Subcommittee on GNSS Network, 2017)
	• The CRC SI (Higgins, 2008)		
	• The ANZLIC (ANZLIC, 2001)		
	• The NPI (ANZLIC, 2010; Hausler and Collier, 2013b)		
	• The ANZLIC's NPI Policy (ANZLIC, 2010)		
	▪ The ICSM (ANZLIC, 2014a; ICSM, 2018)		
	▪ The ICSM permanent sub-committees (ANZLIC, 2014a)		
	▪ The ICSM working groups (ANZLIC, 2014a)		
	▪ The FSDF (ANZLIC, 2014a)		
	• The SPU (Hausler and Collier, 2013b; Space Policy Unit, 2012)		
	• The NPI Plan (Australian Government, 2013)		
	• The NPI-AB (Geoscience Australia, 2018a)		
	▪ The NPIPE (Geoscience Australia, 2018a)		
	▪ The PNT-WG (Geoscience Australia, 2018a)		
	▪ The TWG (Geoscience Australia, 2018a)		
	▪ The BMSC (Geoscience Australia, 2016b)		
International Collaboration			
Singapore	• Data processing algorithms, data management techniques and communication systems (Rizos, 2002) • SNAPper – a research outcome used in the UNSW CORS system (Heo <i>et al.</i>, 2009)		

Cooperativeness	Australia	Thailand
Japan	• The natural hazard mitigation research (Rizos <i>et al.</i>, 2000)	• The Japan - Thailand High Level Joint Commission (HLJC), (MFA, 2017)
China	• GNSS CORS joint research with China (Rizos <i>et al.</i>, 2000)	• Knowledge, technologies and human resources support (National Subcommittee on GNSS Network, 2017)
Europe, New Zealand, the USA	• GNSS CORS joint research with Europe, New Zealand, and the USA (Rizos <i>et al.</i>, 2000)	
ANZLIC	• Spatial information projects in Australia, New Zealand, and the ASIA-Pacific (ANZLIC, 2018)	
ICG	• An international committee was established for the IGS activities governing (Dow <i>et al.</i>, 2007)	
APREF	• The intercontinental project of geodetic datum over Asia and the Pacific region (Geoscience Australia, 2015c; 2020a)	

The comparison of the CORS running development between Australia and Thailand shown in TABLE A – 15 is explainable in light of the theoretical framework. The key terms captured from the previous stage of the study will be the mainstay of the differentiation.

TABLE A - 15 Case comparison regarding the theoretical framework (Source: Author's own research)

Key term	Australia	Thailand
Technology		
CORS Infrastructure	• Thick infrastructure (Lim and Rizos, 2008b)	• System-of-systems (Rizos and Satirapod, 2011)
	• The NGDB (Johnston and Morgan, 2010)	• Real-time service (Charoenkalunyuta <i>et al.</i>, 2012)
	• The APREF monitoring system (ICSM, 2014)	
	• The NGCI database (Hausler and Collier, 2013b)	
Techniques	• TCAR approach (Feng <i>et al.</i>, 2007)	• TCAR approach (Feng <i>et al.</i>, 2007)
	• Server-based and thin-client platform (Lim and Rizos, 2007; 2008a; 2008b)	
	• SNAPper software (Heo <i>et al.</i>, 2009)	

Key term	Australia	Thailand
	• The FSDF unified spatial data (ANZLIC, 2018)	
Tools	• Web server and web map server (Lim and Rizos, 2007) • The NGRS (Johnston and Morgan, 2010) • The APREF web service (ICSM, 2014) • The NGCI web map (Hausler and Collier, 2013b) • The SKI (Duckham <i>et al.</i>, 2017) • The FSDF services (ANZLIC, 2018) • The LBS Positioning System (Roberts <i>et al.</i>, 2004)	• Web-based service
Delivery	• ANZLIC Metadata Guidelines V.2 (ANZLIC, 2001). • GPSnet (Hale, 2007; Hale <i>et al.</i>, 2008) • System of Systems Reference Station Infrastructure (Rizos, 2008a) • AuScope (AuScope Geospatial Team, 2008) • NGRS (ICSM, 2014; Johnston and Morgan, 2010) • LPI (Janssen <i>et al.</i>, 2010; 2016) • CORSnet-NSW (LPI, 2012) • SydNet (Rizos <i>et al.</i>, 2013) • NPI Plan (Hausler and Collier, 2013a) • CRC (CRCSI, 2013) • NPI-AB (Geoscience Australia, 2015a) • Australian NPI Strategic Planning Framework (Geoscience Australia, 2015) • CRCSI (CRCSI, 2017) • FSDF (FSDF, 2019; Queensland, 2018) • FrontierSI (FrontierSI, 2019) • Commercial and service delivery (Hausler, 2014; Heo <i>et al.</i>, 2009; Rizos, 2007) • Role (Hausler, 2014; Higgins, 2008) • Limitation (Dow <i>et al.</i>, 2002; Hausler, 2014)	• Waiting for the decision on service delivery and internet problem resolution • Data format design for the specific types, such as Thaitext, Gtext

Key term	Australia	Thailand
Access	• ANZLIC (ANZLIC, 2001; 2018)	• Waiting for the decision on access and authorisation
	• SydNET (Rizos <i>et al.</i>, 2005)	• Grant access via the RTSD website for temporary National CORS
	• Client-server-based model (Rizos and Van Cranenbroeck, 2006)	
	• GPSnet (Hale <i>et al.</i>, 2008)	
	• Multi-tier CORS (Rizos, 2008a)	
	• LPI (Janssen <i>et al.</i>, 2010)	
	• NGRS (Johnston and Morgan, 2010)	
	• CORSnet-NSW (Janssen <i>et al.</i>, 2011, DCS Spatial Services, 2020)	
	• NPI Plan (Hausler and Collier, 2013b)	
	• Guideline for CORS SP.1 (ICSM, 2014)	
	• FSDF (Bastrakova <i>et al.</i>, 2019; Box <i>et al.</i>, 2015; Queensland, 2018)	
	• NPI-AB (Higgins, 2015)	
	• NPI Capability (Dawson, 2017)	
	• NPI (Woodgate <i>et al.</i>, 2017)	
	• FrontierSI (FrontierSI, 2019)	
	• Networks access (Blick and Sarib, 2010; Hale, 2006; Hale, 2007; Hausler, 2014; Hausler and Collier, 2013a; Higgins, 2009; Lim <i>et al.</i>, 2008; Rizos, 2007; Roberts, 2009; Roberts <i>et al.</i>, 2004)	
	• Role (Higgins, 2008; Rizos, 2010)	
Human Resources		
Professional	• ANZLIC - specialists (ANZLIC, 2014a; ICSM, 2018)	• Require scholars for technical issues and professionals in particular areas.
	• ICSM - secretariat and project assistant (ICSM, 2018)	• The RTSD's Geodesy and Geophysics Division will be a service support team for the temporary National CORS.
	• NPI-AB - Chair and Secretariat (Geoscience Australia, 2018a)	• Prof. Chalermchon Satirapod, the CU's professor, will be the team lead for the technical part.
	• GPSnet - researchers and supervisors (Hale, 2007)	
	• CORSnet-NSW - technical and customer support teams (Janssen <i>et al.</i>, 2011)	

Key term	Australia	Thailand
General Staff	• AuScope (AuScope geospatial Team, 2008)	• The technical support operators for the temporary National CORS Data Center are from RTSD.
	• GPSNet (Hale <i>et al.</i>, 2008)	• Require a proper staff allocation strategy.
	• CORSnet-NSW (Janssen <i>et al.</i>, 2011)	
	• NPI Plan (Hausler and Collier, 2013b)	
	• FrontierSI (FrontierSI, 2019)	
	• Support staff (Hale, 2006)	
	• Field staff (Higgins, 2008; Janssen <i>et al.</i>, 2013)	
	• Customer service staff (Janssen <i>et al.</i>, 2011)	
Improvement Organisational design	• Role (FrontierSI, 2019; Hale <i>et al.</i>, 2008)	
	• Benefits (Allen Consulting, 2008; CRCSI, 2014)	
	• FSDF (ANZLIC, 2019; Geoscience Australia, 2016c)	• Assign the RTSD as a temporary National CORS
	• ICSM (ANZLIC, 2014a; ICSM, 2018)	• Require an organisation as a National CORS.
	• NPI-AB (Geoscience Australia, 2016b; 2018a)	• Require an organisation as a secretariat to drive the project.
	• NCRIS (AuScope geospatial Team, 2008)	• Require a committee comprising the representatives from the relevant organisations.
	• AuScope (AuScope, 2007 in Higgins, 2008)	
	• CRCSI (Hale, 2007)	
Training	• Organisational roles model (Higgins, 2008)	
	○ Limitation	• Limited knowledge in this field.
	○ Plan	
	• Australian Government space capabilities training (Australian Government, 2013)	• Let the institutes reinforce the education and training.
	• GPSnet Team and user training (Hale, 2007)	• Let the organisations that are experts in the field be responsible for knowledge transfer to others.
	• CRCSI IP's Essential Participant training (CRCSI, 2013).	• Let the research sector improves knowledge and development.

Key term	Australia	Thailand
	• CRCSI's National Spatial Education Leadership Group training (CRCSI, 2013). • CRCSI local staff training (CRCSI, 2013) • FrontierSI professional development training (FrontierSI, 2019) • NPI Plan training (Hausler, 2014) • Technical training for a farming system (Allen Consulting, 2008) • Service support training (Cranenbroek <i>et al.</i>, 2006)	
Finance		
Investment	• \$70M for thousands of CORS sites across Australia (AuScope geospatial Team, 2008) • LPI funded AUD7.25M in the Survey Infrastructure Improvement Program (Janssen <i>et al.</i>, 2011) • LPI funded AUD1M in software (Janssen <i>et al.</i>, 2011) • CRC had set up a fund for investment and research (CRCSI, 2020). ▪ \$78M and \$13.3M in 2003 ▪ \$15M and \$2.7M in 2009 ▪ \$160M and \$32.2M in 2010 • AuScope project was funded for \$15.4M, \$4.5M, and \$23M for 123 CORS stations (AuScope Geospatial Team, 2008) • GPSnet has \$650,000 yearly operational costs and \$13.25M 5 years fixed investment (Hausler, 2014) • New Zealand and the Australian Government jointly funded \$14M on the positioning capability improvement (Geoscience Australia, 2017)	• DOL was allocated ฿1,168.80M in 2017 for the RTK Network implementation (DOL, 2017a; 2018). • RTSD submitted a proposal for ฿420M in 2014 for the GNSS CORS system (RTSD, 2014). • DDPM supported ฿26.49M in 2014 for HII and NIMT jointly installed GNSS CORS (Dailynews, 2017).
Maintenance and renewal	• \$120M replacement cost by City of Greater Dandenong Council (Allen Consulting, 2008)	• Require Preventive Maintenance (PM) and a Maintenance (MA) plan from the National CORS central unit.

Key term	Australia	Thailand
Lost	• \$13.5M on capital and operation (Hausler and Collier, 2013a) • \$8.4M of over-investment in AuScope and ARGN sites (Hausler and Collier, 2013a)	-
Return on Investment (ROI)	• Preventable costs strategy (Rizos, 2007a) • \$435M to \$870M per year operating cost savings and \$2.3B per year capital cost savings in using asset mapping (Allen Consulting, 2008) • \$120M per year Queensland's economic growth (Higgins, 2007; 2008) • \$152M – \$206M in 2008 for the agricultural sector (Roberts, 2009) • CORSnet-NSW service package (Janssen <i>et al.</i>, 2010; 2011b)	• Support government organisation missions as a priority • The National CORS Data Center service packages by the RTSD • \$2,200M – \$2,800M per year revenue from registering rights and juristic acts benefited GNSS positioning services (DOL, 2017b) • More than 10 users from government organisations used the services for free, and 13 clients from the private sector paid for the RTSD (temporary National CORS) services.
Prospect	• \$800M to \$1.5B per year in the sector of construction, farming, and mining (Allen Consulting, 2008) • AUD\$73B to AUD\$134B within 2030 (ASC, 2012) • \$32B and \$58B in the economic sectors of agriculture, mining, and civil (Allen Consulting, 2008) • \$1,005M – \$1,357M in 2030 for the agricultural industry (Roberts, 2009)	• The surveying group will be the main clients. • Expect the revenue from the taxes that the private sector pays from benefiting the CORS services.
Policy and Business Model		
Policy	• The Queensland Geospatial Reference Framework Policy (QNRW, 2007 in Higgins, 2008) • The National Positioning Infrastructure (NPI) Policy (ANZLIC, 2010)	• An Application Form suits the GNSS CORS requirements (National Subcommittee on GNSS Network, 2017) • Require an open long-term management plan and policy covering new technology adoption and CORS establishment by the private sector and foreigners.

Key term	Australia	Thailand
	▪ The NPI Plan	▪ The National CORS, supported by the National Subcommittee on the GNSS Network, should be responsible for policy establishment.
	▪ The Intergovernmental Committee on Surveying and Mapping (ICSM) as a Standing Committee	▪ All relevant organisations should take part in policy pursuance.
	▪ The ICSM GNSS CORS Coordination Group	
	▪ The National Positioning Infrastructure Advisory Board (NPI-AB)	
	▪ The Technical Working Groups (TWG)	
	▪ The Positioning, Timing & Navigation Working Group (PNT-WG)	
	▪ The SBAS Interoperability Working Group (IWG)	
Business Model	• GNSS CORS Network Management Model (Hale <i>et al.</i>, 2006)	• Consider the Japanese business model as a role model.
	▪ The data service provider (DSP)	• Consider contract-based relationship or service license as a CORS business model between the owners or National CORS Data Center and the service providers and agencies.
	▪ The value-added reseller (VAR)	• Consider the development of add-on solutions and co-create applications in the business model.
	• The service provider (SP) licensing strategy (Lim and Rizos, 2007)	• RTSD, as a temporary National CORS Data Center, provides service packages for governmental organisations' free access and non-governmental users' service prices using the Malaysian CORS business model as a role model.
	• The CORS infrastructure and service models for commercialising GPS-RTK (Rizos, 2007a)	• The National CORS services target users will be the surveying group.
	• The client-server based model (Rizos and Cranenbroeck, 2006)	

Key term	Australia	Thailand
	• The AuScope project (AuScope, 2007 in Higgins, 2008) • The data service provider (DSP) (Hausler and Collier, 2013a) <i>Current:</i> 8.4% service coverage by independent DSPs <i>Expect:</i> - 11.5% service coverage by independent DSPs when the fundamental geodetic infrastructure is fixed - 14.8% service coverage by joint working DSPs	
Model and Strategy	• The initial Multi-Tier hierarchical system (Rizos, 2007b) • Legal traceability process • The GNSS service broker ▪ The System of Systems Reference Station Infrastructure framework – three tiers (Rizos, 2008a; 2008b) ▪ The Organisational Roles in Precise Positioning partnership model (Higgins, 2008) • The server-based and thin client RTK services framework for Sydney Network (SydNET) (Lim and Rizos, 2007; 2008a) • The National Positioning Infrastructure (NPI) Policy (ANZLIC, 2010) • The TWG – NPI Business Model Subcommittee (BMSC) • The National Positioning Infrastructure (NPI) Capability	• Consider appointing GISTDA or RTSD as a National CORS service provider. • Consider appointing GISTDA and RTSD as the National CORS backup sites. • The revenue from the services will be working capital for the National CORS movements.
Plan	• The ANZLIC Strategic Plan (ANZLIC, 2001; 2014; 2016; 2018; 2020) • The Australian Strategic Plan for GNSS (ASC, 2012)	• The CORS owners stream data for internal use concurrently with streaming for the National CORS. • May follow the Japanese model that separates the overall network control centre from the local offices for site care to prevent overlapping actions.

Key term	Australia	Thailand
	• The CRCSI Strategic Plan (CRCSI, 2012; 2013; 2014)	• International collaboration will emphasise the National CORS Data Center management, knowledge transfer, and technology support.
	• The NPI Plan (Choy <i>et al.</i>, 2017; Dawson <i>et al.</i>, 2014; Hausler and Collier, 2013a; 2013b; Hausler, 2014; Higgins, 2015; Janssen <i>et al.</i>, 2016; LPI, 2012; Geoscience Australia, 2015; 2018a)	• The infrastructure plan will focus on managing existing CORS and maintenance rather than establishing a new network.
	• The ICSM Strategic Plan (ICSM, 2018; 2019)	• Additional CORS investment should be under the consideration of the National CORS or the Board.
Guideline/ Standard	• The Land and Property Information (LPI) Division guidelines for CORSnet-NSW (LPI, 2012)	• May follow the IGS standards for network installation.
	• The CORS unified model (Higgins, 2008)	• Require Thai standards and guidelines for the National CORS system.
Legal Legislation	• The state and territory government CORS (Higgins, 2008)	• Require the legislation for inter-organisational data sharing.
Relevant Act	• The Queensland State Control Survey (Higgins, 2008)	• MOU between government organisations
	• Australian Competition and Consumer Act 2010 (Hausler, 2014)	• Private Surveyor Act 1992 mandated the control of private surveyors on the cadastral survey (DOL, 2017b), and the Land Code (DOL, 2017a) are the exemplars of the National CORS.
	• Broadcasting Services Act 1992 (Hausler, 2014)	
	• National Electricity (South Australia) Act 1996 (Hausler, 2014)	
	• National Electricity (Victoria) Act 2005 (Hausler, 2014)	
	• National Measurement Act 1960 (Hausler, 2014)	
	• National Measurement Regulations 1999 (Hausler, 2014)	
	• Telecommunications Act 1997 (Hausler, 2014)	

TABLE A - 16 A comparison of GNSS CORS management between Australia and Thailand
(Source: Author's own research)

Key term	Australia	Thailand
Technology		
• Space Technology	• None	• None
• CORS Technology	• Same technology (Various manufacturers)	• Same technology (Various manufacturers)
• Facility	• Not a problem: internet (regular landline(fibre-optic)/mobile network) (Rizos <i>et al.</i> , 2004)	• Internet problem, air conditioner problem, site problem (official place only)
• Data Format	• Defined (several formats)	• Using RTSD's chosen formats (several formats)
Finance		
• GDP (UN, 2018)	• 1,453.87 Bn USD	• 504.99 Bn USD
• Population (2018)	• 24.9 M	• 69.4 M
• Budget	• Adequate budget • Have a budget throughout the project • Budgets are from a variety of sources and for various activities, e.g. CORS installation, data precision, observation techniques, applications development.	• Limited budget • Have a budget for some activities, e.g. CORS installation
Model		
• Commercial Business Models	• Australian model - Data licensing - Value-Added Resellers (VARs) occasionally own and operate their own positioning services and act as data brokers for DSPs - Digital Service Providers (DSPs) receive a Return on Investment (RoI) from selling data directly or through an affiliated VAR (Hausler and Collier, 2013b)	• Japanese model + Australian model - Not yet planned - Some ideas for Data licensing - Some ideas for imitation copy the Japanese business model (1 RINEX provider + 3 RTK providers) - Some ideas for imitation copy the Australian business model
• Infrastructure	• Tiered infrastructure (Rizos, 2008a) - Tier 1 High stability monuments to support geoscientific research and global reference frame - Tier 2 High stability monuments, usually established by national geodetic agencies for the purpose of defining and maintaining the NGRS	• No infrastructure categorised

Key term	Australia	Thailand
	- Tier 3 Stable monuments established by Federal, State and Territory governments and/or commercial organisations for the purpose of densification of the national CORS network, often supporting real-time positioning applications	
• Policy	• The NPI Policy (ANZLIC, 2010) 1. Purpose – Fitness-for-Purpose, Flexibility and Extensibility 2. Interoperability – Compatibility and Integrability 3. Performance – Availability, Accuracy, Reliability and Integrity 4. Governance – Transparency, Quality Assurance, Access and Entitlements 5. Privacy – Respecting the privacy rights of NPI users	• No policy was adopted • Some ideas of legislation either - Act of Parliament/ Royal Decree - Service Systems Act/ Data Centre Act • Some ideas for the national plan - A 20–year strategy/20–year development plan - A master plan • Some ideas for the policies - Hardware/ MA/ Coordinates - Data streaming/ Central unit/ Services/ Service charge/ Return/ Giving in return to the owner of CORS
• Interface	• The National GNSS CORS Infrastructure (NGCI) web map	• No interface for the National Data Center
• Data management	• Managed by each jurisdiction	• Managed centrally by each department
Strategy • Key	• The development of a national positioning infrastructure (NPI) (Woodgate <i>et al.</i>, 2017)	• The development of the National Subcommittee on GNSS Network (National Geoinformatics Board, 2017)
• Others	• Collaboration between universities, private industry, and government agencies (Woodgate <i>et al.</i>, 2017), (Geoscience Australia, 2018a)	• Collaboration between universities and government agencies
Vision	• Position and timing information The NPI's vision is "instantaneous, reliable and fit-for-purpose access to position and timing information any-time and anywhere across the Australian landscape and its maritime jurisdictions" (Woodgate <i>et al.</i>, 2017), (Geoscience Australia 2018a)	• Positioning information

Key term	Australia	Thailand
Development Period	• Over three decades - The first CORS was installed in 1992 - The first discussion on duplicated and non-homogenous CORS network development in Australia issue was revealed in 2005 (Hale <i>et al.</i>, 2005) - ANZLIC's NPI Policy was developed in late 2010 (ANZLIC, 2010)	• Over three decades - The first CORS was installed in 1996 - Identified the CORS problem in Thailand in 2011 (Rizos and Satirapod, 2011) - Appointed the National GNSS Infrastructure project in 2017 (National GeoInformatics Board, 2017)
Implementation	• Complete implementation according to the plan	• Partially implemented • Waiting for further update
Economic Impact	• Greatest - Surveying and construction, agricultural and mining sectors important - The transport sectors, through improved fleet management and safety of navigation (Woodgate <i>et al.</i>, 2017)	• Greatest - Surveying
Future Target	• Supply chains	• Other businesses
Future Plan	• Collaborative and coordinated development of the fundamental components of spatial infrastructure in positioning, spatial data infrastructure (SDI), and spatial data analytics (positioning, EO and SDI) • Coordinate across the government, private, research and academic sectors • Multiple positioning capabilities, including GNSS, SBAS, and augmented terrestrial systems such as Locata, beacons, Wi-Fi, cell ID and others, will be fully integrated and opaque to the general user across both outdoors and indoors (Woodgate <i>et al.</i>, 2017)	• Have a Budget for the National CORS Data Center • Form a network of more base stations from every organisation
Barriers		
• Topography	• Predominately flat, desert, coast • Large land area – sparse network (Hale, 2007)	• Predominately mountain, flat, coast
• Geography	• Big Island	• Land surrounded by countries and seas

Key term	Australia	Thailand
• Data at the border	• Have data across the border	• No data at the border
• Climate	• Mostly tropical dry, generally warm and cool • Not a problem	• Mostly tropical wet and dry, generally very hot • Hot weather (require air conditioner)
• Communications infrastructure viability	• User side • Urban/suburban areas with high population density (Southeast Queensland) (Feng <i>et al.</i> , 2007; Hale, 2007)	• Operator side • Mountainous area (Western region)
Points of view		
• Theory	• Collaborative Innovation	• Collaborative Innovation • Stakeholder
• Factors	• Collaboration across - States - Countries	• Collaboration across - Government agencies • Issues - Politics – Military government - Power Asymmetry – Number of CORS

TABLE A - 17 A comparison of GNSS CORS development between Australia and Thailand
(Source: Author's own research)

Key term	Australia	Thailand
Technology CORS Infrastructure	• Thick infrastructure (Lim and Rizos, 2008b) • The NGDB (Johnston and Morgan, 2010) • The APREF monitoring system (ICSM, 2014) • The NGCI database (Hausler and Collier, 2013b)	• System-of-systems (Rizos and Satirapod, 2011) • Real-time service (Charoenkalunyuta <i>et al.</i>, 2012)
Techniques	• TCAR approach (Feng <i>et al.</i>, 2007) • Server-based and thin-client platform (Lim and Rizos, 2007; 2008a; 2008b) • SNAPper software (Heo <i>et al.</i>, 2009) • The FSDF unified spatial data (ANZLIC, 2018)	• TCAR approach (Feng <i>et al.</i>, 2007)
Tools	• Web server and web map server (Lim and Rizos, 2007)	• Web-based service

Key term	Australia	Thailand
	• The NGRS (Johnston and Morgan, 2010) • The APREF web service (ICSM, 2014) • The NGCI web map (Hausler and Collier, 2013b) • The SKI (Duckham <i>et al.</i>, 2017) • The FSDF services (ANZLIC, 2018) • The LBS Positioning System (Roberts <i>et al.</i>, 2004)	
Collaboration	• The Melbourne 2006 Commonwealth Games (Hale <i>et al.</i>, 2006)	• The High Level seminar on creating the National CORS Data Center (National Geo-Informatics Board, 2017)
	• The NCRIS (Hausler and Collier, 2013b; Hale, 2007)	• The National Subcommittee on GNSS Network (National Geo-Informatics Board, 2017)
	• The NGRF (Rizos, 2007b)	• The National CORS Data Center (National Subcommittee on GNSS Network, 2017)
	• The CRCSI (Higgins, 2008)	• A roadmap for policies, standards, and applications (National Subcommittee on GNSS Network, 2017)
	• The SPU (Space Policy Unit, 2012)	• Research and development for the start-ups and SMEs (National Subcommittee on GNSS Network, 2017)
	• The ANZLIC (ANZLIC, 2001) ▪ The ICSM (ANZLIC, 2014a) ▪ The ICSM working groups (ANZLIC, 2014a)	
	• The NPI (ANZLIC, 2010) ▪ The NPI Plan (Australian Government, 2013) ▪ The NPI-AB (Geoscience Australia, 2018a) ▪ The NPIPE (Geoscience Australia, 2018a) ▪ The PNT-WG (Geoscience Australia, 2018a) ▪ The TWG (Geoscience Australia, 2018a)	
Policy and business model		

Key term	Australia	Thailand
Policy	• The Queensland Geospatial Reference Framework Policy (QNRW, 2007 in Higgins, 2008)	• An Application Form suits the GNSS CORS requirements (National Subcommittee on GNSS Network, 2017)
	• The National Positioning Infrastructure (NPI) Policy (ANZLIC, 2010) ▪ The NPI Plan ▪ The Intergovernmental Committee on Surveying and Mapping (ICSM) as a Standing Committee ▪ The ICSM GNSS CORS Coordination Group ▪ The National Positioning Infrastructure Advisory Board (NPI-AB) ▪ The Technical Working Groups (TWG) ▪ The Positioning, Timing & Navigation Working Group (PNT-WG) ▪ The SBAS Interoperability Working Group (IWG)	
Model and strategy	• GNSS CORS Network Management Model (Hale <i>et al.</i>, 2006) ▪ The data service provider (DSP) ▪ The value-added reseller (VAR) • The client-server based model (Rizos and Cranenbroeck, 2006) • The AuScope project (AuScope, 2007 in Higgins, 2008) • The service provider (SP) licensing strategy (Lim and Rizos, 2007) • The CORS infrastructure and service models (Rizos, 2007a) • The initial Multi-Tier hierarchical system (Rizos, 2007b) ▪ Legal traceability process ▪ The GNSS service broker • The System of Systems Reference Station Infrastructure framework – three tiers (Rizos, 2008a; 2008b)	• Japanese business model

Key term	Australia	Thailand
	• The Organisational Roles in Precise Positioning partnership model (Higgins, 2008) • The server-based and thin client RTK services framework for Sydney Network (SydNET) (Lim and Rizos, 2007; 2008a) • The National Positioning Infrastructure (NPI) Policy (ANZLIC, 2010) ▪ The TWG – NPI Business Model Subcommittee (BMSC) ▪ The National Positioning Infrastructure (NPI) Capability	
Guideline	• The Land and Property Information (LPI) Division guidelines for CORSnet-NSW (LPI, 2012)	
Finance Return on Investment (ROI)	• Preventable costs strategy (Rizos, 2007a) • Queensland's economic growth (Higgins, 2007; 2008) • CORSnet-NSW service package (Janssen <i>et al.</i>, 2010; 2011b)	• Support government organisation missions as a priority • The National CORS Data Center service packages by the RTSD
Prospect	• \$800M to \$1.5B per year in the sector of construction, farming, and mining (Allen Consulting, 2008) • AUD\$73B to AUD\$134B within 2030 (ASC, 2012) • \$32B and \$58B in the economic sectors of agriculture, mining, and civil (Allen Consulting, 2008)	
Legal Legislation for	• The state and territory government CORS (Higgins, 2008) • The CORS unified model (Higgins, 2008)	• Require the legislation for inter-organisational data sharing
Relevant Act	• The Queensland State Control Survey (Higgins, 2008) • Australian Competition and Consumer Act 2010 (Hausler, 2014) • Broadcasting Services Act 1992 (Hausler, 2014)	• MOU between government organisations

Key term	Australia	Thailand
	• National Electricity (South Australia) Act 1996 (Hausler, 2014) • National Electricity (Victoria) Act 2005 (Hausler, 2014) • National Measurement Act 1960 (Hausler, 2014) • National Measurement Regulations 1999 (Hausler, 2014) • Telecommunications Act 1997 (Hausler, 2014)	
International collaboration Singapore	• Data processing algorithms, data management techniques and communication systems (Rizos, 2002) • SNAPper – a research outcome used in the UNSW CORS system (Heo <i>et al.</i>, 2009)	
Japan	• Natural hazard mitigation (Rizos <i>et al.</i>, 2000)	• The Japan - Thailand High Level Joint Commission (HLJC), (MFA, 2017)
China	• GNSS CORS joint research (Rizos <i>et al.</i>, 2000)	• Knowledge, technologies and human resources support (National Subcommittee on GNSS Network, 2017)
Europe, New Zealand, the USA	• GNSS CORS joint research (Rizos <i>et al.</i>, 2000)	
ANZLIC	• Spatial information projects in Australia, New Zealand, and the ASIA-Pacific (ANZLIC, 2018)	
ICG	• For the IGS activities governing (Dow <i>et al.</i>, 2007)	
APREF	• The intercontinental project of geodetic datum over Asia and the Pacific region (Geoscience Australia, 2015c; 2020a)	

TABLE A - 18 A summary of GNSS CORS management timeline in Australia (Source: Author's own research)

Year	Events	Key
1978	Navstar 1 (GPS) was launched	DoD, USA
1979		
1980		
1981		
1982		
1983		
1984		
1985		
1986		
1987		
1988	ICSM	Australia and New Zealand
1989		
1990		
1991		
1992	First CORS	LPI, NSW
1993		
1994	Begin CORS network // First CORS network	US Government// Victoria
1995		
1996		
1997		
1998	Discussion on Real-Time Service (RTS)	Hausler and Collier
1999		
2000	Network-RTK over single-base RTK	Chris Rizos
2001		
2002	Prototype of Real-Time Service (RTS) // ICSM	Hausler and Collier// ICSM
2003		University of New South Wales
2004	Network RTK // Invested infrastructure by NCRIS	IAG// Australian Gov
2005	TCAR approaches // CORS networks // Management	IAG// NSW U.// Hale
2006	CORS application // Management // AuScope project	AMSA// Victoria State// Aus Go
2007	QNRW // CRCSI project 1.04 // Technical issues	NRW// CRCSI// Feng, Rizos, Higgins
2008	Australian CORS infrastructure model // Web map	Rizos// ICSM// CRCSI// GA
2009		
2010	SPU // SP1 // Tech & organisational draft// NPI Policy	GA// ICSM// ICSM PCG// NCRIS
2011		
2012	Development of the NPI Plan	Australian Government
2013	NPI Plan // CRCSI program // Launch RTS	Senator Kate Lundy// NPI
2014	PhD Thesis NPI Technical, Institutional and Economic	NPI Coordinator, GA
2015		
2016		
2017		
2018	NPI-AB	NPI
2019	Update: Queensland Geospatial Reference Frame	Queensland

Economics of network-RTK
(government and private)

AuScope (NCRIS)
CORS network Australia
(NCRIS& AuScope)

TABLE A - 19 GNSS CORS management timeline in Australia (Source: Author's own research)

Year	Content	Key Person
1978	The first satellite in the system, Navstar 1, was launched	The Department of Defense (DoD), USA
1988	The Intergovernmental Committee on Surveying and Mapping (ICSM) was established by the Prime Minister, State Premiers, and the Chief Minister of the Northern Territory (ICSM, 2020)	Key government, academic, and private organisations from within Australia and New Zealand
1992	LPI's first CORS was installed in 1992 in Bathurst (Kinlyside and Yan, 2005) in (Janssen <i>et al.</i> , 2011)	Land and Property Information (LPI), a division of the New South Wales (NSW) Department of Finance and Services.
1992	The Australian Fiducial Network (AFN) consists of eight permanent, continuously operating, Geodetic GPS receivers on the Australian mainland and Tasmania. July-August, 1992. The AFN, in conjunction with additional sites beyond the Australian mainland, forms the Australian Regional GPS Network (ARGN)	The Australian Fiducial Network (AFN), Geoscience Australia
1994	The CORS network began with NGS' early 1994 installation of a permanent GPS station on the Gaithersburg (National Institute of Standards and Technology) (Stone, 2006), (NOAA website)	The United States Government
1994	Victoria was the first state to establish a CORS network (Roberts, 2009)	Land and Property Information (LPI), a division of the NSW Department of Finance and Services.
1998	Discussion on Real-Time Service (RTS) (Hausler and Collier, 2013a)	
the late 1990s-early 2000s	Many governments and private network operators became interested in the economics of network-RTK (Rizos, 2007)	government and private
2000	Identified some advantages of network-RTK over single-base RTK (Rizos <i>et al.</i> , 2000)	Chris Rizos
2000	Japan's nationwide GEONET network is the world's largest, numbering nearly 1,000 receiver stations (Rizos <i>et al.</i> , 2007)	
2002	Prototype of Real-Time Service (RTS) followed in 1998 (Hausler and Collier, 2013a)	
2002	ICSM became a Standing Committee of ANZLIC – the Australian and New Zealand Spatial Information Council (ICSM, 2020)	
2003	The development of network-based techniques that enabled cm-accuracy positioning with less dense reference receiver spacing (Rizos and Han, 2003)	University of New South Wales
2004	Introduction to Network RTK (Wanninger, 11 June 2004)	IAG Working Group
2004	There was an investment of nearly \$3.3B to deliver a world-class research infrastructure. Projects funded by the National Collaborative Research Infrastructure Strategy (NCRIS). (education.gov.au, 29 July 2019)	Australian Government

Year	Content	Key Person
2005	Proposed a geometry-free, distance-independent TCAR approach (Feng and Rizos, 2005)	The International Association of Geodesy (IAG)
2005	CORS networks, the result is a technically mature spatial infrastructure. CORS network management is also needed before GNSS and CORS networks are widely adopted. (Rizos <i>et al.</i> , 2005)	The University of New South Wales
2005	Cranenbroek <i>et al.</i> (2005 – published 2006) observe, ‘The majority of permanent GPS networks have been and will continue to be, for some time to come, initiatives primarily from government agencies. It currently lacks high quality, high accuracy ($\pm 2\text{cm}$ horizontal), CORS network correction services in Australia. The coverage that does exist is mainly focused on major population centres. Most GPS RTK network operators hesitate to charge for CORS services primarily because they cannot provide continuous and reliable services.	Networked Reference Stations and Structural Monitoring, Leica Geosystems
2005	Duplicated and non-homogenous CORS network development in Australia has compounded these concerns and led to over capitalisation in infrastructure and poor or inappropriate spatial outcomes for users. A suitable model for state-sponsored CORS network management is currently lacking for Australia. (Hale <i>et al.</i> , 2005 in Hale, 2006)	M. J. Hale Cooperative Research Centre for Spatial Information
2006	Australian tectonic plate movement World Geodetic System 1984 (WGS84) and Geocentric Datum of Australia 1994 (GDA94) are separated	The Australian Government’s Australian Maritime Services Authority (AMSA)
2006	Lack of access to NRTK services and CORS network coverage is Australia wide (D Yules 2006, pers. comm., 28 April in Hale, 2006).	M. J. Hale Cooperative Research Centre for Spatial Information
2006	The application of GNSS/CORS - in counter-terrorism activities: Melbourne 2006 Commonwealth Games - Victoria Police mapped and recorded an underwater dataset of Melbourne (Land Victoria 2005; Victoria Spatial Council 2006 in Hale, 2006)	Victoria State
2006	Management of Australian State and Territory Government CORS networks (Hale, 2006)	Cooperative Research Centre for Spatial Information (University of Melbourne) and Department of Sustainability and Environment
2006	Fund for the AuScope project in December 2006 under the National Collaborative Research Infrastructure Strategy (NCRIS)	Australian Government
2007	Released a new Queensland Geospatial Reference Framework Policy (QNRW, 2007) The role of the Department of Natural Resources and Water is under the Surveying and Mapping Infrastructure Act	The Department of Natural Resources and Water (NRW)

Year	Content	Key Person
2007 July 1	Commenced project 1.04 to investigate the issues associated with extending GNSS precise positioning services into regional areas (Higgins, 2008) The CRCSI project brings together many of the existing government precise positioning service providers, along with key private sector organisations involved in either specific application areas or in supplying key technologies and solutions.	The Cooperative Research Centre for Spatial Information (CRCSI)
2007 September 25 - 28	Investigated technical issues (Feng <i>et al.</i> , 2007)	Yanming Feng, Chris Rizos, Matt Higgins
2007	For real-time precise positioning, the trend is also to move away from sending the corrections to users via ad-hoc radio communications as is routinely done in surveying, precision agriculture, and construction and mining (Higgins, 2007) Detail the business issues. GNSS is used to accurately guide heavy machinery. The Australian market for precise positioning is more than \$120 million per year. Cropping farms have purchased their own GNSS reference stations at approximately A\$20M. (The Queensland Government report in Higgins, 2007)	M. B. Higgins Principal Survey Advisor Department of Natural Resources and Water and Cooperative Research Centre for Spatial Information
2007 December 4-6	A new framework for server-based thin-client RTK services is proposed where distributed computing is essential. (Lim and Rizos, 2007) Provide end-users with “out-of-the-box” services, i.e. end-users obtain extensive GNSS capabilities and high productivity by overcoming the conventional constraints of - an expensive set of GNSS receivers, - proprietary data formats, - user-installed carrier phase processing software, - incomplete interoperability, - limited communication links, - and so on Discuss the design and management of next-generation CORS infrastructure	School of Surveying and Spatial Information Systems/USNW/Australia
2007 December 4-6	Identified the models for the establishment of CORS networks and services (Rizos, 2007) • Institutional CORS infrastructure, no commercial services. • Government CORS infrastructure, operates commercial services. • Government CORS infrastructure, licenses data to the private sector. • Cooperative privately-owned CORS infrastructure, operating commercial services. • Privately-owned CORS infrastructure, operating commercial services Consider the hierarchy of permanent GPS reference stations: (1) Tier 1 being the IGS stations,	Chris Rizos

Year	Content	Key Person
	(2) Tier 2 the primary national geodetic network (e.g. the Australian Regional GPS Network - ARGN), and (3) Tier 3 the state and private GPS networks “The most serious implication was that it was difficult for any agency or private organisation to justify the establishment of a network of GPS reference stations with inter-receiver spacing of the order of 20km covering an entire region, state or even nation.”	
2007 - 2012	The establishment of a national earth science infrastructure program for a sparse GPS/GNSS CORS network across Australia (AuScope, 2007)	The National Collaborative Research Infrastructure Scheme (NCRIS) through AuScope
2008	Discuss further the Australian CORS infrastructure model (Higgins, 2008) Make further contributions to the topic of the design and management of next-generation CORS infrastructure Current GNSS reference station networks in Australia Real-Time Precise Positioning Network in Australia - Government-owned: Victoria, Queensland, New South Wales and the Northern Territory - Private: Western Australia Apply the model to a unified GNSS network for Australia	M. B. Higgins Principal Survey Advisor Department of Natural Resources and Water and Cooperative Research Centre for Spatial Information
2008	Allowed the third party to contribute extra stations to the commercial services (Higgins, 2008)	The National Measurement Act
2008	ICSM coordinated a unified government-owned infrastructure (Higgins, 2008)	The Australian Inter Governmental Committee on Surveying and Mapping (ICSM)
2008	Outline three fundamental categories for classifying Australian CORS infrastructure as “Tiered infrastructure” (Rizos, 2008a) Design hardware equipment, data processing algorithm level, deployment and management The Ground Infrastructure • Tier 1 are the CORS to be used by IGS or equivalent ultra-high accuracy networks to support geoscientific research and global reference frame definition. • Tier 2 are the high accuracy CORS networks operated by national geodetic agencies such as Geoscience Australia (2008) for the purpose of maintaining national geodetic datums and providing the fundamental backbone of the national geospatial reference frame. • Tier 3 are the CORS that densify the national CORS networks, operated by agencies such as state governments, or private companies providing Hierarchy of CORS networks • Tier 1 are the CORS equipped with receivers that can track all the broadcast GNSS/RNSS frequencies/signals, established for ultra-high	Chris Rizos

Year	Content	Key Person
	accuracy networks to support geoscientific research and global reference frame definition. • Tier 2 are the high accuracy CORS networks equipped with receivers that can track all the broadcast GNSS/RNSS frequencies/signals, operated by national geodetic agencies for the purpose of maintaining national geodetic datums and providing the fundamental backbone of a national geospatial reference frame. • Tier 3 are the CORS equipped with minimum interoperable configuration design receivers that can track the L1-L5 GNSS/ RNSS frequencies/signals that densify the national CORS networks, operated by agencies such as state governments or private companies providing commercial DGNSS services. 12) Discuss on future CORS infrastructure “Who will establish and maintain future CORS networks, government or private service providers?” to justify the costs of implementing CORS networks	
2008	The National GNSS CORS Infrastructure (NGCI) web map has been developed as an interactive online tool to visualise and review a range of infrastructure locations and details	The University of Melbourne and Cooperative Research Centre for Spatial Information (CRCSI)
2008	The implementation of the geospatial component of the AuScope programme (AuScope, 2008)	Geoscience Australia (2008)
2010	Australian Government assigned the Space Policy Unit (SPU) within the Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education (DIICCSRTE)	Australian Government
2010	Define standards for GNSS CORS accuracy and stability (Burn and Sarib, 2010) for the Intergovernmental Committee on Surveying and Mapping (ICSM) Standard for the Australian Survey Control Network Special Publication (SP1)	The Intergovernmental Committee on Surveying and Mapping (ICSM)
2010	The ICSM Permanent Committee on Geodesy (ICSM PCG) drafted the recommendations to address technical and organisational challenges (Burn and Sarib, 2010)	The ICSM Permanent Committee on Geodesy (ICSM PCG)
2010	ANZLIC’s NPI Policy developed in late 2010 (ANZLIC, 2010) To set a policy framework. The Policy focuses on deploying nationally compatible CORS infrastructure to support the acquisition, processing and distribution of multi-GNSS data. Discuss and negotiate national and international requirements for an NPI	Australian Government ANZLIC, ICSM, ASC, CRCSI, GA, and DIICCSRTE
2010 - 2012	The development of AuScope at the cost of approximately \$65 million to establish the geoscientific tools for monitoring the Australian continent Improve the National Geospatial Reference Framework (NGRF) by investing in geodetic infrastructure (over 100 GNSS stations) (Rizos, 2007)	The National Collaborative Research Infrastructure Strategy (NCRIS)
2012	The Department of Resources, Energy and Tourism (DRET) is leading the development of the NPI Plan to identify Australia’s future PNT capabilities and requirements (Geoscience Australia, 2012)	Australian Government

Year	Content	Key Person
2013	Australia's Satellite Utilisation Policy was released on 9th April 2013 The need for Australia to focus on space applications of national significance includes developing a National Positioning Infrastructure Plan (NPI Plan) that examines investment in domestic ground infrastructure that will deliver accurate and reliable positioning information to users across Australia (Australian Government, 2013)	Senator Kate Lundy, Minister Assisting for Industry and Innovation
2013	CRCSI (CRCSI, 2013) is a user-driven research program that has 3 core research themes 1. Positioning 2. Spatial Infrastructures 3. Automated Spatial Information Generation	Cooperative Research Centre for Spatial Information (CRCSI)
2013	The global Real-Time Service (RTS) was launched in April 2013 (Hausler and Collier, 2013a)	National Positioning Infrastructure (NPI)
2014	PhD Thesis National Positioning Infrastructure: Technical, Institutional and Economic Criteria for Coordinating Access to Australia's GNSS CORS Infrastructure	Grant J. Hausler National Positioning Infrastructure (NPI) Coordinator, Geoscience Australia
2018	The role of the NPI-AB is to provide strategic oversight and direction on four key areas of NPI planning: whole-of-nation governance and leadership; enhancement of GNSS ground tracking infrastructure; development and analysis of high integrity products and services supporting high accuracy GNSS positioning; and options for delivering these services nationally via ground and satellite communications.	National Positioning Infrastructure (NPI)
2019	Queensland Geospatial Reference Frame	Queensland

TABLE A - 20 A summary of GNSS CORS management timeline in Thailand (Source: Author's own research)

Year	Events	Key
1978	Navstar 1 (GPS) was launched	DoD, USA
1979		
1980	GPS in geodetic control surveys	
1981		
1982		
1983		
1984		
1985		
1986		
1987		
1988		
1989		
1990	GNSS-RTK techniques	
1991		
1992		
1993		
1994		US Government
1995		
1996	First Thailand GNSS CORS network	DPT
1997		
1998	Economics of "network-RTK"	
1999		
2000		Japan – GEONET: world largest nationwide network
2001		
2002		CORS in Bangkok
2003	Japan has installed CORS in Thailand (NICT)	KMITL + NICT
2004		CORS at Chiangmai University
2005		GNSS base station
2006		
2007		CORS tsunami warning// CORS services models
2008		First Thailand N-RTK// First Thailand IGS station
2009		Installed 6 more CORS
2010		
2011		Identified CORS problem in Thailand
2012		
2013		
2014		
2015	Upgraded RTK GNSS Network, Installed 6 more CORS	DPT
2016	Installed 51 more CORS// Installed 6 CORS	DOL // HAIL
2017	Joint working// Installed 30 more CORS// Installed 80 CORS	Japan // DOL // RTSD
2018	GiNNo kickoff// Installed 30 more CORS	MHESI + NEC // DOL
2019	Subcommittee meeting// Capacity Building + Promotion	Subcommittee // 3 working group
2020	Data connection test - successful	The National CORS Data Center

TABLE A - 21 GNSS CORS management timeline in Thailand (Source: Author's own research)

Year	Content	Key Person
1978	The first satellite in the system, Navstar 1, was launched (Tennant, 1981)	The Department of Defense (DoD), USA
1980s	Use GPS in geodetic control surveys (Rizos and Satirapod, 2011)	
the early 1990s	The emergence of GNSS-RTK techniques (Rizos and Satirapod, 2011)	
1994	The CORS network originated in early 1994 when the NGS installed a permanent GPS station in Gaithersburg (National Institute of Standards and Technology) (Stone, 2006)	The United States Government
1996	First Thai GNSS CORS network 9 stations (Rizos and Satirapod, 2011)	The Department of Public Works and Town & Country Planning (DPT)
the late 1990s-early 2000s	Economics of “network-RTK” Many governments and private network operators became interested in the economics of network-RTK (Rizos, 2007)	
2000	Japan’s nationwide GEONET network is the world’s largest, numbering nearly 1,000 receiver stations (Rizos <i>et al.</i> , 2007)	
2002	CORS in Bangkok is a part of the SouthEast Asia Low-latitude Ionospheric Network (SEALION) project for the purpose of monitoring and forecasting equatorial ionospheric disturbances, especially plasma bubbles in the Southeast Asia region. 1 station (Charoenkalunyuta <i>et al.</i> , 2012)	King Mongkut's Institute of Technology Ladkrabang (KMITL) Collaborated Partners: The National Institute of Information and Communications Technology (NICT)
2002	Japan has installed CORS in Thailand, 1 station. Bangkok (KMIT) 2002 – present (Rizos and Satirapod, 2011; Thai GNSS and Space Weather Information Data Center, 2020)	The National Institute of Information and Communications Technology (NICT)
2004	Japan has installed CORS in Thailand, 1 station. Chiangmai University (CIMU) 2004 – 2014 (Thai GNSS and Space Weather Information Data Center, 2020)	Chiangmai University (CIMU) Collaborated Partners: The National Institute of Information and Communications Technology (NICT)
2005	Installed GNSS base station 1 station (Rizos and Satirapod, 2011)	The Royal Thai Survey Department (RTSD)
2005	Japan has installed CORS in Thailand, 1 station. Chumphon (CHPN) 2005 – 2014 (Rizos and Satirapod, 2011; Thai GNSS and Space Weather Information Data Center, 2020)	The National Institute of Information and Communications Technology (NICT)
2006	Japan has installed CORS in Thailand, 1 station. Phuket (PTAC) 2006 – 2014 (Rizos and Satirapod, 2011; Thai GNSS and Space Weather Information Data Center, 2020)	The National Institute of Information and Communications Technology (NICT)
late 2007	Installed CORS receivers as part of a tsunami and earthquake early warning system 5 stations (Rizos and Satirapod, 2011)	The Thai Meteorological Department (TMD)

Year	Content	Key Person
2007 December	Identified the models for the establishment of CORS networks and services (Rizos, 2007)	Chris Rizos
early 2008	First Thai's Real-Time Kinematic (N-RTK) GPS service (Rizos and Satirapod, 2011)	The Department of Lands (DOL)
2008	First Thai's IGS station in Thailand support from JPL and UNAVCO 1 station (Rizos and Satirapod, 2011)	Chulalongkorn University (CU)
2008	Installed Nongkhai (NKKI) CORS 1 station (2008 – 2019) (The National Institute of Information and Communications Technology, NICT)	Chulalongkorn University (CU) Collaborated Partners: Kyoto University
2009	Installed CORS 6 stations to DOL RTK GNSS Network. Total 11 stations (DOL, 2018)	The Department of Lands (DOL)
2011	Identified CORS problem in Thailand (Rizos and Satirapod, 2011)	
2015	Upgraded CORS 9 stations to DPT RTK GNSS Network. Total 9 stations (Yomwan, 2017a)	The Department of Public Works and Town & Country Planning (DPT)
2015	Installed CORS 6 stations to DPT RTK GNSS Network. Total 15 stations (Yomwan, 2017a)	The Department of Public Works and Town & Country Planning (DPT)
2016	Installed CORS 51 stations to DOL RTK GNSS Network. Total 62 stations (DOL, 2018)	The Department of Lands (DOL)
2016	Installed CORS 6 stations (DOL, 2018)	Hydro and Agro Informatics Institute (HAI)
2017 February 24-25	High Level seminar for defining the national geo-informatics movement guidelines, hosted by The National Geo-Informatics Board Discussions about - Creating the National CORS Data Center - Working under the National Subcommittee on GNSS Network (appointed by the National Geo-Informatics Board) - Qualification for the National CORS Data Center candidates - Government organisation - Ability to provide services to the public sector and private sector - Competence in encouraging a diversity of missions - Skilled staff - Technology to support the national infrastructure - The National CORS Data Center in the foreign countries - User: public sector/ private sector/ Hybrid Organisations - Fee: free/ pay - The national GNSS infrastructure - Concept: Network of CORS Networks - Key: non-CORS owner user either public sector or private sector - Problem: lack of national data centre to provide services - Solution: create the national data centre to provide application services in the EEC area - Make GISTDA the leader of the national GNSS infrastructure project - Responsible for the National CORS Data Center - Coordinate with China and Japan	CORS owner RTSD, DOL, DPT, HAI, GISTDA

Year	Content	Key Person
	- Japan will fund the 200 CORS installation project	
2017 March 30	- The National Geo-Informatics Board appointed the National Subcommittee on GNSS Network on 26th May 2017 to implement the National GNSS Infrastructure project under the Network of CORS Networks concept - The National GNSS Infrastructure links with five networks - Surveying and cadastral plan mission: DOL - Surveying, topographic mapping, and national defence mission: RTSD - Town planning and Urban management mission: DPT - Water resource and disaster management mission: HAI and Japan - Research and innovation management mission: GISTDA and Universities - The National Subcommittee on GNSS Network appointed the National CORS Data Center to provide data services to the public sector, private sector, and civilian - GISTDA, as the National Subcommittee on GNSS Network secretary, will be responsible for coordination abroad	The National Geo-Informatics Board
2017 June 7	The signing Ceremony of the Memorandum of Cooperation (MoC) on the Development of Integrated CORS between Thailand and Japan aimed to - Create a CORS data integration centre - Install CORS infrastructure - Found GNSS innovation centre	Deputy Prime Minister and Minister of Science and Technology (Dr. Atchaka Sibunruang) [Now: Ministry of Higher Education, Science, Research and Innovation (MHESI)] with Minister of Land, Infrastructure, Transport and Tourism (Mr. Keiichi Ishii)
2017 June 4-8	- The 3rd Meeting of the Thailand-Japan High Level Joint Commission: HLJC - Minister of Science and Technology (Dr. Atchaka Sibunruang) [Now: Ministry of Higher Education, Science, Research and Innovation (MHESI)] appointed - GISTDA to be accountable to the National CORS Data Center - HAI to take responsibility for CORS installation	
2017 June 29	GISTDA was committed to arranging the GNSS CORS coordination proposal (Application Form) at the meeting held to discuss an Agreement on Academic Cooperation	Ministry of Foreign Affairs (MFA) Ministry of Science and Technology (MHESI) (National Subcommittee on GNSS Network)
2017 August 4	- Japan (Japan International Cooperation Agency (JICA)) proposed the RTSD to be nominated for the National CORS Data Center	Japan International Cooperation Agency (JICA)

Year	Content	Key Person
	- Japan (Geospatial Information Authority of Japan (GSI) + Japan International Cooperation Agency (JICA)) offered assistance in terms of CORS upgrades, technical visit - Japan International Cooperation Agency (JICA) is conducting a resurvey to alter some of the cooperation plans - Japan focused on providing CORS services to the private sector - HALL raised that taking control of the CORS installation is quite beyond their capacity; they needed support from RTSD - RTSD is responsible for Smart map preparation to support Precision farming. The map was expected to be ready in 2019. - CU put RTSD forward as the provider of transformation parameters to unify a national geospatial reference frame - GISTDA presented the Roadmap for data services - GISTDA was appointed to arrange a discussion workshop dealing with the data services management	Geospatial Information Authority of Japan (GSI)
2017 August 24	GISTDA proffered an Application Form to Thailand International Cooperation Agency (TICA), Ministry of Foreign Affairs (MFA) 6. Technical support 7. The National Service Data Center establishment 8. The National Mapping Data Center establishment 9. The GNSS CORS expansion installation 10. Human Resource Development	Ministry of Foreign Affairs (MFA) Ministry of Science and Technology (MHESI) (National Subcommittee on GNSS Network)
2017 August	The Cabinet Office (11 organisations) of Japan suggested to GISTDA instituting the GNSS Innovation Center (GiNNo) at GISTA Si Racha for showcasing an exhibition of GNSS technology application	Japan GISTDA
2017 November 2	Guidelines on the management of the National CORS Data Center - Set up three government working groups 1. Implementation Working Group (IWG) to issue guidelines for the National CORS Data Center implementation: Chairman - Permanent Secretary of MHESI 2. National CORS Data Center Management Working Group: Chairman - Director of RTSD 3. Working Group on Thailand-Japan Joint Commission on CORS infrastructure development: Chairman - Deputy Permanent Secretary of MHESI - DOL and GISTDA will draw up the National CORS Data Center implementation project plan - RTSD will be the National CORS Data Center administrator	Permanent Secretary of the Ministry of Science and Technology (MHESI) Director of Royal Thai Survey Department (RTSD) Deputy Permanent Secretary of the Ministry of Science and Technology (MHESI)
2017	Installed CORS 30 stations to DOL RTK GNSS Network. Total 92 stations (DOL, 2018)	The Department of Lands (DOL)
2017 – 2018	Installed CORS 80 stations. Total 80 stations (DOL, 2018)	The Royal Thai Survey Department (RTSD)
2018 January 10	The kickoff of GNSS Innovation Center (GiNNo)	MHESI + NEC (Japan)
2018	Installed CORS 30 stations to DOL RTK GNSS Network. Total 122 stations (DOL, 2018)	The Department of Lands (DOL)
2019	The National Subcommittee on GNSS Network meeting (1/2019) (Thai GNSS and Space Weather Information Data Center, 2020)	The National Subcommittee on GNSS Network

Year	Content	Key Person
2019 December 4	- No further meeting between the National Geo-Informatics Board and the National Subcommittee on GNSS Network - The national CORS management is underway by the three National CORS working group - Most of the predominant CORS owners have been completing CORS installation - RTSD finished the CORS installation - Developing a Capacity Building and Promotion	CORS working groups
2020 March 19	Performing the test of data connection between relevant organisations. The initial outcome showed a successful test result	The National CORS Data Center (RTSD)

D. DATA ANALYSIS

D.1 Level of Codes

TABLE A - 22 The level of codes used in data analysis (Source: Author's own research)

Level 1	Level 2	Level 3	Level 4	Level 5
Collaboration	Agreement			
	Foreign Case			
	International	<i>China</i>		
		<i>Financial Support</i>		
		<i>Japan</i>		
		<i>Neighbouring Countries</i>		
		<i>Other Countries</i>		
		<i>Research Collaboration</i>		
		<i>Technology Support</i>		
	Inter-organisational	<i>Government-Government</i>		
	Power	<i>Government-Private</i>		
	Source of Problem	<i>Number of CORS</i>		
Finance	International			
	Investment	<i>Additional Investment</i>		
		<i>Foreign Countries</i>		
		<i>Maintenance and Renewal</i>		
		<i>New Investment</i>		
		<i>Private Sector Investment</i>		
	ROI	<i>Design</i>		
		<i>Expect</i>		
Human	Professional and			
	Staff and			
	Training and			
Plan and Policy	Business Model	<i>Compare with Others</i>		
		<i>Design</i>		
		<i>Expect</i>		
	Legislation	<i>Compare with Others</i>		
		<i>Design</i>		
		<i>Expect</i>		
	Plan	<i>Compare with Others</i>		
		<i>Infrastructure Plan</i>		
		<i>International Cooperation</i>		
		<i>Management Plan</i>	Central Network	Central Unit Leader
			Individual Network	
	Policy	<i>Compare with Others</i>		
		<i>Design</i>		
		<i>Expect</i>		
	Standard	<i>Compare with Others</i>		
		<i>Design</i>		
		<i>Expect</i>		
Technology	Access			
	Delivery			
	Infrastructure	<i>Network</i>		
		<i>Standalone</i>		
	Technique	<i>Data</i>		
		<i>Hardware</i>		
		<i>Software</i>		
	Technology Focus	<i>Compare with Others</i>		
		<i>Drive in Thailand</i>		
	Tool	<i>Device</i>		
		<i>LBS</i>		

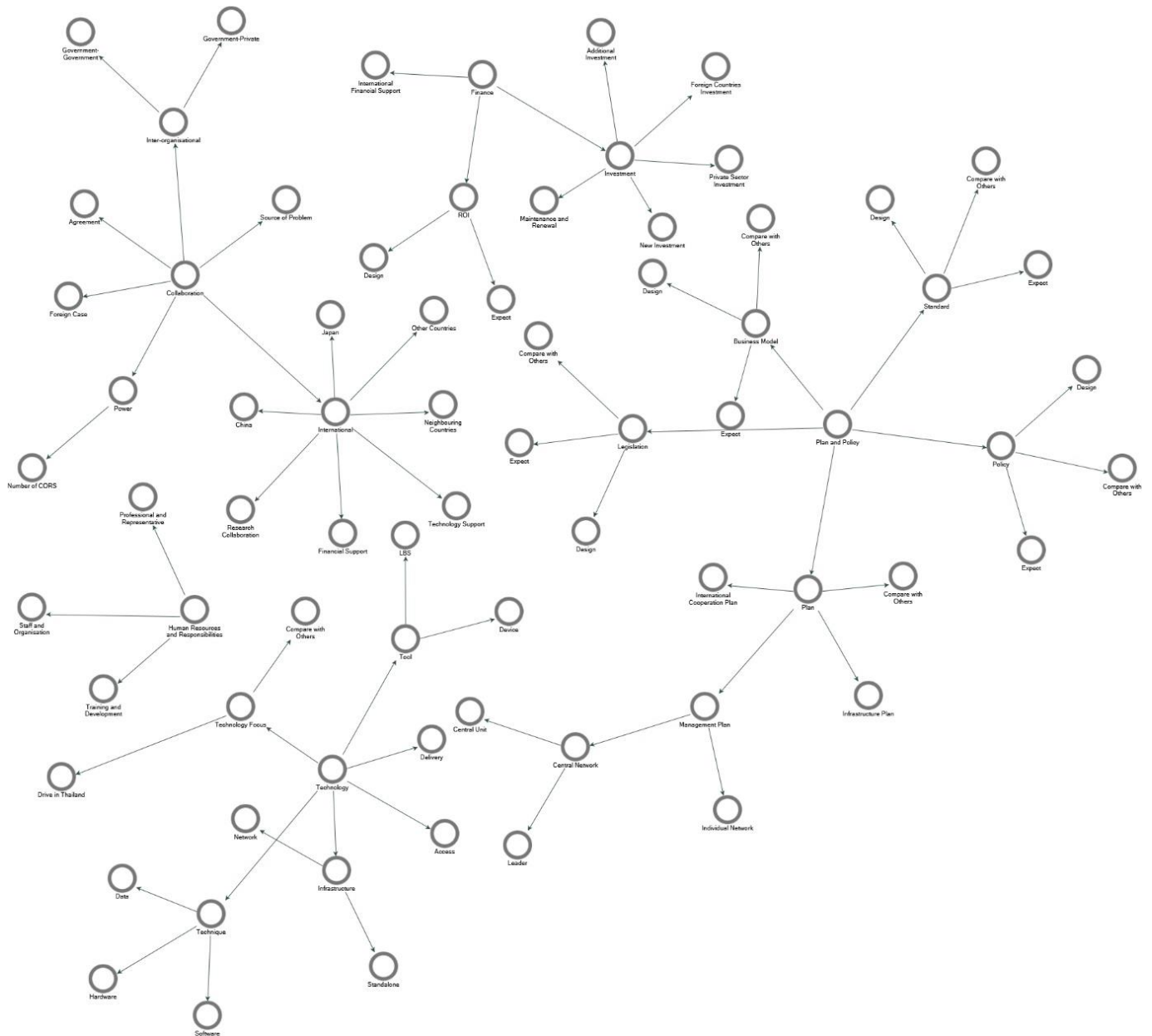


FIGURE A - 6 The selected code relationship (Source: Author's own research)

D.2 Codebook

TABLE A - 23 The codebook used in data analysis (Source: Author's own research)

Name	Description
Collaboration	Collaboration on GNSS CORS
Agreement	Viewpoints on the collaboration on GNSS CORS, either agree or disagree.
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
Foreign Case	Collaboration on GNSS CORS in other countries
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
International	Collaboration on GNSS CORS between Thailand and other countries
China	Collaboration on GNSS CORS between Thailand and China
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.

Name	Description
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
Financial Support	The financial support collaboration on GNSS CORS between Thailand and other countries
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
Japan	Collaboration on GNSS CORS between Thailand and Japan
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.

Name	Description
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
Neighbouring Countries	Collaboration on GNSS CORS between Thailand and neighbouring countries
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
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<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
Other Countries	Collaboration on GNSS CORS between Thailand and other countries (e.g. Europe, USA, Australia)
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.

Name	Description
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
Research Collaboration	The research and education collaboration on GNSS CORS between Thailand and other countries
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
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<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
Technology Support	The technology and knowledge support collaboration on GNSS CORS between Thailand and other countries
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
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<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.

Name	Description
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
Inter-organisational	Collaboration on GNSS CORS between organisations in Thailand
Government-Government	Collaboration on GNSS CORS between government organisations in Thailand
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
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<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
Government-Private	Collaboration on GNSS CORS between government and private sectors in Thailand
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
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<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)

Name	Description
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
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<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
Power	Power or factors that influence the collaboration on GNSS CORS
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.

Name	Description
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
Number of CORS	Size of the CORS network, either large, small, or none
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
Source of Problem	Sources or factors that cause the ineffectiveness of the GNSS CORS implementation in Thailand (e.g. no cooperativeness)
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
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<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
Finance	Financial issues

Name	Description
International Financial Support	Financial support from other countries for the GNSS CORS development in Thailand
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
Investment	GNSS CORS investment and installation in Thailand
Additional Investment	Additional investment and installation of GNSS CORS in Thailand
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
Foreign Countries Investment	Foreigners' GNSS CORS investment and installation in Thailand
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)

Name	Description
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
Maintenance and Renewal	GNSS CORS maintenance and renewal by the government sector in Thailand
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
New Investment	New GNSS CORS investment and installation by the new investors in Thailand
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)

Name	Description
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
Private Sector Investment	GNSS CORS investment and installation by the private sector in Thailand
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)

Name	Description
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
ROI	Benefits from GNSS CORS in Thailand, either financial or non-financial
Design	Plan to benefit from GNSS CORS in Thailand
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
Expect	Expectations for the benefits of GNSS CORS in Thailand
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)

Name	Description
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
Human Resources and Responsibilities	Human resources issues and personal and organisational roles
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
Professional and Representative	Experts in particular areas or the organisations directly responsible for each field
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.

Name	Description
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
Staff and Organisation	General staff and other organisations
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
Training and Development	Staff training, education, and organisational development
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.

Name	Description
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
Plan and Policy	Plans and policies for GNSS CORS management in Thailand
Business Model	The business model for GNSS CORS management in Thailand (e.g. GNSS CORS management plan, marketing plan)
Compare with Others	A comparison between the business model for GNSS CORS management in Thailand and other business models in Thailand or the business model for GNSS CORS management in different countries
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
Design	Plans for a GNSS CORS business model in Thailand (e.g. appointing GISTDA as a service provider and marketing)
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)

Name	Description
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
Expect	Expectations for the GNSS CORS business model in Thailand (e.g. referring to other organisation's business models)
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
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<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
Legislation	Laws, regulations, and guidelines
Compare with Others	A comparison between the laws, regulations, and guidelines for GNSS CORS management in Thailand and legislations in other subjects in Thailand or the directions for GNSS CORS management in different countries

Name	Description
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
Design	Plans for the GNSS CORS laws, regulations, and guidelines in Thailand
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
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<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
Expect	Expectations for the GNSS CORS laws, regulations, and guidelines in Thailand
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)

Name	Description
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
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<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
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<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
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<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
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<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
Plan	Strategic plans and national economic development plans for GNSS CORS in Thailand
Compare with Others	A comparison between the strategic plans and national economic development plans for GNSS CORS in Thailand and plans in other subjects in Thailand or the GNSS CORS plans in different countries

Name	Description
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
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<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
Infrastructure Plan	GNSS CORS infrastructure installation and management plan in Thailand (e.g. hardware and facilities)
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
International Cooperation Plan	Cooperation plan on GNSS CORS between Thailand and other countries
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)

Name	Description
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
Management Plan	GNSS CORS management plan in Thailand
Central Network	The integration of GNSS CORS as a central network
Central Unit	The organisation as a central unit for Thailand's GNSS CORS management
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
Leader	The organisation as GNSS CORS pioneer or leader of GNSS CORS management in Thailand
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)

Name	Description
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
Individual Network	Thailand's GNSS CORS network for internal use only (e.g. no network sharing policy)
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.

Name	Description
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
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<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
Policy	Thailand's GNSS CORS policies and explicit arrangements
Compare with Others	A comparison between the GNSS CORS policies in Thailand and policies in other subjects in Thailand or the GNSS CORS policies in different countries
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.

Name	Description
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
Design	Plans for the explicit arrangements and straightforward policies for GNSS CORS in Thailand
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
Expect	Expectations for Thailand's GNSS CORS policies (e.g. how new policy will benefit Thailand's GNSS CORS)
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)

Name	Description
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
Standard	Standards for GNSS CORS and its components
Compare with Others	A comparison between the standards for GNSS CORS in Thailand and standards in other subjects in Thailand or the guidelines for GNSS CORS in different countries
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
Design	Plans for the standards for GNSS CORS in Thailand (e.g. receiver, data format)
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)

Name	Description
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
Expect	Expectations for Thailand's GNSS CORS standards (e.g. lack of a standard for building CORS)
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
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<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)

Name	Description
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
Technology	GNSS CORS technology
Access	Data access, either GNSS CORS data or service data
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
Delivery	Data delivery, either from CORS sites to control centre or service distribution to users
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
Infrastructure	GNSS CORS infrastructure (e.g. receivers, internet, power supply, ventilation, temperature control)

Name	Description
Network	GNSS CORS network)e.g. DOL CORS(
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
Standalone	Non-network GNSS CORS)e.g. university's CORS, DPT CORS(
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)

Name	Description
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
Technique	GNSS CORS technical issues
Data	Data manipulation techniques (e.g. data processing, network adjustment, data format)
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)

Name	Description
Hardware	GNSS hardware technology (e.g. frequency of the receiver, network connection)
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
Software	Data management software (e.g. central network adjustment software)
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)

Name	Description
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
Technology Focus	GNSS CORS technology interest
Compare with Others	A comparison between GNSS CORS technology in Thailand and other technologies in Thailand or GNSS CORS technology in different countries (e.g. cell-based technologies, RFID tags)
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
Drive in Thailand	Drive for GNSS CORS technology in Thailand (e.g. a drive to improve GNSS CORS in Thailand is not active, a drive by the private sector is more effective)
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)

Name	Description
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
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<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
Tool	Equipment issues
Device	Instrument)e.g. receiver, rover)
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
LBS	Location-based mobile tools (e.g. using LBS for CORS monitoring and alert system)
<i>Nonverbal</i>	The idea-expression uses communication other than words regarding the agreement on the collaboration on GNSS CORS.

Name	Description
<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
<i>Gestures</i>	Particular expression supplementing the speaking of a person through the movements of the head, hands, arms, and legs. (e.g. nodding, pointing, waving, thumbs-up)
<i>Humour</i>	The expression creates and facilitates a pleasurable and friendly atmosphere.
<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)
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<i>Facial Expressions</i>	Feelings expression of a person through the look on the facial area. (e.g. anger, happiness, sorrow, raised eyelids, lowered forehead, wrinkled nose)
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<i>Paralinguistics</i>	The vocal elements for indicating the meaning of a sentence. (e.g. tone, inflexion, rhythm, pitch, timbre, loudness)
<i>Posture</i>	Emotions and attitudes expression of a person through the movements and postures like sitting, standing, walking, and talking. (e.g. leg-crossing, arm-crossing, standing erect, looking at the ceiling)

D.3 Coding Result

TABLE A - 24 A comparison of the empirical findings of the coding (Source: Author's own research)

Code Name	Focus group	Expert	Follow up
Collaboration	For cooperation on GNSS CORS, there must be collaboration, of course! Because Thailand has the designs to set up many CORS by various organisations.	They have some cooperation here. There is a national committee?	In the fiscal year 2021, cooperation will not yet be established.
Agreement	Agree to have the collaboration.	On the matter of cooperation between organisations, this one has to exist anyway.	-
<i>Nonverbal</i>			
<i>Facial Expressions</i>	Yes	-	-
<i>Gestures</i>	Er..No	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	Yes, there should be.		
<i>Posture</i>	-	-	-
Foreign Case	Like Australia and New Zealand, they integrated into one structure and set up an agency to take care of it.	Like Europe, it can happen because each country is close to the other.	-
<i>Nonverbal</i>			

Code Name	Focus group	Expert	Follow up
<i>Facial Expressions</i>	Estimate where earthquakes can occur because the more information, the better.	-	-
<i>Gestures</i>	Well, it's going to be more like, uh, America's, which a board must exist.	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	For regional cooperation, ah region, like ah SDA, or something like that? As I can see in Japan, they use it for ah, what is it called?	-	-
<i>Posture</i>	To the point of Japan, its driving force is clear. This country can even have four earthquakes and hundreds of problems from nature and small earthquakes within one day.	-	-
International	Actually, international collaboration is good, particularly in CORS matters.	We should cooperate; however, it should be on our road map about whether we should cooperate or not or what are the strengths and weaknesses?	-
China	But the Chinese came in and saw what interests us; they will support what we need.	On the Chinese side, they don't come in as government representatives. They came as a private company. Therefore, cooperating with foreign private sectors is more complex. But it will look better if it is between the state and the state.	Cooperation with China is still quiet.

Code Name	Focus group	Expert	Follow up
<i>Nonverbal</i>			
<i>Facial Expressions</i>	Yes, it's over, and that's it. Well, when we're done talking with China, we can say that hey, actually, they don't even need us to buy a train at all. They can give us the train, and we hire them for maintenance. Hahahaha	-	-
<i>Gestures</i>	Like China, they want to enter but don't know how to get in.	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	Then try to disseminate, to transfer knowledge about the applications in many aspects, as far as I know. Make this one more prominent than other countries that we can see clearly or something like this.	-	-
<i>Posture</i>	I think China has the most complete. The rest doesn't cover us at all.	-	-
Financial Support	What do they want from the investment? Such things they want from the investment, can we provide them? And will it justify giving them?	I don't see it this way. I think data is a big deal. The country is not short of money or budgets for doing it ourselves.	-
<i>Nonverbal</i>			
<i>Facial Expressions</i>			
<i>Gestures</i>	What do they want from the investment? Such things they want from the investment, can we	-	-

Code Name	Focus group	Expert	Follow up
	provide them? And will it justify giving them? Because various matters are sensitive.		
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	-	-	-
<i>Posture</i>	Honestly, there is. There's an institution where we don't get support from them. But we use foreign loans to buy tools. A loan initiation like this must be cautious. Even in our case, even though it's a loan, which we have to pay them back the whole with interest. Uh...	-	-
Japan	The Japanese team met with all agencies to collect information, exchange and offer help.	The Japanese government pushed a lot. They moved us to create a central network as soon as possible because they wanted to use it.	The specialists have been changed but are not likely to be a problem with cooperation.
<i>Nonverbal</i>			
<i>Facial Expressions</i>	Before that, our ministers and prime ministers had joint base statements in Japan.	-	-
<i>Gestures</i>	Uh.. Minister of Science signed an MOU with Japan.	-	-
<i>Humour</i>	Uh.. Japan is also like that.	-	-
<i>Paralinguistics</i>	But nowadays, Japan has come in because Japan has been here for a long time.	-	-
<i>Posture</i>	Actually, it has both formats. Between the state and the state, for example, are like the one with	-	-

Code Name	Focus group	Expert	Follow up
	Japan. Japanese came as a team; that is, in an agency that is a government, they draw their private sector to match with our country's people as well.		
Neighbouring Countries	With neighbours, knowledge is used more than structure.	The countries around us try to compete with us. In contrast, we don't see them as competitors.	There is no discussion yet because the service connection requires a lot of details. There must be an MOU with the Ministry of Foreign Affairs.
<i>Nonverbal</i>			
<i>Facial Expressions</i>	It's difficult to get one in Laos or Burma.	-	-
<i>Gestures</i>	Because of this, what will it be open for? There is that one, so I ask what it is for first.	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	If GNSS CORS has widespread popularity, neighbouring countries have this system, cooperation on exchanges at the country's borders are likely to happen. But as far as we know, there are not many of them around. Therefore, cooperation in this area with neighbouring countries is probably not quite there.	-	-
<i>Posture</i>	But CORS, as far as we know, we feel that in Thailand, cooperation may have been talking for a very	-	-

Code Name	Focus group	Expert	Follow up
	long time like, hey, we'll work together. But we haven't found a relationship like what we have found in the circle of metrology.		
<i>Nonverbal</i>			
<i>Facial Expressions</i>	If it's the civilian government, I think it's impossible.	-	-
<i>Gestures</i>	It would be ok as there will be cooperation. They will know about each other, on what we are doing is right and not, good or not, exchanging with each other.	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	For this one, let me think a little differently. Ah, in my opinion, I still do not see how foreign countries will give importance to CORS in Thailand?	-	-
<i>Posture</i>	They still don't dare. Thailand is chaotic.	-	-
Other Countries	Other countries, depending on what they see or can get from Thailand.	For America or Europe, I think there is less percentage of investment, so they don't approach Thailand much.	-
<i>Nonverbal</i>			
<i>Facial Expressions</i>	Well, there are two types. Help, but there must be a win-win situation.	-	-
<i>Gestures</i>	Therefore, there might be other countries.	-	-

Code Name	Focus group	Expert	Follow up
<i>Humour</i>	They used to tell us that they'll give it a try, but it's not happening. However, it doesn't cover us that much, just a bit.	-	-
<i>Paralinguistics</i>	For Europe, if there were cooperation, it would be in the coordinates and research. But, the business partner relationship is not likely to happen now.	-	-
<i>Posture</i>	As someone who has never cooperated, I think we have to balance. Especially talking about it frankly, there is inevitably an effect on the strategy.	-	-
Research Collaboration	Maybe in the form of system joint-development, which will also encourage our potential, not just being the recipient only. I look at cooperation with foreign countries on another scale, not only as a recipient. It'd better be a cooperation that helps each other develop.	It should be fine if we look at it for scientific matters, endeavour, or whatever. Just the question about whether it has to request permission? I think we'd better give the right. For example, they can join research institutes, universities, or whatever, so it can be filtered?	-
<i>Nonverbal</i>			
<i>Facial Expressions</i>	Yes, it's not like coming with a black-box style then wanting to have a knowledge transfer. Because this one will enable both of them to benefit, they will feel good.	-	-

Code Name	Focus group	Expert	Follow up
<i>Gestures</i>	The Chinese cooperation system style is quite complicated. If we really want to make it official, it must be done through their MFA, which is a very long take. But sometimes, something like a university or an organisation has some degree of authority in cooperation.	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	If we look at the matter of foreign countries, it is probably related to technology research.	-	-
<i>Posture</i>	The Chinese cooperation system style is quite complicated. If we really want to make it official, it must be done through their MFA, which is a very long take. But sometimes, something like a university or an organisation has some degree of authority in cooperation.	-	-
Technology Support	Cooperation in the field of know-how or equipment shouldn't be like that we only buy them; there should be knowledge and know-how transfer in terms of technology too. It's not that you only brought it and used it; that's useless.	There are things like low-cost, multi-frequency, multi-constellation, agriculture, car, or anything like this. Let's see their performance.	They are trying to take action on the RTSD CORS management.

Code Name	Focus group	Expert	Follow up
<i>Nonverbal</i>			
<i>Facial Expressions</i>	We must accept that our technology can't compete with them. There are many factors. Anyway, we need to use it. We have to use collaborative mechanisms to bring know-how in.	-	-
<i>Gestures</i>	There is! We don't receive what this institution provides, but we use it anyway.	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	Cooperation in the field of know-how or equipment shouldn't be like that we only buy them; there should be knowledge and know-how transfer in terms of technology too.	-	-
<i>Posture</i>	For use, which must have and need a lot of support from abroad to make it happen.	-	-
Inter-organisational	A country can have CORS because of the integration of many agencies together.	They can develop a paper together or do something together, continue gradually improving things. Then they will all get to know each other. And it has to start from the bottom up.	-
Government-Government	Current cooperation is only for the government sector.	If we don't cooperate, it will be a waste of resources. Because the government organisations use tax money, and if there is no	Preliminary results show that they can be linked together.

Code Name	Focus group	Expert	Follow up
		cooperation, it turns out that our work is redundant anyway.	
<i>Nonverbal</i>			
<i>Facial Expressions</i>	There must be cooperation if the scope is the government agencies that have CORS stations should be joined together.	-	-
<i>Gestures</i>	Ask if it is cooperation; it's not there is none of the cooperativeness. But as they serve their own missions, everyone is doing their duty. But when it became CORS and asked me if I wanted to have it or not, yes, I did.	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	Let's have a talk among the agency that will install CORS that has already received the budget.	-	-
<i>Posture</i>	It's up to the concept, right? If we hold the concept of no matter who will have it, let's connect the network just like we are trying to tell or something.	-	-
Government-Private	There must be a committee for this matter to give the private sector the opportunity to use it while the government sector doesn't lose anything.	It actually should be like that. We have to bring those into CORS. Instead of installing them, we can relocate for better positions and distribution that avoids duplication.	-
<i>Nonverbal</i>			

Code Name	Focus group	Expert	Follow up
<i>Facial Expressions</i>	We can screen anything we want. However, that is our standard authority. But if we think about PPP, we must be open-minded.	-	-
<i>Gestures</i>	It may also be at the purpose of the entry. What is that for? It's not like saying that it can't be, but it's a must-try.	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	The private sector must join.	-	-
<i>Posture</i>	No, we must see that such information has anything that will lead to instability. If there is nothing, we shouldn't block it.	-	-
<i>Nonverbal</i>			
<i>Facial Expressions</i>	Actually, solving these problems should be done through joint working. It's just that it has to be an open collaboration.	-	-
<i>Gestures</i>	Well, cooperation is okay. It's just that now the official letter for confirmation. If the executives have been changed, it will lack continuity.	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	In terms of the technical team, the state of current coordination is pretty good. The DOL by the Mapping Technology Division and the RTSD by the Director of the	-	-

Code Name	Focus group	Expert	Follow up
	Geodesy and Geophysics Division are now technically coordinated in the positions.		
<i>Posture</i>	I think that the cooperation with various agencies is good. But, I personally think that each agency should have to show sincerity in this working. It will be successful and achievable.	-	-
<i>Nonverbal</i>			
<i>Facial Expressions</i>	-	-	-
<i>Gestures</i>	-	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	Because Thailand has the designs to set up many CORS by various organisations.	-	-
<i>Posture</i>	-	-	-
<i>Power</i>	I do not know in the future how long the NGB will stay and how much power it will still have.	The nature of Thailand is that as soon as they are assigned as the main unit, they do anything their own way because they think it's their authority.	-
<i>Nonverbal</i>			
<i>Facial Expressions</i>	As I said from the beginning, CORS wouldn't have been built if it wasn't because of the military government.	-	-
<i>Gestures</i>	In terms of the locations, there still be limitations. The DOL has the least restrictions because land	-	-

Code Name	Focus group	Expert	Follow up
	offices are spread across the country. The RTSD has only a centralised one. There must be an approval request for the place to be used as a site for the RTSD.		
<i>Humour</i>		-	-
<i>Paralinguistics</i>	Talking about the holdings, if I hold shares at a moderate level, and soon after, I can gather people, I will gain power, right?	-	-
<i>Posture</i>	The RTSD came last.	-	-
Number of CORS	The DOL has a lot; the DPT also has a lot.	It should probably be an organisation, such as the DOL or something like this, which takes care of a lot of CORS.	At that time, there was no CORS station.
<i>Nonverbal</i>			
<i>Facial Expressions</i>	For example, the DOL has a lot; the DPT also has a lot.	-	-
<i>Gestures</i>	For example, the DOL has a lot; the DPT also has a lot.	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	Talking about the fiscal budget of our country and the limitations of each organisation, everyone will have a different quantity of the stations.	-	-
<i>Posture</i>	For example, the DOL has a lot; the DPT also has a lot.	-	-

Code Name	Focus group	Expert	Follow up
Source of Problem	The DOL is gradually installing its network due to the constraints of obtaining the budget that is split into 3 phases. The RTSD will install its system separately. Then it turns out that if there is a CORS integration, we do not know yet whether the CORS networks can be combined into an extensive system or not.	Most of the representatives who joined the meeting didn't quite understand the technique.	It is quite quiet without progress because of the pandemic of the coronavirus.
<i>Nonverbal</i>			
<i>Facial Expressions</i>	As far as I've ever seen, the budget for integration resulted in unsuccessful integration because the owners' agencies spent this money on something else.	-	-
<i>Gestures</i>	The problem is that it hasn't been integrated, but they had the budget to do it. But the actor who took this action hasn't been able to use the budget yet. So the ones who had the budgets can set it up first.	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	The RTSD will set up their own system. So if there is an integration, we don't know whether CORS can be extended to a large scale extent.	-	-

Code Name	Focus group	Expert	Follow up
<i>Posture</i>	These two can't be together because they have made them differently (hahaha). The DPT built it sparsely. The DOL also created its own set. The RTSD came last.	-	-
Finance	It's on a budget of our country and the limitations of each organisation.	They probably won't do that because it uses the taxpayers' budget. If they buy it, they must share data.	At this time, there is no budget.
International Financial Support	Japan and China would probably help. As for other countries, it depends on what they think they will get from Thailand.	For the Japanese government, the Cabinet Office is the one that is trying to drive this. They try to get us to request funding or support. At first, they wanted to sponsor CORS installation. But, later, when we discussed it in the subcommittee, we replied that we already had it. We have to invest on our own.	-
<i>Nonverbal</i>			
<i>Facial Expressions</i>	-	-	-
<i>Gestures</i>	-	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	-	-	-
<i>Posture</i>	-	-	-

Code Name	Focus group	Expert	Follow up
Investment	I think the investment capital in establishing CORS stations is considerable. So no company would take the risk of investing in it. I think we have to depend on the government anyway.	CORS is an investment by the government, which does not allow the private sector to install.	Use the revenue for investment.
Additional Investment	For the adding matter, firstly, is there the fund; secondly, is there the user? That's all.	In the past, we tried to enforce using IGS standards as the priority. However, many organisations had limitations; they did their best. For the established part, it is difficult to change.	The DOL has installed additional CORS but is not yet complete as planned.
<i>Nonverbal</i>			
<i>Facial Expressions</i>	This one is hard to say because the agency that will be the central unit should be the one who has to install more.	-	-
<i>Gestures</i>	Uh, all in all, it passed the central unit, through the board, there was a committee consider what you proposed. We can see that it already exists or, ok, I agree here's still lacking it, should be added.	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	It's not that adding it. If you want to set it up, set it up. Or something like that.	-	-
<i>Posture</i>	You have to ask how many is enough. How many bases are enough for Thailand? You have to	-	-

Code Name	Focus group	Expert	Follow up
	design first, realistically; how many stations is enough?		
Foreign Countries Investment	Like China, they want to set it up. They will use their own budget. The question is, can they do it? And whether it can join with National CORS?	China came in later on. They approached the DOL and said they would install CORS as well, which would be around 100-150 more stations. However, the Chinese team did not make it clear as far as I can see. It was just making overtures.	-
<i>Nonverbal</i>			
<i>Facial Expressions</i>	-	-	-
<i>Gestures</i>	-	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	-	-	-
<i>Posture</i>	-	-	-
Maintenance and Renewal	Because, for CORS, when it is time, if there is no way to take care of it, even if it is useful, it is nothing. Can you imagine?	If you provide data continuously and pass the criteria, you will get a budget for the station's maintenance. Something like this can actually happen. Ultimately, we must use a budget to control.	The RTSD is concerned about the maintenance budget. Where should it come from? Maybe the Royal Thai Armed Forces Headquarters – Should try to ask for a budget from this organisation first. Or maybe from the government.
<i>Nonverbal</i>			
<i>Facial Expressions</i>	(Only partially) Yes, it should have come.	-	-
<i>Gestures</i>	Because we know that the life cycle is two months, no matter	-	-

Code Name	Focus group	Expert	Follow up
	what, it will not be down within two months for sure. That is, doing preventive maintenance is ok; if you have money, you can do it often.		
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	CORS needs MA. For now, it's still under warranty. After the contract expires, there will be an MA; and MA is per year. Hahaha!	-	-
<i>Posture</i>	I can say that in Thailand, in a while, CORS will be worthless. Because if we don't have a maintenance budget, it will die in less than five years. Every organisation, I bet, as once the contract is over.	-	-
New Investment	More stations indeed have to be created. But the enlargement size depends on the user's need for accuracy and precision.	The new installation should comply with the standard as well.	The RTSD installed their CORS already.
<i>Nonverbal</i>			
<i>Facial Expressions</i>	Then some organisations don't have it and want to set it up. Two weeks ago, there was the AEROTHAI that will set up its own CORS station.	-	-
<i>Gestures</i>	There are two models: the model that an agency can have its own budget, then invest and connect to	-	-

Code Name	Focus group	Expert	Follow up
	the data centre later to become part of the network that covers all. The second model is to send a request to the main unit or the data centre about where it is still missing. If it's indispensable, they have to request a budget to set up.		
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	For the government sector, it is the help to develop. It will come up with useful stations and be used thoroughly. And it's really worth installing it. Anyway, it must be clear that the government must not lose.	-	-
<i>Posture</i>	Then some organisations don't have it and want to set it up. Two weeks ago, there was the AEROTHAI that will set up its own CORS station.	-	-
<i>Nonverbal</i>			
<i>Facial Expressions</i>	In terms of government agencies, it's not an investment, just that we propose to ask for the budget from the government. But the way to propose a budget depends on what channel we will offer.	-	-
<i>Gestures</i>	When it's time, the government agencies that desire it will not have a budget. So the central unit has to	-	-

Code Name	Focus group	Expert	Follow up
	deal with and wait for the budget because requesting a few stations will be a waste of time. Asking for the entire country, where there is a lack, there must be a survey and complete it, that's all.		
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	I think the investment capital in establishing CORS stations is considerable.	-	-
<i>Posture</i>	It's probably a layer of investment style. And in any part where it's the duty of the government sector, the government has to provide and then let it go. But if the government has to invest more, then, in the end, there will be things that the private sector or even the government itself can easily take advantage of, like this.	-	-
Private Sector Investment	In our country, the private sector is not looking at the big scale. They may set up only one site to manage their stuff. There is very little to set up for themselves because the station has a very high investment.	One reason is that they are not confident that the implementation CORS network in Thailand will not fail because the aviator matters can't crash.	-
<i>Nonverbal</i>			
<i>Facial Expressions</i>	-	-	-
<i>Gestures</i>	-	-	-
<i>Humour</i>	-	-	-

Code Name	Focus group	Expert	Follow up
<i>Paralinguistics</i>	In our country, the private sector is not looking at the big scale. They may set up only one site to manage their stuff. There is very little to set up for themselves because the station has a very high investment.	-	-
<i>Posture</i>	-	-	-
<i>Nonverbal</i>			
<i>Facial Expressions</i>	Oh! It's been three years that the 200 stations haven't been finished setting up. Secondly, if I don't mistake it, the budget for hydro management has already been three years that can't be completed. And Japan has asked for two years and still haven't received it. I finally lost hope.	-	-
<i>Gestures</i>	There is cooperation, but when it concerns budget, there are two units.	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	Suppose you don't have a budget this year; you have to ask the government. But suppose a private agency comes in, you can decrease it. Well, they're accounting and management. They are the budget plan.	-	-
<i>Posture</i>	Budget finding, we can find a budget through the needs of those	-	-

Code Name	Focus group	Expert	Follow up
	who own CORS. Help them find it and send them money; that's all. If it's not enough, let's talk about it later.		
ROI	The overall frame of investment in developing the country is that the government benefits, the private sector benefits, and the country benefits in terms of income return and increased productivity.	Please don't focus on making money to prove its worth. On the other hand, its benefits should be able to quantify in numbers.	Most of the services are provided for education, research and development, such as Khon Kaen University, the Department of Science Service (DSS), and GISTDA.
Design	For the government sector, if there is logistics, it will reduce the cost quite a lot.	However, it depends on how well we can promote usability. If the civil sector has a stake in terms of increasing utilisation, when there are more users, there will be a number of transactions. Let's say tens of billions or hundreds of billions.	The Working Capital Office is responsible for revenue from services.
<i>Nonverbal</i>			
<i>Facial Expressions</i>	-	-	-
<i>Gestures</i>	-	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	-	-	-
<i>Posture</i>	-	-	-
Expect	What each agency will receive in return, overall, it should be able to use the same system throughout the country.	For me, I think that the private sector is civilian. When the private sector makes a profit, part of that will be returned to the state in the form of income tax.	-
<i>Nonverbal</i>			

Code Name	Focus group	Expert	Follow up
<i>Facial Expressions</i>	-	-	-
<i>Gestures</i>	-	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	The overall frame of investment in developing the country is that the government benefits, the private sector benefits, the country benefits in terms of income return and increased productivity. Something like this.	-	-
<i>Posture</i>	-	-	-
<i>Nonverbal</i>			
<i>Facial Expressions</i>	-	-	-
<i>Gestures</i>	-	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	-	-	-
<i>Posture</i>	-	-	-
Human Resources and Responsibilities	There should be, especially academics, they need to join. There must be lecturers from the universities. Because if there are only government agencies that own the assets, it will be the same.	Now we have the one to take care of it. As you know, it's the RTSD.	-
<i>Nonverbal</i>			

Code Name	Focus group	Expert	Follow up
<i>Facial Expressions</i>	-	-	-
<i>Gestures</i>	-	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	-	-	-
<i>Posture</i>	-	-	-
Professional and Representative	For the matter of money, we need to find a financial professional.	We must not think that it is beneficial to the private sector. If they specialise in marketing, they will make it possible.	Prof. Dr Chalermchon Satirapod is the head of the working group.
<i>Nonverbal</i>			
<i>Facial Expressions</i>	Well, actually, if it's a matter of law, this has to be an expert, right?	-	-
<i>Gestures</i>	There are only the experts in this area gathering? What is this? It's biased.	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	As they have a committee here, directors should scrutinise your coming because there are qualified members representing the agencies in the committee.	-	-
<i>Posture</i>	So this one, we might be able to get from the experts who came to help us gain knowledge of that part. But the point to argue is that the benefits must be returned.	-	-
Staff and Organisation	To use a man, dispatch jobs, assign people to work on tasks, should consider whether a person and a task would be a match.	There may be a GNSS unit that is responsible for this. Don't put other tasks on them.	For the operator, it has been supervised by the Geodesy and Geophysics Division, which is the section responsible for surveying.

Code Name	Focus group	Expert	Follow up
<i>Nonverbal</i>			
<i>Facial Expressions</i>	-	-	-
<i>Gestures</i>	To use a man, dispatch jobs, assign people to work on tasks, should consider whether a person and a task would be a match.	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	Regarding the personnel, people are like, eh, the data centre doesn't have personnel like this or people that, ah, I don't know what to say, well, don't judge them, it's not good.	-	-
<i>Posture</i>	To use a man, dispatch jobs, assign people to work on tasks, should consider whether a person and a task would be a match.	-	-
Training and Development	Before starting, we should have some knowledge. Such knowledge is about the actual meaning of that matter and who will get involved.	It's their habits. That is, if any matters they understand, they will instruct. They will be ready to get to know.	The RTSD provides knowledge to some organisations, such as the Agricultural Land Reform Office (ALRO), which requested instruction, and the RTSD sent officers to explain them.
<i>Nonverbal</i>			
<i>Facial Expressions</i>	This knowledge requires equipment A, B and C. Let's see in Thailand where A is, where B is. Who and where is the one who really knows how A B C D works together? There might be; it's not	-	-

Code Name	Focus group	Expert	Follow up
	that it doesn't exist at all, but because they don't know each other.		
<i>Gestures</i>	One of the main functions of this area is how to do it right by knowledge.	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	I think we should learn it first. Let's have some research.	-	-
<i>Posture</i>	This knowledge requires equipment A, B and C. Let's see in Thailand where A is, where B is. Who and where is the one who really knows how A B C D works together? There might be; it's not that it doesn't exist at all, but because they don't know each other.	-	-
Plan and Policy	For the security policy, let's say "Green" is a theme; you have to ask marketers how it can benefit. Green will mention whether it poses a huge risk to national security or not.	Currently, each organisation has its own concept, but they have not yet reached an agreement.	-
Business Model	Such organisation exists. The GISTDA is streamlined. It is a public	We must reach an agreement that we will charge or not charge, how	The number of users in the private sector has consistently increased.

Code Name	Focus group	Expert	Follow up
	organisation, more flexible, able to do business. It can take responsibility or share the money with the transferred central agency, or something like this.	it is open, something like that. But must have an agreement.	The graph is gradually increased, and the line is not steep.
Compare with Others	Experiences from other countries, there will be an intermediary between CORS administrators and users. There will be a company or something like that which specialises in it. They are more flexible in doing business. At the same time, they have the knowledge that can develop the application or add on to the solution.	In Japan, the GSI takes care of the whole network. They found local offices in various places to take care of the station only because their system was already known. They spent a period of time promoting it until everyone realised that this service was necessary. Then they created the local offices for control.	Do it the same way as the working capital for the aerial photo production office that brings income from aerial photography and LiDAR into the fund.
<i>Nonverbal</i>			
<i>Facial Expressions</i>	GNSS is the same. If there are concessions, it's like digital TV now; they all turn to youtube.	-	-
<i>Gestures</i>	For example, in Japan, they also have two series; one supervises hardware, the other supervises service. But the hardware team also take care of some service data.	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	The rails are built by the government. But laying the rails	-	-

Code Name	Focus group	Expert	Follow up
	and running the electric train will be operated by the private.		
<i>Posture</i>	Like NB-IoT of AIS, spread at once in 76 provinces. After finishing it, they sell the starter kit that has been developed.	-	-
<i>Design</i>	It was put forward that the RTSD should be the National CORS, the DOL and the GISTDA are the backup sites, and the GISTDA will also be the provider too.	The government has to run it for a while. If all of a sudden, a civilian does it, it's quite... Well, the government has to keep it stable first. This one is important.	The fee for the private sector are offered in the packages as follows: 2-weeks price of 1,000 baht, 1-month price of 1,500 baht, 6-months price of 4,000 baht, and 1-year price of 6,000 baht.
<i>Nonverbal</i>			
<i>Facial Expressions</i>	-	-	-
<i>Gestures</i>	-	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	It was put forward that the RTSD should be the National CORS, the DOL and the GISTDA are the backup sites, and the GISTDA will also be the provider too.	-	-
<i>Posture</i>	-	-	-
<i>Expect</i>	It is a concession similar to the NBTC that grants the broadcast concession. Let it go. How much did you bid? You pass the concession income to the state. Then you collect the service fee from the users. If Thailand has this structure, it might be good.	The point I am concerned about is how to make it worthwhile. That is, we need to promote its use in all sectors. Whether it's free or not, we don't know yet. But we must try to encourage as many users as possible.	They expect to build a business model. The RTSD thinks that it is due to the expectation of the Japanese private sector and their business.

Code Name	Focus group	Expert	Follow up
<i>Nonverbal</i>			
<i>Facial Expressions</i>	We view these as infrastructure, which is likely to create economic value.	-	-
<i>Gestures</i>	They will service only raw data. They will give raw data, but they will sell the RTK. This one we would have to study. To me, I think they should be in one place.	-	-
<i>Humour</i>		-	-
<i>Paralinguistics</i>	It's similar to the NBTC's broadcast concession. Let's get it; say how much you can bid. And then you send the concession income to the government. Then you collect the service fee from the users. If Thailand has this form, it might be good.	-	-
<i>Posture</i>	If the government views these things as infrastructure, even if it's not profitable, it caused high value from its application; it's actually worth providing.	-	-
<i>Nonverbal</i>			
<i>Facial Expressions</i>	We don't have marketing at all.	-	-
<i>Gestures</i>	When looking at farming, we view them as system users in the field of innovation applications.	-	-
<i>Humour</i>	-	-	-

Code Name	Focus group	Expert	Follow up
<i>Paralinguistics</i>	This business model is important. The private sector wants to use high-precision data; they have to invest. If we have a clear business plan, they can join.	-	-
<i>Posture</i>	The license system is ok, but I don't know. We don't know. We view the property invested by the government as infrastructure. It should be fully utilised. People or any unit that can employ it to create economic value should use it.	-	-
Legislation	For security matters, there is no GNSS law in our country.	I am most concerned about this. If the policy framework for the use of CORS is unclear, it will be related to various legal matters that we must urgently solve.	-
Compare with Others	The laws for governing GNSS technology the countries like Australia and Japan already have.	The case EEC came out as the laws to promote investment.	-
<i>Nonverbal</i>			
<i>Facial Expressions</i>	I can say that I have to learn the model from foreign countries first to see how they think.	-	-
<i>Gestures</i>	There is a law to support it because each country has a law that supports it to set a standard.	-	-
<i>Humour</i>	-	-	-

Code Name	Focus group	Expert	Follow up
<i>Paralinguistics</i>	For security matters, there is no GNSS law in our country. But the countries like Australia and Japan already have.	-	-
<i>Posture</i>	There is a degree of enforcement that just like what UAVs do, don't fly too high, uh, 500, how high it is, 700, 500 feet, uh, no flying around here, well, it's like that.	-	-
Design	Take Australia as a guideline, like the station must have the following formats. Next, it must be bundled with the service, support, etc.	Issues related to international relations or foreign affairs, you have to have someone specialised in these take it. For example, they are good at foreign affairs, particularly legal matters; just let them study the laws, rules and regulations about these things to see what they can do. Abroad, how do they do? So what should we do?	-
<i>Nonverbal</i>			
<i>Facial Expressions</i>	Someone already drafted this. Someone around here already outlined it.	-	-
<i>Gestures</i>	-	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	Take Australia as a guideline, like the station must have the following formats. Next, it must be bundled with the service, support, etc.	-	-

Code Name	Focus group	Expert	Follow up
<i>Posture</i>	I think it's quite a big problem, as far as I ask the agencies. Because it has a law code involved.	-	-
Expect	It might be at the level of the National CORS Act.	Because the laws were codified before these technologies, they've never supported them.	-
<i>Nonverbal</i>			
<i>Facial Expressions</i>	It might be at the level of the National CORS Act.	-	-
<i>Gestures</i>	The cooperation committee does not have an Act or person who is directly responsible.	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	Regarding the law that supports it, others do not easily utilise the governmental assets; there must be a law to support it.	-	-
<i>Posture</i>	Law is like a double-edged sword; that's fine if it's set for the government or government agencies. But if it's already set up, manage it like the private sector wants to set up their stations, then sell it to device manufacturers or start-ups. In some cases, if you set up a law to set up a wall like this, it will be difficult to find people to invest.	-	-
<i>Nonverbal</i>			

Code Name	Focus group	Expert	Follow up
<i>Facial Expressions</i>	For security matters, there is no GNSS law in our country.	-	-
<i>Gestures</i>	There must be legal to support that there's a penalty if you don't inform or don't have permission, and it's illegal. Because, ah, it affects using the coordinates.	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	Particularly the signal service, or maybe the different types or different laws.	-	-
<i>Posture</i>	We have to do it. I don't know. Now, there's nothing or almost none. Thailand doesn't have any.	-	-
<i>Nonverbal</i>			
<i>Facial Expressions</i>	The Green only speaks for the security policy; let's say "Green" is a theme; you have to ask marketers how it can benefit. Green will mention whether it poses a huge risk to national security or not.	-	-
<i>Gestures</i>	The Green only speaks for the security policy; let's say "Green" is a theme; you have to ask marketers how it can benefit. Green will mention whether it poses a huge risk to national security or not.	-	-
<i>Humour</i>	-	-	-

Code Name	Focus group	Expert	Follow up
<i>Paralinguistics</i>	When it's done, it should still be in it; it will be sustainable development. Not only just 20 years, then it's over. Keep it going to keep everything involved. If it's already on the road maps, what should we do? I don't want it ends when it's finished. I want it to be sustainable. Keep doing it.	-	-
<i>Posture</i>	-	-	-
Plan	I separate the issue of CORS and the subject of the data centre, so CORS is something that anyone can have. That is, if it happens as planned, it's good.	Soon, there must be a customer service centre or something like this; the private sector is much more flexible, even about the station's maintenance.	-
Compare with Others	Like many countries, the USA doesn't have a single owner. Japan has three owners, which are three private sectors. But I don't know how foreign countries are; they mostly have one owner.	Like Japan, they outsource to the private sector. You take care and do not let the station... If this station is down, there must be a guarantee that it must be back in operation within minutes or hours.	-
<i>Nonverbal</i>			
<i>Facial Expressions</i>	May consider Japanese models because of the Japanese culture. For the finance issue, I think there should be only one agency that mainly takes care of the station and the coordinate system.	-	-
<i>Gestures</i>	Looking through the Japanese style, they have already completed	-	-

Code Name	Focus group	Expert	Follow up
	their CORS network, so the structures are clear and easy to see.		
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	Actually, in my ideal opinion, it should be like that. Do it like the way Australia has done. If everyone had nothing to do with politics. If they can be together, that would be great.	-	-
<i>Posture</i>	In terms of the NIMT, it doesn't matter. There are also many agencies working on metrology. It has a long history, but it seems like the NMIT has to be established. They can do it suddenly because of the organisation's character, right?	-	-
Infrastructure Plan	A station's design can't be changed too much due to factors like the proper radius, location, and the person responsible for maintaining it. It can't just be placed in a wasteland—it needs electricity, staff, and security fences, or the equipment might go missing.	If we look at it as infrastructure, it must be given importance. Then we have to find a reliable organisation or subcontractor that can fix and repair it immediately.	The total CORS installation plan of 282 stations: the DOL has 181 stations that 134 stations have been completed, and 47 stations were in additional installation plan in 2021, the RTSD completed 80 stations with no additional installation plan, the DPT completed 15 stations with no additional installation plan, the HAI completed 6 stations with no additional installation plan.
<i>Nonverbal</i>			

Code Name	Focus group	Expert	Follow up
<i>Facial Expressions</i>	Well, I'm still confused.	-	-
<i>Gestures</i>	A station can't be adjusted to a great degree because of the proper radius, the location, and the person who will take care of the base. Otherwise, the base can't be located in the wasteland. There must be electricity, people, fences, or else the tools will be lost.	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	At present, this thing is not available because we have to avoid it.	-	-
<i>Posture</i>	It's possible. This one, to me, if it's 200, it's enough at some level. But, which provinces do we need to supplement?	-	-
International Cooperation Plan	I would respectfully disagree with this statement. In my opinion, I still don't see how foreign countries will place importance on CORS in Thailand.	We have to ask, what benefits do we get from that? If we benefit, I agree. But it's not that only we can benefit. If they can take advantage and we can too, that's okay.	The working group on Thai-Japanese Cooperation is now focusing mainly on capacity building and promotion.
<i>Nonverbal</i>			
<i>Facial Expressions</i>	-	-	-
<i>Gestures</i>	-	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	-	-	-
<i>Posture</i>	-	-	-
Management Plan	The cooperation must be phased. Joining together must have a	I think the easiest way is to force through budgeting for station	If the system is down during this warranty period, the company will

Code Name	Focus group	Expert	Follow up
	consolidation plan. A preliminary plan is to stream data from each part and task in the first phase. Then how do we manage it? And in phase 2, if there is an organisation or agency that we agreed directing it, we will know the next duties of each agency.	maintenance. If you don't join this network, you will have to find it on your own.	go to the site according to the contract conditions. The urgency depends on the distance factor of the CORS and how many hours they must access.
Central Network	After GNSS CORS is installed in the entire country and integrated, there will be a system with homogeneous coordinates for the whole country.	There should be an attempt to retrieve data from each section. That's all. Merging means just streaming data.	The National Data Center (by the RTSD) has now tested the data linking with relevant organisations.
Central Unit	The NGB sets up a sub-committee. And there is a committee on the National CORS. At present, the RTSD has been decided in the meeting that it will be the National CORS as the central controller.	I think, in the beginning, they should integrate. But they don't have to produce the data product themselves. They just manage the network. As for the data product, they don't have to make it.	The RTSD now serves as the semi-National CORS.
<i>Nonverbal</i>			
<i>Facial Expressions</i>	I think having a central agency is good as well. Same as everyone.	-	-
<i>Gestures</i>	The central unit can retrieve data and then dispense services.	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	Only one agency is more flexible to fix the problem in some aspects. That kind of situation has two sides.	-	-

Code Name	Focus group	Expert	Follow up
<i>Posture</i>	We have to separate them. The one we called National Data Center or CORS Data Center, we want it.	-	-
Leader	In the beginning, they should be the owners.	Only the GISTDA and the RTSD at that time tried to compete for roles back then.	The National Data Center (by the RTSD)
<i>Nonverbal</i>			
<i>Facial Expressions</i>	Even though they are very competent, their characters are inappropriate; they can't show leadership.	-	-
<i>Gestures</i>	There must be leadership. Leadership isn't that you're a powerful organisation, but it can be from various factors.	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	So they separately lead it, right?	-	-
<i>Posture</i>	The leadership in this matter is probably the national data centre that has to be the one to show leadership because if it's not, it will be the same.	-	-
<i>Nonverbal</i>			
<i>Facial Expressions</i>	It's unbelievable that we've waited for 10.. 30.. 4.. years to start the first network that almost covers the whole country. Another network still has to wait and see. It's unbelievable, but it's okay.	-	-

Code Name	Focus group	Expert	Follow up
<i>Gestures</i>	In fact, we have talked about it at the network structure design stage. Asked if it exists or not, it does. However, the problem is our network coverage is not full. If it's full, we need a talk between the organisations. The concern is the inter-agency problem. If we can talk, it's done.	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	Each part has to take care of itself. Ah, looking on the bright side, there will be cooperation. Some management work, we may avoid by letting others, who are more skilled at it, do it. If you can look at it like that. But there also are disadvantages.	-	-
<i>Posture</i>	The integration is good. But the problem is that if they are together as a National CORS, how will they find a perfect point that will meet the needs of both the whole country and the organisations' missions.	-	-
Individual Network	The DOL had its own network for a long time. The RFD also has its own thing.	The DOL also has its network, which mainly serves land surveying. It is its specific mission. They do not expect the accuracy of a meter or meters level. They need	The RTSD has set up their CORS Data Center already.

Code Name	Focus group	Expert	Follow up
		a centimetre level. They then can complete missions.	
<i>Nonverbal</i>			
<i>Facial Expressions</i>	The RTSD was the first place; the DOL also installed itself, right? The RFD also built itself. Including this, the LDD also has it, right? But there are a few.	-	-
<i>Gestures</i>	The NIMT installed it under the project of the DDPM. That is, the DDPM purchased it for the HAIL and the NIMT.	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	Actually, CORS was built to support the missions of each organisation, such as the DOL.	-	-
<i>Posture</i>	The organisations that built the CORS mostly have their own missions or responsibilities, such as the DOL.	-	-
<i>Nonverbal</i>			
<i>Facial Expressions</i>	It has to count from 1. It has to have a plan. Suppose that ten people say that this is okay. You stand alone and say no because 1, 2, 3. Why didn't you start counting 1? Finally, we must look at whether it's good or bad.	-	-
<i>Gestures</i>	In fact, if we assume that there will be many levels in our country, the	-	-

Code Name	Focus group	Expert	Follow up
	host could be either Academic hosts, Technical hosts, Strategic hosts, Politics hosts. Well, if it's necessary, let's categorise it into levels so that there are levels that can work together, something like this.		
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	Will pass through the National CORS channel, but policy matter has not been discussed.	-	-
<i>Posture</i>	Try to accommodate everyone and make them have no more excuses to say that they need to do this.	-	-
<i>Nonverbal</i>			
<i>Facial Expressions</i>	Because it is an infrastructure, if there isn't any, it's difficult to move forward.	-	-
<i>Gestures</i>	-	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	Australia, well, what name it is, even said that if it started, they would like to be a data centre, too. What is its name? I can't remember. It's from Leica.	-	-
<i>Posture</i>	I separate the issue of CORS and the subject of the data centre, so CORS is something that anyone can have. That is, if it happens as planned, it's good.	-	-

Code Name	Focus group	Expert	Follow up
Policy	Policy for the users or existing owners focuses on the after buying and installing stage. It depends and has diversity.	The policy must be adopted for management matters.	-
Compare with Others	GNSS CORS policy development, for example, USA, Australia, and Japan, these CORS have been since twenty years ago. Of course, they were installed almost at the same time. Those are developed countries.	There must be a policy and a road map that keeps moving: for 10-years, 20-years, I don't know, 20 years is probably too far. The foreign countries may not have like this. In Thailand, it is because they follow the government guidelines.	-
<i>Nonverbal</i>			
<i>Facial Expressions</i>	Must learn from other countries, what structure they have done.	-	-
<i>Gestures</i>	For example, USA, Australia, and Japan, these CORS have been since twenty years ago. Of course, they were installed almost at the same time. Those are developed countries.	-	-
<i>Humour</i>	It's like a road; they built it, but it depends on the user to use it. When you misuse it and blame the road builder for why they made it wrong? It can't be like that. They have to finish building the road. And when the road was built, it was misused; they must arrest the person who misused it.	-	-

Code Name	Focus group	Expert	Follow up
<i>Paralinguistics</i>	Japan, yes, there should be a government agency. However, they might let Japan manage part of it, but the real big one controlling the policy has to be the government sector.	-	-
<i>Posture</i>	I can say that I have to learn the model from foreign countries first to see how they think.	-	-
Design	It should be a cooperation that allows all organisations to participate. If only one organisation becomes the centralised authority and controls everything exclusively, there will be no integration. Should enable all organisations to participate in policy or management.	We try to set up the National CORS. They have already set out some policies.	-
<i>Nonverbal</i>			
<i>Facial Expressions</i>	-	-	-
<i>Gestures</i>	-	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	-	-	-
<i>Posture</i>	It's in terms of cooperation. But in terms of policy, we have to think about it later. But in my opinion, I believe it should be a cooperation that, ah, all organisations are involved. Ah, if one agency is a centralised unit and controls	-	-

Code Name	Focus group	Expert	Follow up
	everything alone, it wouldn't happen.		
Expect	CORS cooperation in Thailand has an impromptu characteristic; everyone jumps in first and talks later. It's not like having a master plan and making long-term policies that really matter. But because they do not want to miss the trend.	Instead of using the word committee or something like that, use it as an A-team, B-team, anyway, and when we come up with ideas together, we use the brainstorming method like what we used to do, but it's not official.	-
<i>Nonverbal</i>			
<i>Facial Expressions</i>	If Thailand sets it up, I can tell it's definitely a mess. In Thailand, it will force too much, then unable to do anything.	-	-
<i>Gestures</i>	Just laying the national positioning infrastructure. But the matter of business expansion must be the private sector. Therefore, Thailand's economy can be driven because of the private sector.	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	Now you have to do this. If this happens, if something is down, how long do you have to fix it or coordinate or something. Must have a clear format.	-	-
<i>Posture</i>	Cooperation is okay. It's just that now the official letter for confirmation. If the executives have been changed....	-	-

Code Name	Focus group	Expert	Follow up
<i>Nonverbal</i>			
<i>Facial Expressions</i>	How long do you think the CORS will be? Because it is tied to policymaking.	-	-
<i>Gestures</i>	Its own network and it also provides its data service. In fact, Thailand has no compulsory rules or regulations, saying that anyone can set it up. The truth is like this.	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	After buying and installing it, a policy is as possible and varies.	-	-
<i>Posture</i>	A policy is from the government that is the Prime Minister.	-	-
Standard	We should develop a standard like this.	Overall, there already is a standard like RINEX. Something like this will be forced indirectly. For the procurement, there will be a specification for control, which most organisations proceed following others.	-
Compare with Others	An example is NOAA which has approximately 2,000 bases or more. They are not only from the central unit; they're also from others. But there is a standard that the members must meet. There are guidelines about the CORS stations, data transfer, and the	In European countries, such as when they talked about standards like ISO, they had not copied the ISO for aerospace standards. They didn't use some of them. They didn't take them all.	-

Code Name	Focus group	Expert	Follow up
	specification for the process to join the network.		
<i>Nonverbal</i>			
<i>Facial Expressions</i>	-	-	-
<i>Gestures</i>	An example is NOAA which has approximately 2,000 bases or more.	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	-	-	-
<i>Posture</i>	An example is NOAA which has approximately 2,000 bases or more.	-	-
Design	Try to meet IGS standards first.	Take the ones that are suitable only. The criteria accepted internationally; we only refer to them.	-
<i>Nonverbal</i>			
<i>Facial Expressions</i>	-	-	-
<i>Gestures</i>	-	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	-	-	-
<i>Posture</i>	-	-	-
Expect	The NIMT should be an intermediary that behaves like the one who will set the utilisation standard. Use it to measure the device as a reference at the international level.	It's more important to make the network more stable.	-
<i>Nonverbal</i>			

Code Name	Focus group	Expert	Follow up
<i>Facial Expressions</i>	They'll see what the network looks like, so they'll see the reliability that will happen is the same as international. I'm talking about global, not about this country. I think it's ok, but it will take a lot to push it stable like Chulalongkorn University.	-	-
<i>Gestures</i>	There must be another control over the standard to guarantee that it is data released by the National CORS. It is a guarantee of accuracy, reliability, mean value, and continuity.	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	Shortly, this standard has to be settled but will be issued by whom.	-	-
<i>Posture</i>	There should be a central standard for whoever will join the network. There should be a standard or a collaboration model.	-	-
<i>Nonverbal</i>			
<i>Facial Expressions</i>	The country must have the identity of being Thai.	-	-
<i>Gestures</i>	Emphasis on the internationalisation of the measurement system, including standardisation of tools and personnel competency. There are many issues.	-	-

Code Name	Focus group	Expert	Follow up
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	It might have a different form than ours; for example, it might be secondary CORS or something that has a pattern you have to follow.	-	-
<i>Posture</i>	Developing measurement standards, how do we know that our developed measurement standards are acceptable?	-	-
Technology	An autonomous vehicle will become operative for sure. Therefore, if GPS positioning is accurate, it will happen because the trend indicates the general tendency to that. No matter the surveying system or others, they're all linked with GPS.	I think the cloud-based is the best. You can do whatever it takes to use cloud-based. GBAS is already enforced by its nature. SBAS, I don't think it could.	-
Access	Is accessibility covered there? Because we, as a government, must remain neutral.	Talking about the users who will access them, Okay, we would see that the private sector should be the main part. No matter the transport or those in agriculture, they are essential.	For the website, we can access the services at https://cors.rtsd.mi.th/sbc
<i>Nonverbal</i>			

Code Name	Focus group	Expert	Follow up
<i>Facial Expressions</i>	-	-	-
<i>Gestures</i>	Is accessibility covered there? Because we, as a government, must remain neutral and maintain our integrity.	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	We have a system that allows the private sector and various agencies to use this service.	-	-
<i>Posture</i>	Consider whether user authorising is okay or not. Therefore, we have to talk clearly first about who has the authority to add users, who will have what authority and what level of power.	-	-
Delivery	The data streaming from the station will have delayed. The delay may affect something.	We want data. There are many types of streams: Post-processing, Offline, Semi-Real-time or Real-time streams. There are several grades. It depends on what kind of stream you want.	There should be both primary and secondary channels for both the CORS and the Data Centre. In addition, it is confident that the internet system is much better than before.
<i>Nonverbal</i>	-	-	-
<i>Facial Expressions</i>	It's not that the HAIL owns stations; it has to send it out. I think it's too many routes. It's too many ways.	-	-
<i>Gestures</i>	-	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	In other forums, when I lecture, they will always focus on cooperation in this field.	-	-

Code Name	Focus group	Expert	Follow up
<i>Posture</i>	An example of the rules is that you need to apply for it with the National CORS if it's a business.	-	-
Infrastructure	In terms of the government, I think that at the moment, it's just laying the national positioning infrastructure.	If we look at it as a national resource, all organisations have joined together. This network is no longer considered an individual asset; it must be seen as Thailand's asset developed from tax money. So how to make it the most worthwhile use.	A brief overview of the current status is that most organisations are almost finished installing their CORS. The RTSD installed their CORS already. The DOL has installed additional CORS but is not yet complete.
Network	The DOL intended to form a network.	The DOL also has its network, which mainly serves land surveying. It is its specific mission.	It is nationwide coverage, including the border of the country except in Tak or Kanchara Buri, which are mountainous areas, the CORS may not reach.
<i>Nonverbal</i>			
<i>Facial Expressions</i>	The problem isn't from the CORS; it has been since it was the triangulation.	-	-
<i>Gestures</i>	The DOL intended to form a network. But it has stopped. Why doesn't it continue?	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	It turned out that some areas are acute triangles.	-	-
<i>Posture</i>	The closest private sector that can be seen is Topcon. Topcon already	-	-

Code Name	Focus group	Expert	Follow up
	has its own network and services data.		
<i>Nonverbal</i>			
<i>Facial Expressions</i>	-	-	-
<i>Gestures</i>	Have to look at it as parts. We look at it as parts. For example, when we talk about GNSS CORS, for me, we look at the form of a structure or a network.	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	-	-	-
<i>Posture</i>	Now, for data transfer, we want to use, uh, the internet that, uh, the government already has. But they may not know the importance of the role of being the infrastructure in data communication over the network.	-	-
<i>Standalone</i>	However, in the beginning, it wasn't the CORS performed as a network.	-	-
<i>Nonverbal</i>			
<i>Facial Expressions</i>	-	-	-
<i>Gestures</i>	When complete performing independent operation, the restrictions are at 10 km.	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	CU installed it long ago to enable data for studying and a lot of research.	-	-

Code Name	Focus group	Expert	Follow up
<i>Posture</i>	-	-	-
<i>Nonverbal</i>			
<i>Facial Expressions</i>	When would this system be obsolete?	-	-
<i>Gestures</i>	The technology has been utilised for a long time.	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	In the next five years, what we're discussing or bringing to talk about right now may be out or obsolete already.	-	-
<i>Posture</i>	The matter of technology is hard to say, but it can be said that it's still deficient.	-	-
Technique	In terms of the technical team, the state of current coordination is pretty good.	The DOL focuses on the land plots. The RTSD aims at the reference frame for the control points. That is, they only look at their tasks. But they do not see how the future of Thailand will progress if there is no such support from this facility.	The baseline distance is 30 - 40 km. It is + 3 cm accuracy nationwide coverage.
Data	The streaming via the CORS database should be no problem. But it may require the formats of streaming. However, most of the time, it's in the standard format.	They have to convert it into another format in order to use the service. It's not just providing the raw information.	The RTSD uses data from the DOL, only about 40 stations for forming the network because using many stations will waste processing resources.
<i>Nonverbal</i>			
<i>Facial Expressions</i>	In conclusion, we use their data. But calculating the coordinates, we	-	-

Code Name	Focus group	Expert	Follow up
	use ours. Or if they will use ours, it's up to them.		
<i>Gestures</i>	In addition to references regarding the coordinates, we provide reference services. In the future, it was intended to provide corrections as well.	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	One is the coordinates, and another one of their coordinates.	-	-
<i>Posture</i>	The DPT is interested because they give RINEX data, but you can use it to do post-processing yourself.	-	-
Hardware	Trimble can't take it anymore; it needs a complete upgrade.	Nowadays, hardware doesn't cost much in replacing receivers. The price has dropped a lot because of the technology trends.	The RTSD needs storage for archiving data from the stations to back up at the RTSD.
<i>Nonverbal</i>			
<i>Facial Expressions</i>	Buy it! It is hardware, like Mi8 surveying equipment.	-	-
<i>Gestures</i>	Accuracy means buying better tools! But actually, maybe accuracy isn't just buying better tools.	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	In the future, to expand the station, the hardware is important. If we are the buyer only, we will feel bad. We also need to be producers of parts or anything that	-	-

Code Name	Focus group	Expert	Follow up
	is a maintenance part or something like this.		
<i>Posture</i>	The way they made it low-priced sometimes it's because of tools.	-	-
<i>Nonverbal</i>			
<i>Facial Expressions</i>	It is bundled with hardware only, but what about software and knowledge? There are various matters.	-	-
<i>Gestures</i>	Let's say we have Leica instruments and take them as part of the network. Does Leica perform VRS? It performs MAC, right? They operate a MAC data centre; they should also be able to provide MAC service.	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	They might not be able to approach our area. They can choose the location.	-	-
<i>Posture</i>	If you work related to the DOL, you use the DOL's system. But if it's road surveying, you use the central system.	-	-
Software	For the software, we should be co-developers because each country has different requirements. Thus, the development of software capabilities.	I think it is necessary because each program has its advantages and disadvantages. But they haven't talked about this; they still don't understand this issue at the subcommittee level.	Leica Spider Business Centre is the software that came with the RTSD CORS.

Code Name	Focus group	Expert	Follow up
<i>Nonverbal</i>			
<i>Facial Expressions</i>	We should have set the spec. I think it wouldn't have many choices. If we say we will force using VRS only, you have to use it only. If we can control using the VRS, we can control anything else, including the MAC.	-	-
<i>Gestures</i>	I don't know whether other countries that operate many stations use the same thing.	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	For the software, we should be co-developers because each country has different requirements. Thus, the development of software capabilities.	-	-
<i>Posture</i>	I've come across a case that uses the XYZ equation of the RTSD to adjust Indian datum like this. I don't think it's reliable. Using it could cause distortion. How suppose it can be to use the same number for the whole country?	-	-
Technology Focus	In Thailand, it has already begun. We can see from Kubota. Regarding the drones, in Suphanburi, I saw a drone spraying insecticide.	In case we can provide service from CORS that gives the more precise and more accurate position for their car.	-

Code Name	Focus group	Expert	Follow up
Compare with Others	In Japan, most of the use is in agricultural tools.	In Japan, they chose a program that could provide two types of corrections parallelly. It uses the concept of VRS and FKP, which is from Germany.	-
<i>Nonverbal</i>			
<i>Facial Expressions</i>	I saw a model of the Electricity Authority in Location-Based Services. The Electricity Authority and the Waterworks Authority should be proficient in this.	-	-
<i>Gestures</i>	IGS also communicates with people in the network who are associate members via email.	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	Like the IGS, there will be sites worldwide, and they will put everything on the web, IGS web; we can click into it.	-	-
<i>Posture</i>	The case in Japan or the case in our country last year, I can tell you that 30% of hard disks disappeared from the world in 2011 because the hard disk factory here was ruined.	-	-
Drive in Thailand	d as the person who is directly affected.	Next, it will be mandated by ICAO (International Civil Aviation Organization) to establish GNSS to provide the corrections. The facility	It is to emphasise the usage stimulation.

Code Name	Focus group	Expert	Follow up
		provided from the base station is required for operation.	
<i>Nonverbal</i>			
<i>Facial Expressions</i>	It's a push from one side that they want to use it. The government sector uses it.	-	-
<i>Gestures</i>	The drive is not as straightforward as the person who is directly affected.	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	GNSS in the future maybe not be very important because the cell-based one would be much better.	-	-
<i>Posture</i>	The private sector can do anything right away. The government agencies have different boundaries. Ah, it would be better.	-	-
<i>Nonverbal</i>			
<i>Facial Expressions</i>	It has been said that other technologies go further. It's like digital TV. If there are concessions now, it's ruined and ruined.	-	-
<i>Gestures</i>	Suppose we pass by the shop, oh, it comes up! There's a 50% discount right away! Okay, it's useful, right?	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	In Thailand, it has already begun. We can see from Kubota. Regarding the drones, in	-	-

Code Name	Focus group	Expert	Follow up
	Suphanburi, I saw a drone spraying insecticide.		
<i>Posture</i>	-	-	-
Tool	We provide the position. They already have a GPS device; it can show the rough coordinates because they perform VRS, and they won't get the precise coordinates. They will get rough coordinates the same as a single handheld, like a cell phone GPS.	For CORS management, I think Mobile Based is still not that necessary.	The RTSD also purchased 20 rovers.
Device	There are Android phones that support these corrections, but they're high-priced.	For the service sector, applications for general use, moving into Mobile Based allows the user group to be expanded.	The problem is that the government sector is interested in using the services but does not have a rover.
<i>Nonverbal</i>			
<i>Facial Expressions</i>	It has many advantages as well as many disadvantages. It's easy, but the Thai are careless.	-	-
<i>Gestures</i>	It must be, but it doesn't have to be mobile at all. I don't see a need at all.	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	-	-	-
<i>Posture</i>	Using a mobile is a matter of modern times.	-	-
LBS	Location-Based Services can be applied variously.	Using technology to manage the location makes it much easier. Bringing in technology, Okay, so it will be able to visualise where it is.	-

Code Name	Focus group	Expert	Follow up
		Actually, it's good. It's certainly fine. I indeed agree.	
<i>Nonverbal</i>			
<i>Facial Expressions</i>	Actually, this one by itself is already like that.	-	-
<i>Gestures</i>	Suppose we already have a data centre. Do you think this data centre should have a 24-hour watchman? If there is a 24-hour watchman, why do we need a mobile?	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	It still can't see that much. These matters can be seen in the installation contract more than the expiration of the warranty period.	-	-
<i>Posture</i>	To me, it's not necessary. One day, there might be software. I'm trying to think about the user; the user is probably the one who will reach the area. They should know if there are some network failures.	-	-
<i>Nonverbal</i>			
<i>Facial Expressions</i>	-	-	-
<i>Gestures</i>	-	-	-
<i>Humour</i>	-	-	-
<i>Paralinguistics</i>	The surveyors have to determine the approximate position for us and send us the location. They	-	-

Code Name	Focus group	Expert	Follow up
	already have GPS devices, which can show rough coordinates.		
<i>Posture</i>	-	-	-

TABLE A - 25 A summary of the empirical findings from the different data sources (Source: Author's own research)

Code Name	Focus group		Expert		Follow-up	
	Files	References	Files	References	Files	References
Collaboration	1	1	3	14	1	6
Agreement	5	31	3	27	0	0
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	1	1	-	-	-	-
<i>Gestures</i>	1	2	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	2	3	-	-	-	-
<i>Posture</i>	0	0	-	-	-	-
Foreign Case	5	8	2	6	0	0
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	2	3	-	-	-	-
<i>Gestures</i>	2	4	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	3	3	-	-	-	-
<i>Posture</i>	2	2	-	-	-	-
International	6	100	3	37	0	0
China	5	21	2	13	1	1
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	1	2	-	-	-	-
<i>Gestures</i>	3	8	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	3	5	-	-	-	-
<i>Posture</i>	4	9	-	-	-	-
Financial Support	1	5	3	10	0	0
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	0	0	-	-	-	-
<i>Gestures</i>	1	2	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	0	0	-	-	-	-
<i>Posture</i>	1	2	-	-	-	-
Japan	6	44	3	22	3	17
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	3	4	-	-	-	-
<i>Gestures</i>	3	5	-	-	-	-
<i>Humour</i>	1	3	-	-	-	-
<i>Paralinguistics</i>	5	8	-	-	-	-
<i>Posture</i>	3	7	-	-	-	-
Neighbouring Countries	3	59	3	32	1	2
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	3	12	-	-	-	-
<i>Gestures</i>	2	9	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	3	38	-	-	-	-
<i>Posture</i>	1	7	-	-	-	-
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	5	17	-	-	-	-

Code Name	Focus group		Expert		Follow-up	
	Files	References	Files	References	Files	References
<i>Gestures</i>	5	20	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	6	54	-	-	-	-
<i>Posture</i>	3	25	-	-	-	-
Other Countries	5	70	3	9	0	0
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	2	3	-	-	-	-
<i>Gestures</i>	2	6	-	-	-	-
<i>Humour</i>	1	1	-	-	-	-
<i>Paralinguistics</i>	4	13	-	-	-	-
<i>Posture</i>	3	14	-	-	-	-
Research Collaboration	5	13	2	8	0	0
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	1	1	-	-	-	-
<i>Gestures</i>	2	2	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	4	14	-	-	-	-
<i>Posture</i>	1	1	-	-	-	-
Technology Support	5	21	3	7	1	4
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	3	3	-	-	-	-
<i>Gestures</i>	2	4	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	4	12	-	-	-	-
<i>Posture</i>	2	4	-	-	-	-
Inter-organisational	6	69	3	34	0	0
Government-Government	5	60	3	32	6	36
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	3	10	-	-	-	-
<i>Gestures</i>	4	12	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	5	17	-	-	-	-
<i>Posture</i>	4	22	-	-	-	-
Government-Private	5	60	3	24	0	0
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	2	5	-	-	-	-
<i>Gestures</i>	4	7	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	2	27	-	-	-	-
<i>Posture</i>	4	10	-	-	-	-
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	4	5	-	-	-	-
<i>Gestures</i>	5	10	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	5	50	-	-	-	-
<i>Posture</i>	6	18	-	-	-	-
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	0	0	-	-	-	-
<i>Gestures</i>	0	0	-	-	-	-

Code Name	Focus group		Expert		Follow-up	
	Files	References	Files	References	Files	References
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	1	2	-	-	-	-
<i>Posture</i>	0	0	-	-	-	-
Power	6	14	3	29	0	0
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	2	2	-	-	-	-
<i>Gestures</i>	1	1	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	3	7	-	-	-	-
<i>Posture</i>	3	4	-	-	-	-
Number of CORS	5	52	3	9	1	1
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	2	4	-	-	-	-
<i>Gestures</i>	3	3	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	4	12	-	-	-	-
<i>Posture</i>	3	10	-	-	-	-
Source of Problem	6	154	3	82	1	4
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	5	22	-	-	-	-
<i>Gestures</i>	5	27	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	6	57	-	-	-	-
<i>Posture</i>	3	24	-	-	-	-
Finance	5	25	3	6	3	9
International Financial Support	0	0	2	7	0	0
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	0	0	-	-	-	-
<i>Gestures</i>	0	0	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	0	0	-	-	-	-
<i>Posture</i>	0	0	-	-	-	-
Investment	5	25	3	7	1	1
Additional Investment	2	32	1	3	3	6
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	2	4	-	-	-	-
<i>Gestures</i>	1	4	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	1	5	-	-	-	-
<i>Posture</i>	1	2	-	-	-	-
Foreign Countries Investment	0	0	3	17	0	0
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	0	0	-	-	-	-
<i>Gestures</i>	0	0	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	0	0	-	-	-	-
<i>Posture</i>	0	0	-	-	-	-

Code Name	Focus group		Expert		Follow-up	
	Files	References	Files	References	Files	References
Maintenance and Renewal	6	30	3	12	1	3
Nonverbal	0	0	-	-	-	-
Facial Expressions	3	4	-	-	-	-
Gestures	3	3	-	-	-	-
Humour	0	0	-	-	-	-
Paralinguistics	5	10	-	-	-	-
Posture	3	5	-	-	-	-
New Investment	4	26	2	7	3	5
Nonverbal	0	0	-	-	-	-
Facial Expressions	2	3	-	-	-	-
Gestures	2	5	-	-	-	-
Humour	0	0	-	-	-	-
Paralinguistics	3	8	-	-	-	-
Posture	3	9	-	-	-	-
Nonverbal	0	0	-	-	-	-
Facial Expressions	4	6	-	-	-	-
Gestures	3	4	-	-	-	-
Humour	0	0	-	-	-	-
Paralinguistics	2	5	-	-	-	-
Posture	3	7	-	-	-	-
Private Sector Investment	1	6	3	6	0	0
Nonverbal	0	0	-	-	-	-
Facial Expressions	0	0	-	-	-	-
Gestures	0	0	-	-	-	-
Humour	0	0	-	-	-	-
Paralinguistics	1	4	-	-	-	-
Posture	0	0	-	-	-	-
Nonverbal	0	0	-	-	-	-
Facial Expressions	2	4	-	-	-	-
Gestures	1	1	-	-	-	-
Humour	0	0	-	-	-	-
Paralinguistics	3	9	-	-	-	-
Posture	3	9	-	-	-	-
ROI	0	0	3	7	1	2
Design	0	0	2	8	1	7
Nonverbal	0	0	-	-	-	-
Facial Expressions	0	0	-	-	-	-
Gestures	0	0	-	-	-	-
Humour	0	0	-	-	-	-
Paralinguistics	0	0	-	-	-	-
Posture	0	0	-	-	-	-
Expect	1	6	2	6	0	0
Nonverbal	0	0	-	-	-	-
Facial Expressions	0	0	-	-	-	-
Gestures	0	0	-	-	-	-
Humour	0	0	-	-	-	-
Paralinguistics	1	4	-	-	-	-
Posture	0	0	-	-	-	-
Nonverbal	0	0	-	-	-	-

Code Name	Focus group		Expert		Follow-up	
	Files	References	Files	References	Files	References
<i>Facial Expressions</i>	0	0	-	-	-	-
<i>Gestures</i>	0	0	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	0	0	-	-	-	-
<i>Posture</i>	0	0	-	-	-	-
Human Resources and Responsibilities	0	0	3	25	0	0
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	0	0	-	-	-	-
<i>Gestures</i>	0	0	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	0	0	-	-	-	-
<i>Posture</i>	0	0	-	-	-	-
Professional and Representative	4	27	3	50	1	6
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	1	1	-	-	-	-
<i>Gestures</i>	2	4	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	2	2	-	-	-	-
<i>Posture</i>	2	5	-	-	-	-
Staff and Organisation	3	10	2	19	3	6
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	0	0	-	-	-	-
<i>Gestures</i>	1	2	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	2	6	-	-	-	-
<i>Posture</i>	1	1	-	-	-	-
Training and Development	2	10	2	6	3	5
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	1	3	-	-	-	-
<i>Gestures</i>	1	2	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	1	1	-	-	-	-
<i>Posture</i>	1	2	-	-	-	-
Plan and Policy	3	6	3	14	1	1
Business Model	6	79	2	15	1	3
Compare with Others	6	23	2	16	1	2
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	1	3	-	-	-	-
<i>Gestures</i>	3	5	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	5	8	-	-	-	-
<i>Posture</i>	1	3	-	-	-	-
Design	1	4	2	18	3	19
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	0	0	-	-	-	-
<i>Gestures</i>	0	0	-	-	-	-

Code Name	Focus group		Expert		Follow-up	
	Files	References	Files	References	Files	References
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	1	2	-	-	-	-
<i>Posture</i>	0	0	-	-	-	-
Expect	6	57	3	30	1	1
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	4	8	-	-	-	-
<i>Gestures</i>	4	6	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	6	33	-	-	-	-
<i>Posture</i>	2	7	-	-	-	-
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	4	13	-	-	-	-
<i>Gestures</i>	4	14	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	5	30	-	-	-	-
<i>Posture</i>	3	12	-	-	-	-
Legislation	5	40	3	12	0	0
Compare with Others	3	23	1	4	0	0
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	3	4	-	-	-	-
<i>Gestures</i>	1	5	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	2	4	-	-	-	-
<i>Posture</i>	1	3	-	-	-	-
Design	3	21	2	2	0	0
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	2	6	-	-	-	-
<i>Gestures</i>	0	0	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	3	5	-	-	-	-
<i>Posture</i>	2	2	-	-	-	-
Expect	5	90	3	8	0	0
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	3	8	-	-	-	-
<i>Gestures</i>	2	12	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	5	28	-	-	-	-
<i>Posture</i>	2	11	-	-	-	-
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	2	3	-	-	-	-
<i>Gestures</i>	1	3	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	4	9	-	-	-	-
<i>Posture</i>	2	3	-	-	-	-
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	1	1	-	-	-	-
<i>Gestures</i>	1	1	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	1	1	-	-	-	-

Code Name	Focus group		Expert		Follow-up	
	Files	References	Files	References	Files	References
<i>Posture</i>	0	0	-	-	-	-
Plan	1	13	2	10	0	0
Compare with Others	6	21	3	5	0	0
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	3	3	-	-	-	-
<i>Gestures</i>	2	4	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	4	10	-	-	-	-
<i>Posture</i>	3	4	-	-	-	-
Infrastructure Plan	5	31	3	22	3	8
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	1	1	-	-	-	-
<i>Gestures</i>	4	6	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	3	11	-	-	-	-
<i>Posture</i>	1	3	-	-	-	-
International Cooperation Plan	0	0	3	19	3	14
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	0	0	-	-	-	-
<i>Gestures</i>	0	0	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	0	0	-	-	-	-
<i>Posture</i>	0	0	-	-	-	-
Management Plan	6	137	3	45	1	2
Central Network	6	69	3	20	4	12
Central Unit	6	179	3	48	5	18
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	6	18	-	-	-	-
<i>Gestures</i>	4	26	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	6	100	-	-	-	-
<i>Posture</i>	5	29	-	-	-	-
Leader	4	33	3	31	2	4
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	2	2	-	-	-	-
<i>Gestures</i>	1	6	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	3	12	-	-	-	-
<i>Posture</i>	1	1	-	-	-	-
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	4	5	-	-	-	-
<i>Gestures</i>	3	11	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	4	25	-	-	-	-
<i>Posture</i>	3	11	-	-	-	-
Individual Network	5	23	2	10	4	14
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	1	1	-	-	-	-

Code Name	Focus group		Expert		Follow-up	
	Files	References	Files	References	Files	References
<i>Gestures</i>	3	5	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	3	14	-	-	-	-
<i>Posture</i>	2	3	-	-	-	-
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	6	15	-	-	-	-
<i>Gestures</i>	5	20	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	6	59	-	-	-	-
<i>Posture</i>	3	31	-	-	-	-
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	1	4	-	-	-	-
<i>Gestures</i>	0	0	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	1	2	-	-	-	-
<i>Posture</i>	1	2	-	-	-	-
Policy	6	52	3	14	0	0
Compare with Others	4	9	2	2	0	0
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	1	4	-	-	-	-
<i>Gestures</i>	1	1	-	-	-	-
<i>Humour</i>	1	1	-	-	-	-
<i>Paralinguistics</i>	2	3	-	-	-	-
<i>Posture</i>	2	2	-	-	-	-
Design	1	1	3	6	0	0
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	0	0	-	-	-	-
<i>Gestures</i>	0	0	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	0	0	-	-	-	-
<i>Posture</i>	1	1	-	-	-	-
Expect	6	94	3	18	0	0
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	2	4	-	-	-	-
<i>Gestures</i>	4	8	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	5	67	-	-	-	-
<i>Posture</i>	4	11	-	-	-	-
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	4	9	-	-	-	-
<i>Gestures</i>	3	5	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	5	25	-	-	-	-
<i>Posture</i>	4	8	-	-	-	-
Standard	6	57	2	6	0	0
Compare with Others	2	2	2	4	0	0
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	0	0	-	-	-	-
<i>Gestures</i>	1	1	-	-	-	-

Code Name	Focus group		Expert		Follow-up	
	Files	References	Files	References	Files	References
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	0	0	-	-	-	-
<i>Posture</i>	1	1	-	-	-	-
Design	2	4	3	9	0	0
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	0	0	-	-	-	-
<i>Gestures</i>	0	0	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	0	0	-	-	-	-
<i>Posture</i>	0	0	-	-	-	-
Expect	5	43	3	11	0	0
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	2	5	-	-	-	-
<i>Gestures</i>	2	5	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	3	9	-	-	-	-
<i>Posture</i>	2	8	-	-	-	-
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	2	3	-	-	-	-
<i>Gestures</i>	2	4	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	5	24	-	-	-	-
<i>Posture</i>	2	5	-	-	-	-
Technology	5	60	3	11	0	0
Access	4	10	1	2	1	5
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	0	0	-	-	-	-
<i>Gestures</i>	1	1	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	2	3	-	-	-	-
<i>Posture</i>	2	2	-	-	-	-
Delivery	3	7	2	11	2	13
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	1	1	-	-	-	-
<i>Gestures</i>	0	0	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	2	4	-	-	-	-
<i>Posture</i>	1	1	-	-	-	-
Infrastructure	3	9	2	10	3	10
Network	5	31	1	2	2	3
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	1	3	-	-	-	-
<i>Gestures</i>	2	9	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	1	5	-	-	-	-
<i>Posture</i>	2	9	-	-	-	-
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	0	0	-	-	-	-
<i>Gestures</i>	3	4	-	-	-	-

Code Name	Focus group		Expert		Follow-up	
	Files	References	Files	References	Files	References
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	0	0	-	-	-	-
<i>Posture</i>	2	3	-	-	-	-
Standalone	3	3	0	0	0	0
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	0	0	-	-	-	-
<i>Gestures</i>	2	2	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	2	2	-	-	-	-
<i>Posture</i>	1	1	-	-	-	-
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	4	11	-	-	-	-
<i>Gestures</i>	2	6	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	5	29	-	-	-	-
<i>Posture</i>	2	7	-	-	-	-
Technique	5	46	3	24	3	12
Data	6	41	3	41	4	23
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	2	3	-	-	-	-
<i>Gestures</i>	4	8	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	5	21	-	-	-	-
<i>Posture</i>	3	4	-	-	-	-
Hardware	5	30	3	3	1	6
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	1	2	-	-	-	-
<i>Gestures</i>	2	5	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	4	16	-	-	-	-
<i>Posture</i>	2	5	-	-	-	-
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	3	8	-	-	-	-
<i>Gestures</i>	2	9	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	4	11	-	-	-	-
<i>Posture</i>	3	12	-	-	-	-
Software	6	64	3	8	2	5
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	2	10	-	-	-	-
<i>Gestures</i>	2	8	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	6	16	-	-	-	-
<i>Posture</i>	2	9	-	-	-	-
Technology Focus	4	33	3	14	0	0
Compare with Others	6	24	2	16	0	0
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	3	3	-	-	-	-
<i>Gestures</i>	2	5	-	-	-	-

Code Name	Focus group		Expert		Follow-up	
	Files	References	Files	References	Files	References
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	3	4	-	-	-	-
<i>Posture</i>	2	5	-	-	-	-
Drive in Thailand	4	49	2	23	1	1
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	3	7	-	-	-	-
<i>Gestures</i>	2	4	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	2	7	-	-	-	-
<i>Posture</i>	3	8	-	-	-	-
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	3	7	-	-	-	-
<i>Gestures</i>	1	2	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	1	14	-	-	-	-
<i>Posture</i>	0	0	-	-	-	-
Tool	1	1	3	11	1	1
Device	5	34	3	11	2	6
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	2	4	-	-	-	-
<i>Gestures</i>	2	2	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	3	5	-	-	-	-
<i>Posture</i>	3	5	-	-	-	-
LBS	6	214	3	14	0	0
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	5	20	-	-	-	-
<i>Gestures</i>	4	17	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	5	64	-	-	-	-
<i>Posture</i>	3	16	-	-	-	-
<i>Nonverbal</i>	0	0	-	-	-	-
<i>Facial Expressions</i>	0	0	-	-	-	-
<i>Gestures</i>	0	0	-	-	-	-
<i>Humour</i>	0	0	-	-	-	-
<i>Paralinguistics</i>	1	1	-	-	-	-
<i>Posture</i>	0	0	-	-	-	-

TABLE A-26 below summarises the extent to which the primary data collected from the focus group, expert interviews, and follow-up interviews align with each category of key factors in the theoretical framework, namely collaboration, finance, human resources, plan and policy, and technology. In the table, “Y” indicates that the collected data include ideas or insights related to the corresponding factor, while “–” signifies that no relevant statements were identified. It should be noted, however, that the absence of such statements does not imply that the data are inconsistent with the factor; rather, it reflects that no explicit reference to that factor was made by participants.

TABLE A - 26 A comparison of findings between Thailand and Australia (Source: Author's own research)

Key factors regarding Theoretical Framework	Data Analysis			
	Focus group	Expert	Follow-up	Australia
Collaboration	Y	Y	Y	Y
Agreement	Y	Y	-	Y
Foreign Case	Y	Y	-	Y
International	Y	Y	Y	Y
Other Countries	Y	Y	Y	Y
Financial Support	Y	Y	-	Y
Research Collaboration	Y	Y	-	Y
Technology Support	Y	Y	Y	Y
Inter-organisational	Y	Y	Y	Y
Government-Government	Y	Y	Y	Y
Government-Private	Y	Y	-	Y
Power	Y	Y	-	Y
Number of CORS	Y	Y	-	Y
Source of Problem	Y	Y	-	Y
Finance	Y	Y	Y	Y
International Financial Support	-	-	-	Y
Investment	Y	Y	Y	Y
New and Additional Investment	Y	Y	Y	Y
Maintenance and Renewal	Y	Y	Y	Y
ROI	Y	Y	Y	Y
Preventable cost	-	-	-	Y
Profit	-	-	-	Y
Human Resources and Responsibilities	Y	Y	Y	Y
Professional and Representative	Y	Y	Y	Y
Staff and Organisation	Y	Y	Y	Y
Training and Development	Y	Y	Y	Y
Plan and Policy	Y	Y	Y	Y
Business Model	Y	Y	Y	Y
Legislation	Y	Y	-	Y
Plan	Y	Y	Y	Y
Infrastructure Plan	Y	Y	Y	Y

Key factors regarding Theoretical Framework	Data Analysis			
	Focus group	Expert	Follow-up	Australia
International Cooperation Plan	-	Y	-	Y
Management Plan	Y	Y	Y	Y
Central Network	Y	Y	Y	Y
Central Unit	Y	Y	Y	Y
Leader	Y	Y	Y	Y
Individual Network	Y	Y	Y	Y
Policy	Y	Y	-	Y
Standard	Y	Y	-	Y
Technology	Y	Y	Y	Y
Access	Y	-	Y	Y
Delivery	Y	Y	Y	Y
Infrastructure	Y	-	Y	Y
Network	Y	-	Y	Y
Standalone	Y	-	-	-
Technique	Y	Y	Y	Y
Data	Y	Y	Y	Y
Hardware	Y	Y	Y	Y
Software	Y	Y	Y	Y
Technology Focus	Y	Y	Y	Y
Drive	Y	Y	Y	Y
Tool	Y	Y	Y	Y
Device	Y	Y	Y	Y
LBS	Y	Y	-	Y

D.4 Theoretical - Empirical Congruency

Focus Group Interview Data Analysis

- **Ownership and governance**
 - Lack of effective infrastructure plan and monetary allocation plan for the whole country, “The DOL is gradually installing its network in three phases due to budget constraints, while the RTSD is setting up its system independently. As a result, if CORS integration is attempted, it remains uncertain whether these networks can be combined into an extensive system.”.
 - Limited scope of work, “The DOL still uses it for the land surveying mission as usual. The DPT still uses it for town planning surveying as usual. The RTSD also uses it for surveying as usual”.
 - Lack of common purpose, “The DPT had no intention of using real-time services; instead, it focused on providing RINEX data, allowing users to perform post-

processing regardless of distance. In contrast, the DOL aimed to establish a network.”.

- Lack of homogeneity of requirements, “It’s a government sector requirement. But what are the needs of the private sector?”.
- Lack of awareness, “We bought them though we didn’t even know that Thailand had them.”.
- Lack of harmonious conceptualisation, “The DOL had its own network for a long time. The RFD also has its own thing. Then said that they are in different areas. They have taken the area approach for a long time. In fact, this should be functional-based, which is bound with work, not determined by the area.”.
- Lack of equivalence of knowledge, “They focus solely on their areas of expertise.”.
- Lack of trust and reliability, “To claim that the references are from credible sources.”
- Lack of openness, “They must be open-minded, including being willing to disclose their methodology.”.
- Lack of co-working and meeting opportunities, “We may not have had many opportunities to talk with each other in the past.”.
- Lack of authority, “Everyone has to be mindful of whether it falls within our authority. Are we permitted to proceed?”.
- Lack of intermediary, “I think it lacks a host.”.

- ***Power asymmetries***

- Inequality in the government’s power, “CORS implementation would not have been possible without the presence of a military government.”.
- Inequality in the political endorsement, “While the DOL holds the most CORS data and the total number of CORS stations will eventually exceed a hundred, the RTSD will also operate 80 stations. Meanwhile, GISTDA, despite having minimal CORS infrastructure, strongly aspires to take the lead. This dynamic is likely driven by political influences.
- Inequality in the distribution of budget allocation, “Because of our fiscal budget and the constraints of each organisation, they will have a different amount of stations.”.
- Inequality in the priority, “Should take the owners with lots of CORS first; for example, the DOL has a lot, the DPT also has a lot.”.
- Inequality in the weight, “The RTSD came last. Though it came last, it’s very powerful.”.
- Inequality in the potential, “The central unit must find a budget, so it must be a powerful unit.”.

- Inequality in the power of organisation, “It could be anyone who is well equipped, with great power and budget.”.
 - Inequality in the existent internal resources, “In the beginning, it should be the one with the most assets.”.
 - Inequality in the resource arrangement power, “They must also have the power to acquire resources on their own.”.
 - Inequality in resource recruitment power, “If I hold shares at a moderate level, and soon after, I can gather people, I will gain power, right?”.
 - Inequality in the well-preparedness, “The DOL has the least restrictions because land offices are spread across the country. The RTSD has only a centralised one.”.
 - Inequality in the decision-making criteria, “It is not the first, but the most.”.
 - Inequality in the external drives, “Most of the propulsion will come from the surveying organisations or in connection with the surveying. It doesn't come directly from the private sector. I think this is the challenging part.”.
 - Inequality in authority to control and inspection, “We can screen anything we want. But that one is our standard power.”.
 - Lack of an administration in regard to authority, “Now the problem is that there is nothing to empower each one.”.
 - Lack of clarity in giving authority, “Who grants these powers? Is it the law? You can't just suddenly have such authority without legal backing.”.
 - Lack of obviousness of authority, “The defined authorities were outlined too broadly.”.
 - Lack of certainty in exerting authority, “Everyone has to be strictly mindful of whether it is within our authority. Can we do it?”.
 - Lack of effectiveness of authority, “There must be the real power in order to direct the operation sector.”.
 - Lack of sustainability of the authority, “I do not know in the future how long the NGB will stay.”.
- ***Interaction processes and supporting technologies***
 - Lack of adequacy of arrangements, “No matter how much we do, it doesn't complete the coverage area.”.
 - Lack of practical design, “You have to ask how many is enough. How many bases are enough for Thailand? You have to design first, realistically; how many stations is enough?”.
 - Lack of big-picture vision, “At the moment, the government is just laying the national positioning infrastructure.”.

- Lack of homogeneous requirements, “The HAIL and the NIMT thought there must be a levelling control point as a reference station for checking the height. It's a vertical control point. So they set up their CORS.”.
- Lack of adequacy of finance, “At that time, the ideal national CORS network was estimated at around 400 stations based on academic guidelines recommending a 30–50 km baseline distance. However, due to budget constraints and separate allocations for each organization, the plan was adjusted to add 200 more stations to maximize coverage as effectively as possible.”.
- Lack of authority for cooperation, “The location of CORS is a significant limitation if there is no master plan. If there is a government policy so that they can command the municipality. CORS sites are now only at the land office.”.
- Lack of fundamental requisite, “The RTSD, as they say, doesn't have an available CORS site. They had to lean on the land office.”.
- Lack of appropriate site selection procedure, “Choosing a site should focus on the location of the land offices as a priority. We try to pick these because it is easy and convenient to find.”.
- Lack of facility for security, “There need to be fences, or the equipment might go missing.”.
- Lack of a co-working programme, “When integrating base station locations, there should be a discussion on how to set them up and use them collaboratively. The placement should be strategically planned to maximise benefits for the country.”.
- Lack of coordination on the CORS site planning, “In some areas, certain organisations have already set up their CORS. Since we've also established ours within this radius, there's no need for other departments to do the same. It's better to share resources and focus on other priorities together.”.
- Lack of overall CORS distribution design, “Integrating CORS for the whole country, where it's already dense, we probably won't install it because it is considered redundant.”.
- Lack of facility management, “A station's design can't be changed too much due to factors like the proper radius, location, and the person responsible for maintaining it. It can't just be placed in a wasteland—it needs electricity, staff, and security fences.”.
- Lack of common goal, “In the beginning, it is not the CORS that is formed as a network.”.
- Lack of technical concerns administration, “It doesn't progress. It is partly because the CORS is not a network.”.
- Lack of practical technological development plan, “We do not look at it as separate parts, don't we? Have to look at it as parts. We look at it as parts. For

example, when we talk about GNSS CORS, for me, we look at the form of a structure or a network. It's a group of receivers setting up as the stations.”.

- Lack of prioritisation, “Cooperation should be prioritised. The first is to set up a station.”.
- Lack of awareness of public services, “We want to use the internet that the government sector already has for data transfer. But they may not be aware of their important roles as an infrastructure in the field of data communication over a network.”.
- Lack of awareness of its importance, “Suppose they know that their network has something important, they might do or take care of it better than it is.”.
- Lack of technological readiness, “Using mobile devices it's not for now. But in the future, it might be. It's coming.”.
- Lack of budget for technology, “But it concerns a budget or something; it is expensive. Android phones that support these corrections exist but have a high price. But in the future, it will likely have a lower price. That is, the opportunity to use it on mobile devices or the general accessibility is likely to be higher.”.
- Lack of service quality, “An autonomous vehicle will become operative for sure. Therefore, if GPS positioning is accurate, it will happen.”.
- Lack of public service for the agricultural sector, “Farming already uses it, yet they have their own stations. It's a mobile base that is moveable. If our structure is complete, I think they will use it for sure because it can reduce the cost partially.”.
- Lack of awareness of applied technology, “It has already begun. We can see from Kubota. Regarding the drones, in Suphanburi, I saw a drone spraying insecticide.”.
- Lack of security control, “Using a drone for delivery, I see that this technology is going to happen. So I can register for the committee that I use specifically for this purpose. It might need to be secure or encrypted, or someone could hack my drone.”.
- Lack of awareness of the obsolescence of technology, “Technology has moved past that—people don't watch traditional or digital TV anymore; they've switched to YouTube. It's the same with GNSS—everyone now relies on Cell-Based systems.”.
- Lack of keeping up with the evolution of disruptive technology, “Technology is further. Further is not that significant, but it's very swift. It changes rapidly.”.
- Lack of innovation management, “In the future, CORS will be smaller and cheaper. But there will be a lot more. How are we going to deal with these?”.
- Limited knowledge development of technology, “Along the way, we have learned so we can catch up on technology. It's certainly good.”.

- Lack of assessment protocol for the new coming technology, “Is it convenient? It's undoubtedly convenient. But, is it worth? That's all.”.
- Lack of enlightenment of recognition and rationality, “Technology makes it possible. But the challenge is, afterwards, how can we use it awarely and rationally?”.
- Lack of balance between cultural working behaviour and technology, “Can our work culture go as far as the technology itself?”.

- ***Setting direction of collaboration***

A number of barriers greatly impact completing the infrastructure and developing the central administration of CORS in Thailand. The adoption and establishment of inter-organisational collaboration on GNSS CORS would be taken into consideration to formulate the structure of cooperation between diverse stakeholders. Coded data indicated that the partakers subscribed to this proposition, as captured from the orientations below.

- Agree to the collaboration between organisations, “I agree to have cooperation.”.
- Agree to the collaboration between Thailand and foreign countries, “We need to collaborate with other countries since we're not yet a technology developer ourselves.”.
- Give importance to the international collaboration issues, “What do they want from the investment? Such things they want from the investment, can we provide them? And will it justify giving them?”.
- Legislate in this area, “If there is a law, it's all easy. If there's no law, it's all unsmooth.”.
- Adopt policies, “The government, specifically the Prime Minister, should propose the policy, incorporating input from committee members (key stakeholders), the Permanent Secretary, and the Minister.”.
- Design the policies, “As case studies, we can learn from countries like the USA, Australia, or Japan, which are developed countries. So what we're doing or policy-making, I think it is easier because there are exemplars.”.
- Design a collaboration structure, “It must be a board or a working group with authority. Cooperation should not be just a signing of an MOU.”.
- Give authority and design approval protocol, “Must have the authority to set up or empower any committee, working group, sub-committee. There is authority and may report to the NGB; the Prime Minister will approve directly.”.
- Design an authorisation protocol, “The Minister sets up a committee consisting of representatives from organisations involved in this. And then there might be experts.”.

- Design authorisation level, “It doesn’t have to be the RTSD; just set an authorisation level that the DOL has the authority to access and authorise the users.”.
- Design authority for each stakeholder, “Clear protocols must be established in advance to define the authority levels and responsibilities for managing user access to the system.”.
- Design the decision-making procedure, “Maintenance budget requests shall be submitted to the Office of the National Geo-informatics Board (NGB), which falls under the Office of the Prime Minister, by the Board, itself under the NGB's supervision. The Office of the NGB is likely responsible for budget preparation.”.
- Design a security control scheme, “Robust security measures must be implemented to protect executive access from unauthorised intrusion.”.
- Design the matters in the collaboration, “At least, there should be a specification that we have to comply with them.”.
- Design the product quality guarantee, “The data should be provided continuously.”.
- Design the standard of the network, “We wish some of our CORS could be part of the IGS network.”.
- Design the technical issues handling for the central network, “For the National CORS, there will be a common reference frame. At the same time, due to each organisation's mission, they still need to use their own frames. This is the first of the problems that may occur in the matter of the management software.”.
- Design for product strength, “We can use it as a reliable reference.”.
- Design the service strategy, “If we have a transparent service policy, they are ready for the service requesting.”.
- Design the marketing plan, “Government organisations will receive access to services at no cost, whereas private sector users will be subject to a fee structure.”.
- Design for project encouragement, “The external drive will make it happen more effortless than the push from the government.”.
- Design for the maintenance plan, “If we collect money for the central unit and use it for maintenance, I think it's not enough. It will take a fiscal budget to subsidise anyway, but at least it's the sum of money that will help to keep the National CORS moving forward.”.
- Design for human resources, “Marketing should not use GIS officers or surveyors; it has to bring in the staff who have marketing or MBA educational background.”.

Expert Interview Data Analysis

- ***Ownership and governance***

- Lack of effective infrastructure plan and monetary allocation plan for the whole country, "It's no matter which organisations they are. Every government organisations use the tax money. If there's no cooperation, it will turn out that we work duplicated anyway."
- Limited scope of work, "The DOL will use for land parcels, right? The RTSD will also use the reference frame for the control points. Well, they didn't see that... I mean, they only focus on their major jobs."
- Lack of common purpose, "The DOL may want to provide some services of their own. Because other organisations may take it for different objectives."
- Lack of homogeneity of requirements, "They have different requirements".
- Lack of awareness, "They aren't involved in this group, so they don't know that this kind of activity is happening. They then proposed that they want to install their own CORS to serve the airports."
- Lack of harmonious conceptualisation, "We have to find a way to minimise the differences in the level of understanding and talk to each other on the same platform."
- Lack of equivalence of knowledge, "There is inequality in the level of understanding. It's very much. It's very distinct."
- Lack of trust and reliability, "One reason is that they are not confident that the implementing CORS network in Thailand will not fail."
- Lack of openness, "They think that the private sector will come for profit only."
- Lack of co-working and meeting opportunities, "There are few discussions within the subcommittee. At present, it seems that it rarely happens; there will be a meeting only when there is an issue."
- Lack of authority, "Must be able to proffer to the executives and then they make decisions."
- Lack of intermediary, "Who will be a host? I tried to push the RTSD to do it."

- ***Power asymmetries***

- Inequality in the government's power, "It takes time. And when it takes time, the superiors can't wait. The government or the executives can't wait."
- Inequality in the political endorsement, "But, after being taken by the RTSD, it seems to slow down a lot, much slower. So there are few discussions within the subcommittee."

- Inequality in the distribution of budget allocation, “Everyone must accept. The term accepts it is not just about admitting that you have a big budget.”.
- Inequality in the priority, “If these two organisations speak, the sound will be loud. Their voice is pretty loud.”.
- Inequality in the weight, “Small organisations may not be able to attend, but the big organisations are working together.”.
- Inequality in the potential, “It must be quite powerful. The term power does not mean only military power, but it's also a term like knowledge or acceptance.”.
- Inequality in the power of organisation, “GISTDA itself is not powerful enough. The RTSD also wants to take it. But they wanted a budget too.”.
- Inequality in the existent internal resources, “It should probably be an organisation, such as the DOL or something like this, which takes care of a lot of CORS.”.
- Inequality in the resource arrangement power, “The easiest way is to force through budgeting like station maintenance. If you don't join this network, you have to find your own way.”.
- Inequality in resource recruitment power, “Initially, GISTDA was given a role; many organisations were dissatisfied. They also showed awkwardness and did not want to cooperate. Consequently, this project failed.”.
- Inequality in the well-preparedness, “Sometimes, it's not just like you're more powerful or something. Sometimes, if you know more, we will accept.”.
- Inequality in the decision-making criteria, “Having it a lot or having it before is not good that much because it has a lot of weaknesses. The point is that it has multiple weaknesses to attack.”.
- Inequality in the external drives, “It's over 20 pieces of paper. It's like a power bank supporting us because it will have weight when talking to anyone.”.
- Inequality in authority to control and inspection, “Another kind of power will be the military, which takes the leading. If so, you have to make an order. You have to order, such as you do this, then do this. You have to command.”.
- Lack of an administration in regard to authority, “When we contribute something, we have to give them authority.”.
- Lack of clarity in giving authority, “The nature of Thailand is that as soon as they are assigned as the main unit, they do anything their own way because they think it's their authority. It will be proposed and voted on when it is passed to the sub-committee. The procedure will be succinct. If they are right, it's fine. If they are wrong, it will be complex.”.
- Lack of obviousness of authority, “As soon as they are assigned as the main unit, they do anything their own way because they think it's their authority.”.

- Lack of certainty in exerting authority, “Previously, GISTDA offered itself as a data centre and had a stake, so it was driven speedily. But, after being taken by the RTSD, it seems to slow down a lot, much slower.”.
 - Lack of effectiveness of authority, “ (If you become the central unit with no power and everyone doesn't respect you, you just have a position here. Those conversations will matter differently.”.
 - Lack of sustainability of the authority, “The change of Thai organisations' executives happens quite often. One year they were a director-general or director; later, these positions changed. So the synchronisation is scrappy. It's not continuous.”.
- ***Interaction processes and supporting technologies***
 - Lack of adequacy of arrangements, “The CORS of each organisation itself is not as large as those of the national central one.”.
 - Lack of practical design, “When we talk about the department like the DOL, I'm still surprised that the RTDS has just had it.”.
 - Lack of big-picture vision, “They don't want to change into the central one, but they wanted... If the others would turn into their platform, this one is okay.”.
 - Lack of homogeneous requirements, “One reason is that they are not confident that the implementation CORS network in Thailand will not fail because the aviator matters can't crash. There are different requirements.”.
 - Lack of adequacy of finance, “Whoever will take care of it will find the budget. Or the central unit will find it. Budget is a big deal.”.
 - Lack of authority for cooperation, “They'll listen, listen, but don't take action. Okay, so take it, take it and move.”.
 - Lack of fundamental requisite, “The DOL installed them at the Land Offices. The DPT installed them at the Provincial Civil Office.”.
 - Lack of appropriate site selection procedure, “We try to avoid the complexity. But it was redundant before; it's hard to say. If we try to relocate them, most of them were located at their own places.”.
 - Lack of facility for security, “In Japan, the GSI takes care of the whole network. They found local offices in various places to take care of the station only.”.
 - Lack of a co-working programme, “The organisations likely to set up the stations have to discuss compatibility first on how we would take forward. Then we need this subcommittee stamp out that 'Okay, we've already talked.'. Then they can deliver the project.”.
 - Lack of coordination on the CORS site planning, “The organisations likely to set up the stations have to discuss compatibility first on how we would take forward.”.

- Lack of overall CORS distribution design, “It actually should be like that. We have to bring those into CORS. Instead of installing them, we can relocate for better positions and distribution that avoids duplication.”.
- Lack of facility management, “We have to accept that the government sector itself doesn't have the potential to repair or recover the station. Like Japan, they outsource to the private sector. You take care and do not let the station... If this station is down, there must be a guarantee that it must be back in operation within minutes or hours. This one includes a power outage or something like this.”.
- Lack of common goal, “Now it's like everyone is standing apart at where they are, right? It seems a bit difficult to find common ground because everyone wants to have CORS. However, they see themselves as experts in their field.”.
- Lack of technical concerns administration, “Most of the representatives who joined the meeting didn't understand the work or technique well.”.
- Lack of practical technological development plan, “In order to bring in CORS, there must be an agreement upon the coordinate system and the host.”.
- Lack of prioritisation, “The chairman was the secretary of the ministry, which he had a lot of missions. If there is no secretary to notify, the issue will be missed.”.
- Lack of awareness of public services, “We have to talk to them that we have a service like this. Let's try to use it first and see it actually happens.”.
- Lack of awareness of its importance, “They spent a period of time promoting until everyone knew that this service was important, then they built local offices for taking care and supervision.”.
- Lack of technological readiness, “The fact that we do not have our own technology, and it's very difficult for us to develop our own technology. Nowadays, we buy equipment from China, right? They're quite reasonable. If you ask whether developing it on our own is difficult, it's pretty hard. In this country, the human resource with technical knowledge hasn't reached that point yet.”.
- Lack of budget for technology, “I don't know how ready it is in terms of technique. But if you allocate the budget, they then will be ready.”.
- Lack of service quality, “Everyone wants positioning data, right? They need location data that is reliable and real-time.”.
- Lack of public service for the agricultural sector, “The stakeholders in the CORS don't really know what the other sectors need. They haven't included smart farming.”.
- Lack of awareness of applied technology, “Like Kerry, it delivers parcels. It has a system to monitor its products. The more accurate position may help in terms of delivering their products faster, better, more accurately.”.

- Lack of security control, “I think maintenance should be outsourced. I think it concerns various things. There may be a jamming problem or other problems. The central unit probably couldn't deal with them.”.
- Lack of awareness of the obsolescence of technology, “Because of technology obsolescence, it has to be adjusted. It's possible. We may also have to look at the receiver to see the type of receiver you want to use that is not very expensive but can provide the data as well.”.
- Lack of keeping up with the evolution of disruptive technology, “It's just like a cellular telephone that when we see new 4G technology, we will not go back to using 3G or 2G. If it's better, people will use it. Or even the current mobile phone that it's better with two frequencies or something. If you get service from CORS, it's going to be even better. I even see it as an add-on making it accessible to the general civilians who use the service.”.
- Lack of innovation management, “CORS management, I think mobile-based technology is still not that necessary because there are few people. But, for general applications in the service sector, moving to mobile-based ones will expand the user group.”.
- Limited knowledge development of technology, “Ultimately, in terms of technology transfer, capacity building, or application promotion, I would say it's inevitable.”.
- Lack of assessment protocol for the new coming technology, “According to the Thai style, they like to have multiple organisations, but is it actually effective?”.
- Lack of enlightenment of recognition and rationality, “We have to find a way to minimise the differences in the level of understanding and talk to each other on the same platform.”.
- Lack of balance between cultural working behaviour and technology, “The country's fundamental problem must be solved. Bringing in new technology doesn't fix the root cause of the non-homogeneous coordinate system.”.

- ***Setting direction of collaboration***

- Agree to the collaboration between organisations, “Cooperation is good, for sure.”.
- Agree to the collaboration between Thailand and foreign countries, “I definitely agree. You have to understand what each country is like. For that cooperation, we also need the data.”.
- Give importance to the international collaboration issues, “I don't think it's going to be easy for the Chinese side because they did not come as the sector of government representatives. They came as a private company; therefore, I think it is more difficult for us to cooperate with foreign private sectors. But if it's between state and state, it will look better.”.

- Legislate in this area, “If it's not necessary, we shouldn't legislate about these matters too specifically. It will become a waste of time. And in the end, we may be never-ending to revise the law.”.
- Adopt policies, “The maintenance, upgrade, the constellation, or something like this, are the long term. There must be a policy and road map.”.
- Design the policies, “In regards to the cooperation; there must be about how to share data, data management, organisations that are responsible for it, how to share it further, or something like this. It includes maintenance and business. Businesses must have policies in terms of management.”.
- Design a collaboration structure, “For the subcommittee; I want it to have a role in controlling to act as a board as well.”.
- Give authority and design approval protocol, “No meeting; it's like the board does not take action. So the organisation must act. As a result of this, it will be difficult to push the agencies forward. There will be no resolution from the subcommittee.”.
- Design an authorisation protocol, “It should act as a secretary to implement various things and oversee whether maintenance, budget request, or CORS quantity management is required. Expanding CORS must be taken by the board.”.
- Design authorisation level, “The organisations likely to set up the stations have to discuss compatibility first on how we would take forward. Then we need this subcommittee stamp out that 'Okay, we've already talked.'. Then they can deliver the project.”.
- Design authority for each stakeholder, “Each organisation has its own division of responsibility. Therefore, each organisation must feed the budget to the sub-units.”.
- Design the decision-making procedure, “To gain success; it is in need to consider personnel first. Like, that person must need to know, must be able to proffer to the executives and then they make decisions. The executives should not have to see it themselves, but the subordinates must propose.”.
- Design a security control scheme, “Concerning secrets or non-secrets, actually, for GNSS, I don't see it as a secret because it is point data that we already know. It's not the map data. But to close or not to close, it's on the user. The software for controlling the system can see who the user is. Registering a user is already a certain level of control.”.
- Design the matters in the collaboration, “For the procurement; there will be a specification for control, which most organisations proceed following others. If the quality is different? It's different, but it isn't as significant as the issue of data quality or making the network more stable; these are more important.”.
- Design the product quality guarantee, “If a centralised service is really good and reliable, everyone will use it.”.

- Design the standard of the network, “There must be a guideline or standard that you have to follow this standard. So far, we have tried to enforce using IGS standards as the main.”.
- Design the technical issues handling for the central network, “Each program has its pros and cons. But, for this one, they haven't talked about it. They still don't understand it at the subcommittee level.”.
- Design for product strength, “The more accurate position may help in terms of delivering their products faster, better, more accurately.”.
- Design the product solutions, “It will provide information to the public and private sectors without limitation.”.
- Design the service strategy, “We must promote its use in all sectors. Whether it's free or not, but must try to produce as many users as possible.”.
- Design the marketing plan, “It depends on the services that will go to the sector. We must reach an agreement that we will charge or not charge, how it is open, something like that. But must have an agreement.”.
- Design for project encouragement, “Because of their invested industry in Thailand, I understand that it's worth a lot, maybe more than they invested in their country. So, if we are able to build this infrastructure for them, they will continue to grow their businesses well. Therefore, they try to push us a lot. They are trying to push us together to create harmonious cooperation.”.
- Design for the maintenance plan, “If you provide data continuously and pass the criteria, you will get a budget for the station's maintenance. Something like this can actually happen. Ultimately, we must use a budget to control.”.
- Design for human resources, “Most of the representatives who joined the meeting didn't quite understand the technique. They came as the positions of executives. Therefore, they may not be able to keep up with what has been raised.”.

Timeline Data Analysis

• *Ownership and governance*

- Lack of effective infrastructure plan and monetary allocation plan for the whole country, “Coverage is not enough. Currently, they are using the CORS data from the RTSD and the DOL.”.
- Limited scope of work, “The DOL uses data from the RTSD for the DOL's mission; the surveyors use it to issue rights documents. The RTSD uses DOL data for RTSD's mission and releases services to government agencies and the private sector.”.
- Lack of common purpose, “The RTSD is afraid there will be a problem if they define the parameter because they do not know how each organisation work. Let the organisations that use the data find the parameters themselves.”.

- Lack of homogeneity of requirements, “The NIMT has officially used the service from the RTSD. The NIMT use the post-processing data to find the reference coordinates for the NIMT's mission as the NIMT's works require a post-processing method. The NIMT use the coordinates obtained as a fixed positioning value or a known parameter in the equation for the international time comparison. Some of the NIMT studies need real-time coordinates, so they use the RTSD corrections, but it is just occasionally.”.
 - Lack of awareness, “The working capital office has issued notification letters to government agencies.”.
 - Lack of harmonious conceptualisation, “In Thailand, most of the workers in the GNSS field graduated in the Survey Engineering discipline and have knowledge of land surveying. They know about the positioning very well but may not have done or studied about timing at all.”.
 - Lack of equivalence of knowledge, “We have educated some organisations; for example, the Agricultural Land Reform Office (ALRO) requested education and the RTSD sent out officers to explain and educate.”.
 - Lack of trust and reliability, “Some tried it out first by applying a 1-month package for one user. When satisfied, they applied for a 1-year package for two users.”.
 - Lack of openness, “The RTSD has to allow the Japanese to come in for sure. The RTSD does not block them. However, the RTSD do not want the Japanese to work at the RTSD.”.
 - Lack of co-working and meeting opportunities, “There were not many board meetings and subcommittee meetings.”.
 - Lack of authority, “The RTSD is concerned about the maintenance budget. Where should it come from?”.
 - Lack of intermediary, “Now, the RTSD performs the role of the Semi-National CORS.”.
- ***Power asymmetries***
 - Inequality in the distribution of budget allocation, “If the budget is not enough, they may request a budget to increase the capability of the RTSD.”.
 - Inequality in the priority, “The RTSD uses data from the DOL, only about 40 stations for forming the network.”.
 - Inequality in the weight, “Resolutions from the latest meeting of the year 2019, the role of the RTSD, at that time there was no CORS, the RTSD acts as a data centre.”.
 - Inequality in the potential, “It has been supervised by the Geodesy and Geophysics Division, which is the section responsible for surveying.”.

- Inequality in the power of organisation, “Current situation of the cooperation between organisations, the HII has no further information; for details, you should ask the GISTDA.”.
- Inequality in the existent internal resources, “At that time, there was no CORS.”.
- Inequality in the resource arrangement power, “The Japanese team can sit at the GISTDA but can stream data from the RTSD. If they want to work at the RTSD only, the RTSD must request approval from the supreme commander.”.
- Inequality in resource recruitment power, “The specialists have been changed but are not likely to be a problem with cooperation.”.
- Inequality in the well-preparedness, “Streamed data could not be backed up; it could only check the data quality. The RTSD needs storage for archiving data from the stations to back up at the RTSD.”.
- Inequality in the decision-making criteria, “Insufficient communication channel causing bottleneck due to the concurrent. The RTSD had planned in advance since the project was created. Col. Chaiwat Promthong, former director of the Geodesy and Geophysics Division, studied and designed together with the DOL that there should be both primary and secondary channels.”.
- Inequality in the external drives, “The users are afraid that the rovers they have are not compatible.”.
- Inequality in authority to control and inspection, “The working capital office is responsible for revenue from services. Use the revenue in the working capital system.”.
- Lack of an administration in regard to authority, “The RTSD is concerned about the maintenance budget. Where should it come from? Royal Thai Armed Forces Headquarters – We should try to ask for a budget from this organisation first or the Government.”.
- Lack of clarity in giving authority, “Cooperation with neighbouring countries, Malaysia, there is no discussion yet because the service connection requires a lot of details. There must be an MOU with the Ministry of Foreign Affairs. The RTSD cannot process it by themselves.”.
- Lack of obviousness of authority, “The RTSD is afraid there will be a problem if they define the parameter.”.
- Lack of certainty in exerting authority, “If they want to work at the RTSD only, the RTSD must request approval from the supreme commander.”.
- Lack of effectiveness of authority, “There is no meeting and no report to the executives for the next step.”.
- Lack of sustainability of the authority, “I want the RTSD to manage all the 250-CORS stations, but the RTSD does not have enough potential. I am afraid that the system will crash.”.

- ***Interaction processes and supporting technologies***

- Lack of adequacy of arrangements, “Coverage area is all over the country, including the border areas, except Tak or Kanchanaburi. They are mountainous areas where CORS could not reach.”.
- Lack of practical design, “The system is down due to an internet crash because they are located on the mountain. There are only 1-2 stations that are often down.”.
- Lack of big-picture vision, “The purchased equipment has a 5-year warranty. They were installed in 2019; the insurance period will expire in August 2024, as specified in the contract. The RTSD is concerned about the maintenance budget. Where should it come from?”.
- Lack of homogeneous requirements, “The HII (HAI) requested to stream data for weather forecast calculation.”.
- Lack of adequacy of finance, “At this time, there is no budget.”.
- Lack of authority for cooperation, “Service operation has been made in the name of the RTSD, not the National CORS.”.
- Lack of fundamental requisite, “Facility for temperature control system – There is no air conditioner, only a fan.”.
- Lack of appropriate site selection procedure, “The CORS has been installed in military units and land offices areas.”.
- Lack of facility for security, “The Japanese team asked to sit and work at the RTSD. They want a workplace where they can get in and work. They need the RTSD to allocate space or office for them inside the RTSD.”.
- Lack of a co-working programme, “The working group on Thai-Japanese Cooperation is currently focusing mainly on capacity building and promotion.”.
- Lack of overall CORS distribution design, “DOL = 181 stations – Status: Completed = 134 stations. Additional installation plan in 2021 = 47 stations; RTSD = 80 stations – Status: Completed (No additional installation plan); DPT = 15 stations – Status: Completed (No additional installation plan); HAI = 6 stations – Status: Completed (No additional installation plan)”.
- Lack of facility management, “The former director of the Geodesy and Geophysics Division had studied and designed together with the DOL that there should be both primary and secondary channels for both the CORS and the Data Centre.”.
- Lack of common goal, “The DOL would like to link their data with the 80 CORS of the RTSD for continuous use of land surveying tasks to serve the public. The DOL allowed the RTSD to link the CORS data with the DOL for 134 stations for continuous use in surveying and mapping missions of the RTSD and the provision of positioning observation data through the CORS network to government

agencies in the Ministry of Defence, the Royal Thai Armed Forces, the government and private sectors.”.

- Lack of technical concerns administration, “They have knowledge of land surveying. They know about the positioning very well but may not have done or studied about timing at all.”.
- Lack of practical technological development plan, “The National CORS requires storage because it has to support more CORS stations in the next several years.”.
- Lack of prioritisation, “The government sector is interested in using the services but does not have a rover.”.
- Lack of awareness of public services, “For the Thai Meteorological Department (TMD), the RTSD is not sure whether the TMD has requested the network RTK data or not. But, it is likely that it has not sent a data streaming request yet.”.
- Lack of awareness of its importance, “The working capital office has issued notification letters to government agencies.”.
- Lack of technological readiness, “Coverage is not enough. Currently, they are using the CORS data from the RTSD and the DOL. The National CORS requires storage because it has to support more CORS stations in the next several years.”.
- Lack of budget for technology, “There is no clear arrangement about when the budget will be provided and when the setup will be completed.”.
- Lack of service quality, “To provide data services nationwide with reference coordinates on a single frame.”.
- Lack of awareness of applied technology, “They have knowledge of land surveying. They know about the positioning very well but may not have done or studied about timing at all.”.
- Lack of security control, “However, the RTSD does not want the Japanese to work at the RTSD. It is due to restrictions on military units in terms of foreigners working in the military workplace problems. There is a risk of security.”.
- Lack of innovation management, “Japan focuses on technical consulting on CORS management. They are trying to take action on the RTSD CORS management.”.
- Limited knowledge development of technology, “Offered the documents to enlighten in the form of textbooks. The book is titled GNSS Time Transfer.”.
- Lack of assessment protocol for the new coming technology, “Japan has a lot of diligence in collecting and analysing data and presenting it as a report. It is very different from Thai working habits.”.
- Lack of balance between cultural working behaviour and technology, “Japan has a lot of diligence in collecting and analysing data and presenting it as a report. It is very different from Thai working habits.”.

- ***Setting direction of collaboration***

- Agree to the collaboration between organisations, “There were many joint meetings between organisations in the past year (2019).”.
- Agree to the collaboration between Thailand and foreign countries, “Thai-Japanese cooperation, last year (2019), Thailand organised meetings to discuss this matter between organisations.”.
- Give importance to the international collaboration issues, “Cooperation with neighbouring countries, Malaysia; there is no discussion yet because the service connection requires a lot of details. There must be an MOU with the Ministry of Foreign Affairs.”.
- Design a collaboration structure, “Early this year (2020); the NIMT has streamed data to various organisations, including DOL, HII to try the database integration between organisations.”.
- Give authority, and design approval protocol, “The DOL has requested data streaming and has already taken action.”.
- Design an authorisation protocol, “There is no meeting and no report to the executives for the next step.”.
- Design authorisation level, “As a member, the RTSD will be informed when they have a discussion.”.
- Design authority for each stakeholder, “The DOL has requested data streaming and has already taken action.”.
- Design the decision-making procedure, “The service connection requires a lot of details. There must be an MOU with the Ministry of Foreign Affairs. The RTSD cannot process it by themselves.”.
- Design a security control scheme, “The RTSD does not want the Japanese to work at the RTSD. It is due to restrictions on military units in terms of foreigners working in the military workplace problems. There is a risk of security.”.
- Design the matters in the collaboration, “Test the data streaming between the RTSD and other organisations.”.
- Design the product quality guarantee, “It has a 30 - 40 km baseline distance, ± 3 cm accuracy with nationwide coverage.”.
- Design the standard of the network, “The National CORS Data Center development of the RTSD under the National Subcommittee on GNSS Network will provide satellite data to the private and public sectors in the long term.”.
- Design the technical issues handling for the central network, “The frame has not been finalised, so it is not yet determined whether to opt for 2008/2014/2020.”.

- Design for product strength, “Coverage area is all over the country, including the border areas.”.
- Design the product solutions, “The service types are available in VRS, FKP, MAC, and iMAX formats. Provide the RINEX data download service and RINEX data processing services on the website.”.
- Design the service strategy, “It was available for free during the first three months. The RTSD started charging for service in early 2020.”.
- Design the marketing plan, “It is free of charge for government agencies. The fees for the private sector are offered in the packages.”.
- Design for project encouragement, “The RTSD had planned in advance since the project was created. Col. Chaiwat Promthong, former director of the Geodesy and Geophysics Division, studied and designed together with the DOL that there should be both primary and secondary channels for both the CORS and the Data Centre. We are also confident that the internet system is much better than before, and the bandwidth is sufficient for concurrent delivery.”.
- Design for the maintenance plan, “It is considered okay if it is not down for over a day. In terms of hardware, if the system is down during this insurance period, the company will go to the site according to the conditions in the contract. The urgency depends on the distance factor of CORS that must be reached within hours.”.
- Design for human resources, “It has been supervised by the Geodesy and Geophysics Division, which is the section responsible for surveying.”.

TABLE A-27 provides a summary of the extent to which the primary data collected from the focus group, expert interviews, and follow-up interviews correspond to each category of factors in the initial conceptual framework. In the table, “Y” denotes that the available evidence supports alignment with the respective factor, whereas “–” indicates that no confirming evidence was identified. It is important to note, however, that a lack of confirmation reflects the absence of relevant data rather than evidence of misalignment with the factor.

TABLE A - 27 A comparison of findings congruency of Thailand's case (Source: Author's own research)

Key Factors regarding Initial Conceptual Framework	Data Analysis		
	Focus group	Expert	Follow-up
Ownership and governance			
Lack of effective infrastructure plan and monetary allocation plan for the whole country	Y	Y	Y
Limited scope of work	Y	Y	Y
Lack of common purpose	Y	Y	Y
Lack of homogeneity of requirements	Y	Y	Y
Lack of awareness	Y	Y	Y
Lack of harmonious conceptualisation	Y	Y	Y
Lack of equivalence of knowledge	Y	Y	Y

Key Factors regarding Initial Conceptual Framework	Data Analysis		
	Focus group	Expert	Follow-up
Lack of trust and reliability	Y	Y	Y
Lack of openness	Y	Y	Y
Lack of co-working and meeting opportunities	Y	Y	Y
Lack of authority	Y	Y	Y
Lack of intermediary	Y	Y	Y
Power asymmetries			
Inequality in the government's power	Y	Y	Y
Inequality in the political endorsement	Y	Y	Y
Inequality in the distribution of budget allocation	Y	Y	Y
Inequality in the priority	Y	Y	Y
Inequality in the weight	Y	Y	Y
Inequality in the potential	Y	Y	Y
Inequality in the power of organisation	Y	Y	Y
Inequality in the existent internal resources	Y	Y	Y
Inequality in the resource arrangement power	Y	Y	Y
Inequality in resource recruitment power	Y	Y	Y
Inequality in the well-preparedness	Y	Y	Y
Inequality in the decision-making criteria	Y	Y	Y
Inequality in the external drives	Y	Y	Y
Inequality in authority to control and inspection	Y	Y	Y
Lack of an administration in regard to authority	Y	Y	Y
Lack of clarity in giving authority	Y	Y	Y
Lack of obviousness of authority	Y	Y	Y
Lack of certainty in exerting authority	Y	Y	Y
Lack of effectiveness of authority	Y	Y	Y
Lack of sustainability of the authority	Y	Y	Y
Interaction processes and supporting technologies			
Lack of adequacy of arrangements	Y	Y	Y
Lack of practical design	Y	Y	Y
Lack of big-picture vision	Y	Y	Y
Lack of homogeneous requirements	Y	Y	Y
Lack of adequacy of finance	Y	Y	Y
Lack of authority for cooperation	Y	Y	Y
Lack of fundamental requisite	Y	Y	Y
Lack of appropriate site selection procedure	Y	Y	Y
Lack of facility for security	Y	Y	Y
Lack of a co-working programme	Y	Y	Y
Lack of coordination on the CORS site planning	Y	Y	-
Lack of overall CORS distribution design	Y	Y	Y
Lack of facility management	Y	Y	Y
Lack of common goal	Y	Y	Y
Lack of technical concerns administration	Y	Y	Y
Lack of practical technological development plan	Y	Y	Y
Lack of prioritisation	Y	Y	Y
Lack of awareness of public services	Y	Y	Y
Lack of awareness of its importance	Y	Y	Y
Lack of technological readiness	Y	Y	Y
Lack of budget for technology	Y	Y	Y
Lack of service quality	Y	Y	Y
Lack of public service for the agricultural sector	Y	Y	-
Lack of awareness of applied technology	Y	Y	Y
Lack of security control	Y	Y	Y
Lack of awareness of the obsolescence of technology	Y	Y	-

Key Factors regarding Initial Conceptual Framework	Data Analysis		
	Focus group	Expert	Follow-up
Lack of keeping up with the evolution of disruptive technology	Y	Y	-
Lack of innovation management	Y	Y	Y
Limited knowledge development of technology	Y	Y	Y
Lack of assessment protocol for the new coming technology	Y	Y	Y
Lack of enlightenment of recognition and rationality	Y	Y	-
Lack of balance between cultural working behaviour and technology	Y	Y	Y
Setting direction of collaboration			
Agree to the collaboration between organisations	Y	Y	Y
Agree to the collaboration between Thailand and foreign countries	Y	Y	Y
Give importance to the international collaboration issues	Y	Y	Y
Legislate in this area	Y	Y	-
Adopt policies	Y	Y	-
Design the policies	Y	Y	-
Design a collaboration structure	Y	Y	Y
Give authority, and design approval protocol	Y	Y	Y
Design an authorisation protocol	Y	Y	Y
Design authorisation level	Y	Y	Y
Design authority for each stakeholder	Y	Y	Y
Design the decision-making procedure	Y	Y	Y
Design a security control scheme	Y	Y	Y
Design the matters in the collaboration	Y	Y	Y
Design the product quality guarantee	Y	Y	Y
Design the standard of the network	Y	Y	Y
Design the technical issues handling for the central network	Y	Y	Y
Design for product strength	Y	Y	Y
Design the product solutions	-	Y	Y
Design the service strategy	Y	Y	Y
Design the marketing plan	Y	Y	Y
Design for project encouragement	Y	Y	Y
Design for the maintenance plan	Y	Y	Y
Design for human resources	Y	Y	Y

E. POLICY FRAMEWORK

E.1 Learn from Australia

TABLE A - 28 A conclusion of an organisational model by Higgins (2008) for suggesting the Thai National CORS policy development

Roles	Examples of Suggestions
Organisational roles	
Role: Specify system	To define the CORS network's characteristics.
1. Target Density	Baseline distance has no excess of 70km.
2. Target Coverage	Extend over Southeast Queensland or nationally.
3. Target Accuracy	$\pm 2\text{cm}$ in horizontal plane and $\pm 4\text{cm}$ in vertical plane at 95% confidence.
4. Target Reliability	The initialisations can fix ambiguity within three minutes for 95% of users.
5. Target Availability	99% availability of data and access.
6. Site Quality	The antenna has $\pm 2\text{mm}$ accuracy with a 10° elevation mask setting.
7. Equipment Quality	The receiver has a dual-frequency, multipath resistance and can track both GPS and GLONASS.
8. Geodetic Reference Frame	The ITRF will have $\pm 1\text{cm}$ absolute positioning accuracy and allow GDA94 and AHD geoid model connection.
9. Data Services Produced	Support dual-frequency GPS and GLONASS post-processing and GPS RTK, and single-frequency GPS post-processing and real-time differential GPS with submeter accuracy.
10. Data Access Policy	Free 30-second epochs post-processed data for scientific users and national geodetic reference frame. Free single-station real-time data for scientific users Free 1-second epochs post-processed data for commercial users. Free dual-frequency real-time GPS corrections for commercial users Free dual-frequency real-time GPS and GLONASS corrections for commercial users
Role: Own Stations	To define details for owning a station and the relevant responsibilities.
1. Site Selection	Comply with the Specify System role.
2. Site Construction	Comply with the Specify System role.
3. Equipment Purchasing	Rely on instrument quality and specifications.
4. Station Data Communications	The method for data streaming from the site to the control centre and the owner's internal use of a single-station RTK link

Roles	Examples of Suggestions
5. Site Maintenance	Maintain a free-of-obstructions site, reboot a receiver, and repair data communications.
6. Equipment Replacement Cycle	Fund for the replaced receiver for the original owner and the owner of the equipment ownership transitions Demand site hosting agreements between the owner in an Own Stations role and the network supervisor in a Network the Data role
Role: Network the Data	To define details about the business and the relevant responsibilities.
1. Data Communications from Network Stations	Retrieve and combine data from each site to the Network Control Centre. Payment could be the responsibility of either the CORS owner or the Network the Data role.
2. Control Centre	The Network Control Centre will • retrieve, monitor, and store data, • either process and deliver data or forward them to the Process Network role, • perform a station quality control, including station's multipath analysis, data latency, data completeness
3. Quality Control of Data	Verify the pre-processed data factors in terms of completeness for the number of signals tracked, data frequency and coverage, and signal quality and multi-path.
4. Data Archive	Concern about the long-term value of CORS for the geodetic infrastructure and legal issues for the Network the Data role.
Role: Process Network	To define details about the business and the relevant responsibilities.
1. Copy of Network	Make a copy of retrieved data under the Network the Data role and add value.
2. Data Processing	Create value-added solutions from the retrieved data and computed network corrections.
3. Production of Correction Data Streams	Generate corrections computed from software according to the derived model.
4. Distribution of Correction Data Streams	Deliver generated corrections to users via the selected communications, generally NTRIP.
5. Data Wholesaling	Generate, deliver, and wholesale the correction data to the organisations in the Deliver Service role and perform all relevant operations as a wholesaler.
6. Retailer Support	The organisations with the Process Network role would be optimal to support the retailer with the Deliver Service role in technical and

Roles	Examples of Suggestions
	business performance, accuracy, and availability.
Role: Deliver Service	To define the service delivery chain to retailers and end-users.
1. Retail Sale of Data Products	Sell all the correction products.
2. Marketing	Market the sales to diverse groups.
3. Rover Equipment support	Configure the equipment correctly to obtain the best performance and application.
4. End User Support	Support all user needs regarding positioning, communication, radio interference, or multipath.
5. Liaison with User Communications Providers	Cooperate with telecommunications providers to address mobile internet issues, including prices and deals.
Governance	
Business	Confirm position in the industries.
Legal	Ascertain the role in legal issues.
Give Confidence to End Users	Guarantee the services' reputation and reliability.
Agreements Between the Different Organisations	Define the organisation's authority and responsibilities.

E.2 Recommendations for Thailand

The case learning experiences in Australia and Thailand led to the determination to outline recommendations for GNSS CORS management policy in Thailand, as described below.



Policy:

The GNSS CORS system shall be available outside the ownership boundary for optimum usability and sharability, which enable cooperative movements between organisations, sectors, and countries across public, private, research, and business societies.

Target:

To facilitate the creation of an agreement for GNSS CORS management in Thailand among government organisations and between the public sector and other sectors.

1. Inter-organisational collaboration
2. International collaboration

Advantage:

Thailand will have a superior network of GNSS CORS with a higher degree of signal coverage, site denseness, data accuracy, system reliability, and service availability. The integrated network would reduce the conflicts between different data sources from multiple providers. It also makes available a variety of solutions and increases the user groups. Further, the budgetary allocation for the site establishment, maintenance, renewal, and redundant components will be reasonably estimated.

Implementation:

The policy can be implemented as follows:

1. The *National Subcommittee on GNSS Network* has inclusive responsibility with respect to policy initiating and reviewing.
2. The *National CORS Data Center*, which could be led by the assigned government organisation or the newly instituted board, directs the association of the integrated CORS network under the supervision of the *National Subcommittee on GNSS Network*. The National CORS Data Center will have the authority to proceed with all the partnership formats.
3. The *National CORS Data Center* enacts the policy through the *Working Groups for National CORS Data Center Management* for inter-organisational collaboration and the *Working Groups for Thailand-Japan Joint Commission* for international cooperation.



Policy regarding finance

Policy:

The National CORS Data Center shall balance the portion of expenditures and revenues complying with the national economy to withstand the contingent provision of fiscal budgets and persist in advancing the GNSS CORS system operation.

Target:

To design the arrangement of the financial issue for GNSS CORS management in Thailand, either the budgets or the incomes.

1. Expense
2. Income

Advantage:

The National CORS Data Center will preserve its economic stability to grow and maintain the GNSS CORS system to serve Thailand-wide positioning services for government, private, industry, and research sectors. In addition, the monetary management appositeness will be capable of enhancing the delivery of the profit returns to the CORS owner.

Implementation:

The policy can be implemented as follows:

1. The National CORS Data Center should have a financial management orientation for the disbursement of money, including base installations, facilities expenses, communication links bills, preventive maintenance, repairs, spare parts, renewals, upgrades, annual fees, instruments, and other overheads.
2. The National CORS Data Center should have money management for the fiscal budget provision from the government and the revenues from the National CORS business. The profit-sharing should be allocated to adhere to the business model and laws.



Policy regarding roles

Policy:

The National CORS Data Center shall align the roles of organisations, including the respective staff, to conform to the developed structure of the GNSS CORS organisational responsibility model to move forward the joint agreement authoritatively, systematically, and synchronously.

Target:

To assign the responsibilities and authorities for each organisation involved in GNSS CORS management in Thailand.

1. Organisational roles and authorities
2. Human resources and competency development

Advantage:

The organisations, including their executives and subordinates involved in the GNSS CORS mutual relationship in Thailand, will realise their functions in the cooperative agreements and the limit of power underpinned by the authoritative directives. The redundancy will be avoided by refraining from duplicating acts in the same tasks. Organisational roles will also ascertain investment in human capital and foster personnel to be competent human resources.

Implementation:

The policy can be implemented as follows:

1. The National Subcommittee on GNSS Network should assign organisational roles and authorities for each player in the National CORS, including the National CORS Data Center, owners, data custodians, data service providers, value-added resellers, marketers, technical supports, contact points, maintenance and repair team, finance, research and development society, and other relevant organisations and persons.
2. The National Subcommittee on GNSS Network should specify human resources qualifications, conform to organisational role models and pass the educational and training plan for competency development.



Policy regarding plans

Policy:

The National CORS Data Center shall deliver an optimistic master scheme for the GNSS CORS network and its components under the umbrella of the relevant laws covering the actions in terms of joint ventures, facility planning, and commercialisation.

Target:

To devise the plans, models and legislation relevant to GNSS CORS management in Thailand.

1. **Plan:** Infrastructure Plan, Business Model, Data Centre
2. **Standard:** Site, Equipment, Service
3. **Law:** Owner, Collaboration, Authority, Data Centre, Business, Finance, Security

Advantage:

The National Subcommittee on GNSS Network will have straightforwardly viable strategic plans and gain mastery over the National CORS Data Center and movements concerning the GNSS CORS system in Thailand, either infrastructure or business aspects, without vagueness. The investors or owners of the CORS systems can take the initiative to follow the rules that abide by the core standards for the sites, instruments, and services. Laws and regulations will protect the campaigns, operations, and executions, and penalties will be imposed for breaking these laws.

Implementation:

The policy can be implemented as follows:

1. Implementing the policy regarding the National CORS plan:
 - 1.1. The National CORS Data Center should devise the master plan for overall infrastructure development protocols, including new installation, additional installation, linking the networks, purchase, construction, maintenance, renewal, upgrade, location request, and cross-sector infrastructure connection process.
 - 1.2. The National CORS Data Center should design the National CORS Business Model for data custodians, data service providers, value-added resellers, solution preparation, product distribution, data wholesaling, price, marketing plan, ROI management, transaction, compensation, user service, user privacy, user contact point, and non-profit services.
 - 1.3. The National CORS Data Center should programme the data centre service and management for data retrieval, solution handling, service delivery, data streaming procedure, data custodians contact, data service providers contact, value-added resellers contact, user contact, technical support, preventive maintenance, repairs, education and training, and transactions.

2. Implementing the policy regarding the National CORS Standard:
 - 2.1. The National CORS Data Center should set a standard regarding the CORS sites, including site selection criteria and process, specification, construction, location approval, equipment specification, communication system, maintenance and repair, access, safety and security.
 - 2.2. The National CORS Data Center should provide a standard for the equipment used with the National CORS services, including specification, communications, access, safety and security.
 - 2.3. The National CORS Data Center should offer a service standard, including product types, access, delivery, archive, accuracy, reliability, availability, reference frame, data processing method, security control, data loss protocol, and compensation.
3. Implementing the policy regarding the laws for the National CORS:
 - 3.1. The government should legislate the laws for the CORS owner, including ownership, sharing, and benefits portion.
 - 3.2. The government should effectuate the laws regarding collaboration, including inter-organisational, inter-governmental, international, and cross-sector cooperation.
 - 3.3. The government should establish laws regarding authority to empower the actors and the organisations in proceeding with the National CORS activities.
 - 3.4. The government should enforce the laws for the National CORS Data Center to authorise and permit further plans and actions regarding the National CORS.
 - 3.5. The government should enact laws for commercialisation regarding the National CORS businesses, including licensing, payment mechanism, pricing, selling, and profit-sharing.
 - 3.6. The government should execute the laws regarding finance, including disbursement of infrastructure and utilities, earnings, fiscal subsidisation, financial support, funding, budget allocation, and profit-sharing.
 - 3.7. The government should practice the laws regarding security, including CORS site safety, data security control, device access control, user privacy, and payment mechanism security.



Policy regarding technology

Policy:

The National CORS Data Center shall complete the fundamental requirement for the high-quality GNSS CORS system to provide a network of excellence viable through the fitness of systems, fit-for-purpose technical mechanisms, and the aptness of services.

Target:

To specify the structure, specification and standard of GNSS CORS-related components in Thailand, including technical issues and services.

1. **System:** Site Selection, Site Specification, Equipment Specification, Communications, Maintenance, Safety and Security
2. **Techniques:** Coverage, Density, Accuracy, Reliability, Availability, Reference Frame, Data Processing, Data Transfer, Security Control
3. **Services:** Product, Access, Delivery

Advantage:

The National Subcommittee on GNSS Network will have a definite design of system components, including sites, equipment, communication links, and securities. The explicitly technical framework will be equipped for GNSS CORS implementation to predesign and evaluate the system's quality, assuring its conformity to the requisites. Thailand will have unambiguous service models for versatily excellent product generation, proper access control, and regular service delivery for the CORS system.

Implementation:

The policy can be implemented as follows:

1. The National CORS Data Center should have system criteria, including site selection, site specification, equipment specification, communications, maintenance, safety and security, and the system configurations of interval setting, elevation mask, multipath, antenna type, and antenna phase setting.
2. The National CORS Data Center should set a benchmark on the National CORS technical standards, including coverage, density, accuracy, reliability, availability, reference frame, data processing, data transfer, security control, and other details regarding software, processing method, time interval, data projection, data transformation, atmospheric model, network adjustment, and corrections generation.
3. The National CORS Data Center should have a touchstone of the service performance as follows:

- 3.1. The product includes data format, archiving, real-time services, post-processed services, PPP services, Single Point Positioning services, differential GNSS positioning services, very long baseline services, value-added solutions, and other solutions.
- 3.2. Access, including web-based portal, mobile access, account access level, access request authorisation, service approval, site remote access, other permission request approvals, and data concurrency setting.
- 3.3. Delivery includes service distribution, internet capacity, off-tolerance service delivery, offline service delivery, data upload/ download system, and archive services.

F. VALIDATION

External validation involves the broader lessons learned from this research that are applicable beyond the specific case of CORS technology in Thailand. Although the study is grounded in a well-defined theoretical framework and focused on recent developments in Thailand, its insights are relevant to other projects involving government collaboration with multiple stakeholders on complex technologies. Therefore, the findings can inform similar initiatives in different countries, sectors, or time periods—even for those not directly interested in CORS.

TABLE A - 29 Validation of the case study research (Yin, 2009)

Research proceedings	Strategies	Methodology	Criteria	Chapter
Literature review	• Select crucially relevant literature	• Review the literature based on relevant contents	Construct validity	Chapter 3
	• Establish an evaluation framework	• Develop a theoretical framework based on the literature		
Research design	• Use single cases	• Within-case analysis	External validity	Chapter 5
	• Use multiple cases	• Within-case analysis • Cross-case analysis		Chapter 6
Data collection	• Use multiple sources of evidence • Develop a case study database • Construct a chain of evidence - Use multiple data collection methods	• Focus group interview • Expert interview • Follow up interview • Documentation	Construct validity	Chapter 4
	• Collect all essential data	• Primary data source • Secondary data source	Reliability	Chapter 4
Data analysis	• Use a draft case study report	• Document analysis • Interview data analysis	Construct validity	Chapter 5 Chapter 6
	• Establish a logical causal relationship	• Within-case analysis • Cross-case analysis	Internal validity	Chapter 5 Chapter 6
		• Pattern matching		
	• Establish findings reliability	• Comparative analysis	Reliability	Chapter 6
		• Relate research findings with the evaluation framework		Chapter 7

TABLE A - 30 Validation of the study using research triangulation (Source: Author's own research)

Triangulation approaches	Strategies	Methodology	Details	Chapter
Theoretical triangulation	• Use multiple theories	• Collaborative Innovation • Networked Innovation • Innovation Ecosystem • Stakeholder Theory	• Use for developing the theoretical framework	Chapter 3
Data triangulation	• Use multiple data sources	• Primary data source	• Focus group interview • Expert interview • Follow up interview	Chapter 4
		• Secondary data source	• Documents	
Methodological triangulation	• Use multiple research designs	• Focus group interview	• 6 Thai government organisations that own the CORS infrastructure	Chapter 4 Chapter 5 Chapter 6
		• Expert interview	• 3 Thai experts in GNSS technology from 3 universities	
		• Follow up interview	• 5 Thai participants from 5 government organisations that previously engaged in the focus group interviews	
		• Documentation	• Papers, theses, official copy, official announcement, official website, news, and other evidence about CORS implementation in Thailand and	
Investigator triangulation	• Use multiple researchers	-	-	-
Analytical triangulation	• Use multiple analytical techniques	• Pattern-matching analysis	• Focus group interview • Expert interview • Follow up interview	Chapter 5 Chapter 6
		• Content analysis	• Case study documents	
		• Comparative analysis	• Output from the analyses	

CONFERENCE PAPERS

I. British Academy of Management (BAM) Conference 2018

An Investigation of the Collaborative Innovation in GNSS CORS Technology between Government Organisations in Australia.

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Abstract

Public collaboration on CORS technology is a key development in the planning process in many countries. There are two major aspects to the technology adoption; the potential transformative impact of the CORS and applications, and potential for collaborative innovation between governmental authorities. The advent of a national planning strategy, which does not accommodate the CORS installation means that Australian agencies will not reap the full potential of duplicate investment. For instance, military uses satellite data for territory measurement while transport uses for logistics. This paper will focus on the development of CORS and the effectiveness of cooperative innovation management among government agencies in Australia. Then consider the similarities between Australia and Thailand.

Key word: GNSS, CORS, Collaborative Innovation, Inter-Organisation Management

Track: Innovation

Word count: 1,993

An Inter-Organisational Collaboration between government agencies on GNSS CORS administration in Australia has gradually developed over the past few decades. The Australian government has attempted to create a public collaboration on this technology and pursue a policy of managing CORS. Continuously Operating Reference Stations (CORS) is a ground augmentation system that functions to enhance signals of Global Navigation Satellite Systems (GNSS) which is a group of satellites that transfers position information to users who need to find a particular target location, for example, a road, or a particular landmark (Haw, 2018, GSA, 2018). The satellite signals are widely used in surveying and mapping, however, solitary direct signals from satellites are deficient for high accuracy task like county boundary measurement. As a consequence, the CORS was initialised to supply an auxiliary data that can improve result quality. As a cooperative administrator of CORS technology, Australia operates approximately one hundred base stations under various governmental organisation's supervision which creates a high degree of complexity in terms of managing facility sharing and service centralisation (Geoscience Australia, 2018). Consequently, time, budgets, and experts are being continually reviewed and revised. This paper will discuss the development of CORS governance and the effectiveness of the co-management and inter-agency collaboration of CORS technology in Australia.

Rizos (2002) and Roberts et al. (2004) outline the genesis of GNSS CORS in Australia in the 1990s and the expansion by a number of government authorities to 31-35 stations in 2005. The primary benefits of these services, summarised by Roberts (2009) and Wang and Abareshi (2015), are in

mapping, precision farming, and transport and logistics tracking for supply chain businesses. Although Australia is the leader in applying GNSS technology for public and private facilities, there are two key aspects that have been addressed since the advent of the technology. Firstly, there are a number of GNSS agencies that do not share their services with other agencies (Higgins, 2008, ICSM, 2015). Roberts (2009) suggests that relevant agencies should work together to provide the necessary infrastructure all over the country. Secondly, action from government is needed to create a framework policy to ensure this happens. There have been attempts by organisations to adopt a policy, ANZLIC (2014) reported that ten government organisations were collaborating to create a framework; however, this would have been more appropriate to be created by central government.

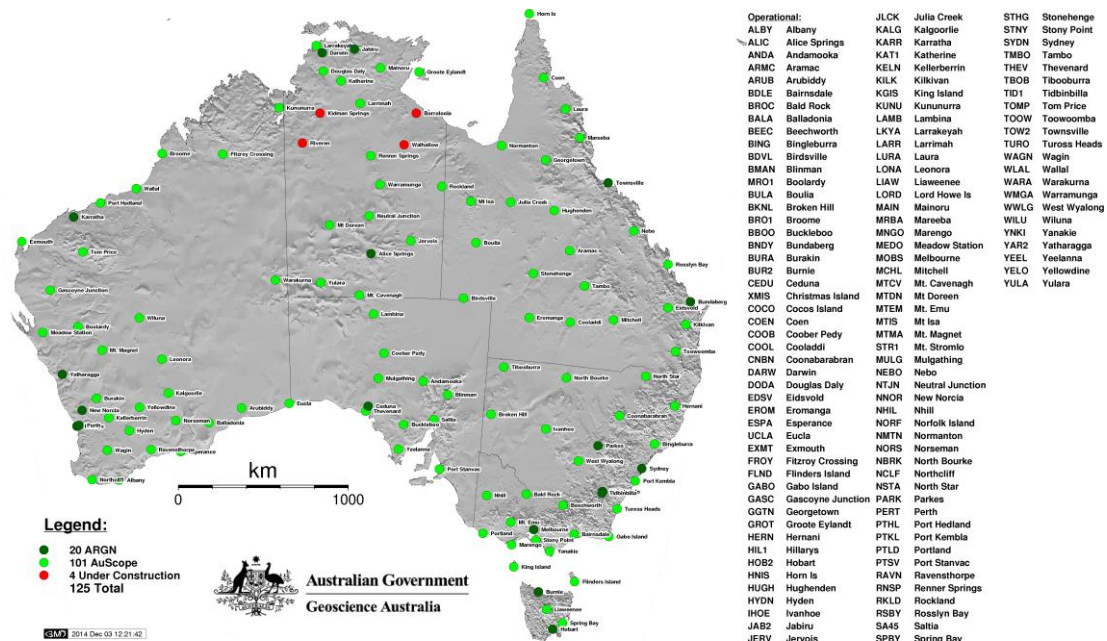


Figure 1. Global Navigation Satellite Systems Continuously Operating Reference Stations (GNSS CORS) in Australia.

Note: From GNSS Network Maps and Time Series, August 2017 (Geoscience Australia, 2018)

As stated by Tidd and Bessant (2009), one of the challenges in operating innovation networks is how administrators can administer the other's things without reducing the exploration of the potential positive impacts they can have in wider and different applications. The organisation that administers the CORS in Australia also encounters this challenge. Hausler and Collier (2013) concluded that an organisational business model in CORS investment and management policy have been raised by several sectors, the Australian government thus considered to use these ideas to adopt the CORS management policy in the National Plan.

In Thailand's there have been comparable CORS management implications to that of Australia. GNSS CORS started in Thailand in 1996 and has continued to grow to the present day. It has aimed to achieve a number of key objectives for the country such as county boundary measurement, national mapping, and land survey. As referred by Rizos and Satirapod (2011), the CORS authorities, including of the Department of Public Works and Town & Country Planning (DPT), the Royal Thai Survey Department (RTSD), the Department of Lands (DOL), and universities, have installed and managed this technology individually without a collaborative policy being in place. There are clear similarities between Thailand and Australia in terms of the implementation of the technology, how it is managed and the potential for better collaboration and use of the technology between inter-government agencies.

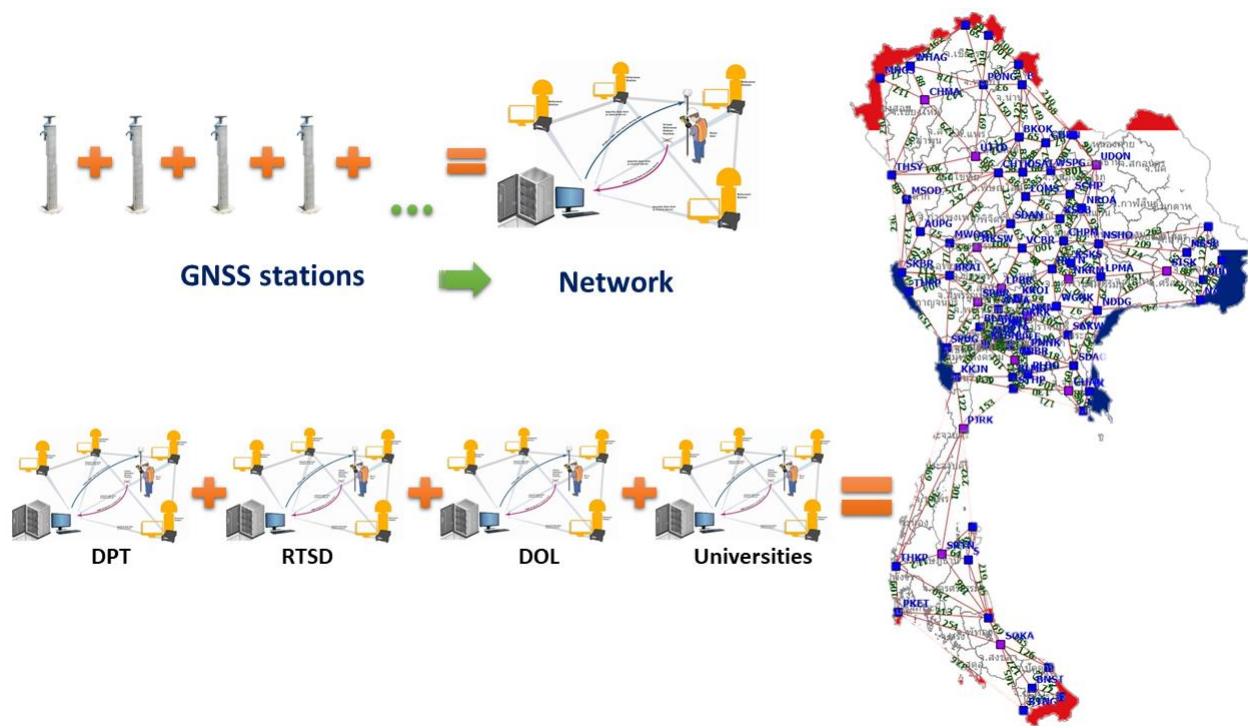


Figure 2. Global Navigation Satellite Systems Continuously Operating Reference Stations (GNSS CORS) in Thailand.

Note: From *From GPS to GNSS: who uses the real-time network – and why?*, August 2017 (CSD, 2017)

Collaboration refers to a framework of performing together in order to understand another person or organisations point of view or ‘worldview’, to discover mutual beneficial opportunities and to foster the management and development of innovation (Jassawalla and Sashittal, 1998). Powell et al. (2005) suggested that collaboration is an essential in constructing resources and experts in an associated field to evolve centrality in various network inclusive scientific areas. Hansen (2009) posits that a crucial point of achievable disciplined collaboration is an improved result and outcome for both parties, although critical questions are required to avoid over-collaboration.

According to Tidd and Bessant (2009), innovation is directed by a potential to discover relationships and define possibilities for acquiring benefits. As a consequence, managing innovation needs to find the importance of innovation, collect relevant viewpoints, and introduce the prospects of innovation for a core procedure. An innovative organisation is a group of various entities that has cooperate to build and encourage the correct environment for innovation enhancement. Thus, it requires a shared vision, appropriate structure, effective team working and a creative climate. Since networking is pivotal in completing particular operations innovation networks correspondingly require prospective partners who have the capability to work with and harness diverse operating situations and have the ability to break down internal organisational barriers.

The need for a policy framework for CORS management in Australia has been raised by the public, academic, and private sector. Higgins (2008) pointed out that the individual ownership of GNSS reference stations in Australia should be regulated by the government in order to unify the GNSS networks, indicate the roles of the significant authorities, and provide high accuracy data service throughout the country to achieve this aim. Janssen (2011) stated that it is an essential to establish collaboration between the CORS owners and operators, both those in the government and private sector to allow interoperability among the base stations. This study identified the components needed to create a viable framework and policy to deal with the complexity of handling and accessing data

from a variety of sources. This could potentially lead to an expansion of the current service coverage area as well as increasing network density and the distribution of high quality homogeneous information. Additionally, Hausler and Collier (2013) pointed that this will also meet the need called for by various bodies in the Australian Government, who are looking for a clear and robust policy for CORS management. These bodies include ANZLIC the Spatial Information Council, the Australian Spatial Consortium (ASC), and the Geoscience Australia. In compliance with current Australian policy, the coordination between the National Geospatial Reference Framework (NGRF) and other agencies offers data free of charge for the Commonwealth Government (Rizos, 2007). Nevertheless, Geoscience Australia acknowledged that investment in the CORS service and the arrangement and addition of non-GNSS augmentation should be a priority (Hausler and Collier, 2013). Hausler (2014) also suggests a framework for the National Positioning Infrastructure (NPI) of Australia. It described that further CORS infrastructures should be associated with the functional framework and outlined that, in the future, both public and private CORS should be operated under collaborative endeavor.

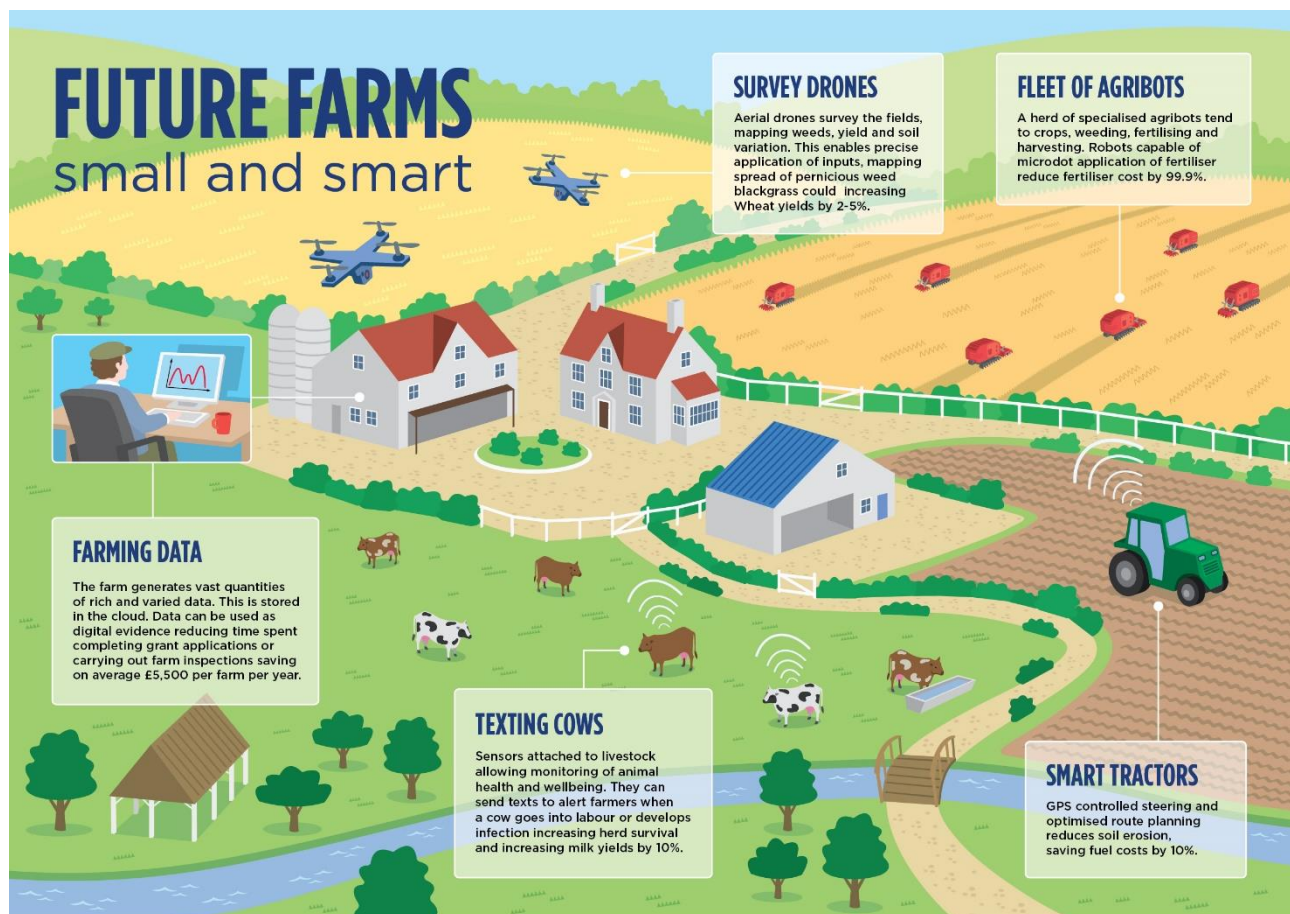


Figure 3. Precision Agriculture.

Note: From Image Gallery, February 2018 (Shree Agro Irrigation, 2018)

As mentioned, the applications of GNSS technology have been widely employed in Australia, especially in the agricultural and transport sectors, for example, for inter-row sowing precision improvement (Roberts, 2009). However, CORS cooperative sector is merely concerned due to the technology investment satisfies user requirements. The Australian government has received numerous recommendations from government agencies and academics with respect to reference station management policy creation. The main points that have been emerged are the duplication of equipment expenditure, issues with service quality control and the lack of cooperative management. Owing to the lack of a CORS central unit and policy, each government office works in isolation,

hence there is unnecessary duplication of effort and expenditure while some parts of country lack coverage. Some user groups are restricted in the data which they can access due to unavailability of a suitable data sharing solution. Adopting a CORS framework and policy would be a logical and practical solution to these problems; accordingly, the collaborative innovation of the CORS in Australia seems to achieve this objective.

Like Australia CORS management in Thailand, is a key government imperative. Inter-organisational coordination is seen as a solution to the same issues as faced by the government in Australia. Both Thailand and Australia have similar CORS technology and distribution, with a variety of government agencies providing an unbalanced coverage area of networks. Furthermore, there are limited accesses to data due to the absence of data control centres. It is believed that it would be feasible to apply a similar framework and policy in Thailand. These are similarities owing to the unavailability of centralised management among the disparate organisations.

These are same issues in respect to the authorities which are the CORS owners and administrators; however there are also differences. Most of Australia's CORS operators are states, while Thailand's are ministries and universities, so that they have different mechanism in which base stations are propagated throughout the country. Although Thailand's ministries that possess the reference networks are separate, members undertaken of these government units can access the services of all areas, for example, DOL government officer in Bangkok, also has the right to receive data from Chon Buri stations, whereas only membership of each Australian state is eligible to use their state facilities. In Thailand, those ministries originally established the CORS for their own purposes, for example, DPT utilised the CORS for Thailand national map, and universities focus on research and study, the users are subject to the CORS possessor's members solely. The budgetary management of each organisation is typically concerned in investing in infrastructure throughout the kingdom; hence there has been no need or interest in developing an inter-government sharing policy. In Australia, the states adopt their local policies of CORS investment and service without inter-state data sharing. Australia started managing their collaboration by establishing ANZLIC which is the federation of Australia and New Zealand cooperation on CORS sharing. The NPI is then appointed as a centre of government to develop policy of the GNSS ground infrastructure and service management. This unit is composed of advisory board from variety of organisations, both Australia and New Zealand's public and private sector. For instance, Geoscience Australia, Land Information New Zealand RMIT University, Civil Aviation Safety Authority Precision, and Australian Maritime Safety Authority NovAtel Inc. (Geoscience Australia, 2018). The NPI also proposes roles and responsibilities of relevant organisations in the policies; hence they have been forwarding the assignments to involved sectors such as ANZLIC and ICSM (The Intergovernmental Committee on Surveying and Mapping) (NPI, 2010). In Thailand, there is an initiative underway to construct a collaborative agreement on the utilisation of the GNSS networks among agencies. Unlike Australia, the leader of this cooperation seems to be RTSD which is one of the CORS key dominant players. However, the CORS management in Thailand is currently under preliminary stage of contribution so that the player roles could be justified during the development.

On this basis it may be inferred that the development of CORS infrastructure and relevant applications can be strengthened by adopting policies which identify budgets for instruments, data manipulation and access, which can create a shared service all over Australia. It is also believed that this is a plausible solution for Thailand.

Table 1: Comparison of GNSS CORS management between Australia and Thailand.

Description	Australia	Thailand
1. GNSS CORS owner	States of Australia and New Zealand as follows:	administrative agencies and institutions as follows

	• Australian Government • Queensland • New South Wales • Australian Capital Territory • Northern Territory • South Australia • Tasmania • Victoria • Western Australia • New Zealand Government	• Department of Public Works and Town & Country Planning (DPT) • Royal Thai Survey Department (RTSD) • Department of Lands (DOL) • universities
2. Users	• state government officers for example, CORS services member of Victoria can access data within Victoria territory but cannot access services from New South Wales or Australian Capital Territory	• central government officers for example, government officer of DPT can access DPT's CORS all over Thailand but cannot access services from DOL or RTSD in the same area
3. Accessibility	• able to access the CORS that possessed by state • throughout state	• able to access the CORS that possessed by department • throughout country
4. Leader of collaboration	National Positioning Infrastructure (NPI) • new organisation	Royal Thai Survey Department (RTSD) • one of the CORS owner
5. Administration tool	Web-based Services	Location-based Services
6. Current status	• collaboration established and policies adopted • action stage	• establishing collaboration to adopt the policy

In conclusion, the Australian government has a powerful encouragement from multiple sections in order to establish a national policy for GNSS CORS management. Organisations, including academic and government departments have managed to facilitate and formulate this policy. Furthermore, policies and web based administration tools have been created to facilitate CORS management. It can be seen from this initial research that the CORS administration process and inter-organisational

cooperative management in Australia are a practical solution to the lack of collaboration that was experienced in the past. Aspects of how this evolved and developed can be seen as a key learning tool in implementing a similar framework and policy in the context of Thailand's GNSS CORS services.

Therefore, the further research activities will aim at Thai government agencies' collaboration on GNSS CORS management and the possible difficulties in applying the predetermined criteria in Australia to Thailand. Then investigate the potential of using Location-based services as centralised management tool.

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II. European Operations Management Association (EurOMA) Conference 2019

Collaborative innovation in the public sector to manage GNSS CORS technology in Thailand

Keywords: GNSS CORS, Collaborative innovation, Public sector

Topics: Operations Innovation, Operations in the Public Sector, Technology Management in Operations

Word count: 998

Purpose

Public and private organisations in sectors such as health care, construction and logistics that require satellite data for ensuring target locations are faced with a proliferation of positioning applications. Continuously Operating Reference Stations (CORS) constitutes one of the technologies designed as a supplement to Global Navigation Satellite System (GNSS) signals to improve positioning precision (GPS.GOV, 2017). Effectively implementing this land-based augmentation system has presented difficulties for countries such as Thailand. In particular, independent ownership and management of the GNSS CORS network has led to problems of duplication and overinvestment and the lack of facility sharing has adverse effects on the budgetary requirements of individual CORS users. To resolve such complications, the various Thai government agencies involved have developed a form of collaborative innovation. But this must take account of the different levels of power among the CORS licence holders based on their number of assets and major missions.

Bommert (2010) contends that collaborative innovation is closely connected the public sector concept of networked government and the private sector concept of open innovation. He argues that collaborative innovation should open the innovation cycle to innovation assets controlled by both internal and external players, and facilitate risk taking in the public sector. However, as Simon *et al.* (2016) argue, getting multiple stakeholders to approach innovation in a collaborative manner involves complex challenges related to knowledge boundaries, interest and ownership.

The present study into the complexity of managing the GNSS CORS system in Thailand aims to analyse how different government agencies are collaborating in terms of data gathering, data management and service distribution. Our study will also evaluate the role played by prominent owners of GNSS network infrastructure in this collaboration.

Design

An earlier case study of interagency cooperation relating to GNSS reference station administration in Australia has shown the need to make proper allowance for the innovation capability of each participating organisation and to assign the separate key roles (Hausler and Philip, 2013; Higgins, 2008). Based on the apparent similarities, we seek to build on the Australian research findings in our own study of GNSS CORS management in Thailand.

A central feature of the Australian case was the establishment of ANZLIC as the top government body in Australia and New Zealand responsible for the accessibility and usability of spatial information (ANZLIC, 2019). In Thailand, nine organisations are getting involved in GNSS ground infrastructure technology, including six government agencies and three universities – for instance, the Royal Thai Survey Department, the Department of Lands, and Chulalongkorn University (Rizos and Satirapod, 2011).

Our research is founded on a realist ontology combined with a multi-methodology approach including interviews and in-depth case studies. In practical terms, this involves focus group interviews with six organisations who own the base stations in Thailand and expert interviews with academics from three universities, supported by simultaneous analysis of the Australian case study documentation. The data collection phase started in the summer of 2018 and is currently ongoing. Following transcription and translation of the focus group and expert interviews, detailed content analysis is applied and findings are compared.

Findings

Data collection and analysis will continue for another year. But based on a preliminary analysis of the primary research data already collected, we can summarise the participants' perspectives in two key areas; namely, the positioning of the different organisations in the collaborative innovation effort and the precise nature and shape of the coordination framework.

First, the interviewees are concerned about: whether public collaborative innovation relating to GNSS technology will come into effect; which government agency (between the one who has the maximum number of the assets and the one who has core responsibility for state surveying) should be the project leader; which organisation should be the national data centre; what should be the shape of the cooperation design; what business model should be selected; and what technology should be installed for the overall network configuration.

Second, the interviewees desire effective regulations or policies for inter-organisational cooperation so that each organisation is allocated a suitable role and appropriate authority is given to each office.

Contribution

The ultimate goal of our research is to support the adoption of the policy framework for strengthening the GNSS CORS collaborative innovation in Thailand. This will include the development of a viable business model to formulate budgetary guidance and resolve budgetary issues.

From a theoretical perspective, our research contributes to a better understanding of the roles that each of the stakeholders should play in a collaborative innovation effort, taking account of their different levels of power and interest. Collaborative innovation holds considerable promise in breaking individual policy deadlocks, minimising system-wide investment costs and improving public service quality. However, Bommert's (2010) contention still holds: there is an urgent need for empirical research, typically in the form of in-depth case studies, to substantiate such potential benefits. Our research aims to make an original contribution to fulfilling this need.

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Collaborative innovation in the public sector to manage GNSS CORS technology in Thailand

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Abstract

Organisations require effective access to disruptive technology management including a generation of a culture of continuous innovation. Therefore, the open innovation paradigm has been established as a theoretical base for managing innovation in the enterprises and public sectors. In order to handle the independent ownership and management of GNSS CORS technology complexity in Thailand at the national level, collaborative innovation has arisen for building and refining the creative ideas and sharing internal resources and external knowledge. Moreover, stakeholder theory is deployed to consider the role-plays and the power of each of the partners over an inter-organisational collaboration.

Keywords: GNSS CORS, Collaborative innovation, Public sector

Introduction

Public and private organisations in sectors such as health care, construction and logistics that require satellite data for ensuring target locations are faced with a proliferation of positioning applications. Continuously Operating Reference Stations (CORS) constitutes one of the technologies designed as a supplement to Global Navigation Satellite System (GNSS) signals to improve positioning precision (GPS.GOV, 2017). Effectively implementing this land-based augmentation system has presented difficulties for countries such as Thailand. In particular, independent ownership and management of the GNSS CORS network has led to problems of duplication and overinvestment and the lack of facility sharing has adverse effects on the budgetary requirements of individual CORS users.

To resolve such complications in the management of GNSS CORS technology in Thailand requires the adoption of technological innovation in the public sector. To this end, the various Thai government agencies involved have developed a form of collaborative innovation. But

this must take account of the different levels of power among the CORS licence holders based on their number of assets and major missions. The present paper analyses key issues surrounding innovation management with respect to GNSS reference networks from the perspective of the open innovation paradigm, with a particular focus on collaborative innovation and stakeholder engagement.

Theoretical Background

Open innovation

The term ‘open innovation’ was coined in 2003 by Chesbrough in his seminal book, since then open innovation has become a term synonymous with modern approaches to innovation (Cassiman and Valentini, 2016). Essentially open innovation means that the innovation process is permeable, meaning that “there are many ways for ideas to flow into the process, and many ways for it to flow out into the market” (Chesbrough, 2006). This understanding that innovation transpires across the boundaries of individual firms and involves many actors linked together in formal and informal innovation activities has resulted in Chesbrough (2003) distinguishing open innovation from the traditional closed model of innovation. Closed innovation is based on the premise that investment in R&D results in technological discoveries that advance into new products and services, which increase profits that are then reinvested into the development of further new technologies, all in a process controlled and managed by a single firm. Conversely, within open innovation this process is opened up with ideas and technologies being developed externally to the firm. What also occurs is the spinout of ideas, technologies and business models from the open innovation activities to other firms who perhaps create new ventures.

Since 2003 a plethora of studies have emerged on the topic of open innovation. While we agree with Huizingh (2011), who highlights that innovation has very rarely been ‘closed’, there is no denying the increased focus on more complex forms of innovating with multiple actors, across organisational boundaries. What we see in the literature is the use of ‘open innovation’ as an umbrella term, with other forms of innovation such as collaborative innovation, network innovation, co-creation, user-driven innovation, crowdsourcing all falling under the broader term of open innovation. While it is not the purpose of our paper to disentangle the knotty conceptual underpinnings of various types of openness within innovation practices, it is important to recognise the shared dimension of these concepts – namely, that innovation takes place with multiple actors and not within the confines of a single organisation.

Open innovation in the public sector; collaborative innovation

While much of the literature in this area has its roots in for-profit organisations there is a growing body of research focusing on the application of these practices of innovation in public sector organisations. There is a recognition that open and collaborative forms of innovation may support an increase in the quality and quantity of innovations in the public sector (Nambisan, 2008; Bommert, 2010), at the same time as helping to remove policy impasses and deadlocks while dealing with ever increasing complex societal problems (Torfing, 2016). It is also known that models of open and collaborative innovation cannot be directly transferred into a public sector setting due to the policy processes and cycles that determine the introduction of new policies (Mergel and Desouza, 2013). However, there is a growing literature on the development of guidelines and frameworks applying the principles of open and collaborative innovation into the public sector (e.g. Bloch and Bugge, 2013; Brown and Osborne, 2013; Crosby et al., 2016).

In a related field, collaborative governance is defined as the inclusion of government organisations in formal discussion in order to reach agreement with respect to public policy

adoption or how government resources or plans are managed (Ansell and Gash, 2008). Networked government engages all types of organisations (for and not-for profit organisations) and citizens in the system to attain relevant public goals. As a result, the concept of collaborative innovation emphasises that resources should be shared over different organisational boundaries (Moore, 2009; Bommert, 2010). Also, a cross-disciplinary approach is proposed to the collaborative work between governments in which the advanced collaborative innovation hierarchies could strengthen public innovation by instigating stable processes (Sørensen and Torfing, 2011).

Stakeholder management

A key aspect of open and collaborative innovation is the management of stakeholders to engage with innovation. This appears to be more of a challenge in public sector led collaborative innovation where IP issues are less transparent, knowledge is often more tacit and there are inherently more politics at play (Mergel and Desouza, 2013). Furthermore, the literature identifies a key consideration concerning the management of the open and collaborative innovation, which is ‘who’ takes ownership and responsibility for the innovation. This means that the facilitation of the collaboration is of utmost importance in the success of the collaborative innovation (Sørensen and Torfing, 2011); but there is limited theoretical or practical insight into how this facilitation can be done effectively.

A multi-stakeholder partnership (MSP) is an idea in which stakeholders, both governmental players and non-governmental players, make an effort to do something together under a win-win situation, with each actor given a clearly defined role (Simon et al., 2016). When the stakeholder-based process is applied to local government administration, the decision makers are influenced by the stakeholders who are empowered to deploy the power over their organisation (Gomes, 2006). There appears to be an element of power differential that can impact the success of the collaboration; for example, the individual managers’ consideration of power and power-motivated behaviours can impact the success of the innovation (Cankar and Petkovšek, 2013). This can result in power asymmetries that can risk the operation of the collaborative innovation (Sørensen and Torfing, 2011). In order to overcome these power differentials there are traditionally five elements that underpin the collaboration concept; namely:

1. organisation,
2. associateship,
3. interaction process,
4. objective, and
5. temporal attribute.

The task of exploring the stakeholders’ role needs the comprehension of the distinctiveness, the depth, area of interest, distinct portion and logic deducting of players. The requisite conditions are as follows: to obtain the arrangement of the public value that needed to be co-produced; to gain legitimacy and authorisation over the converging and diverging points; and to create the required capability of co-producing the public value, especially delivery and interconnected system capacity with a close attention to the important route, divergent resourcing, and contrasting time frames (Bryson et al., 2017).

Initial conceptual framework

This demonstrates the complexity of the areas to be considered in the setting up and management of a collaborative innovation network. Figure 1 outlines the initial conceptual framework for our study. It illustrates the key areas of importance and will provide guidance as an analytical framework for our empirical data.



Figure 1 - Initial conceptual framework

Our study into the complexity of managing the GNSS CORS system in Thailand aims to analyse how different government agencies are collaborating in terms of data gathering, data management and service distribution. Our study will also evaluate the roles played by prominent owners of GNSS network infrastructure in this collaboration.

Research Methodology

Outline of the research design

An earlier case study of interagency cooperation relating to GNSS reference station administration in Australia has shown the need to make proper allowance for the innovation capability of each participating organisation and to assign the separate key roles (Hausler and Philip, 2013; Higgins, 2008; Roberts et al., 2004; Roberts, 2009). Based on the apparent similarities, we seek to build on the Australian research findings in our own study of GNSS CORS management in Thailand. A central feature of the Australian case was the establishment of ANZLIC as the top government body in Australia and New Zealand responsible for the accessibility and usability of spatial information (ANZLIC, 2019). In Thailand, no less than nine organisations are getting involved in GNSS ground infrastructure technology, including six government agencies and three universities (Rizos and Satirapod, 2011).

Our research design is founded on a realist ontology combined with a multi-methodology approach to data gathering, including focus groups, expert interviews and in-depth case studies. In practical terms, this involves focus group interviews with six organisations who own the base stations in Thailand and expert interviews with academics from three universities, supported by simultaneous analysis of the Australian case study documentation. Our approach to data analysis is based on deductive content analysis to derive our research findings. The broad objectives and scope of our study and somewhat convoluted nature of the research design lead to a large set of multifarious research data (Stewart et al, 1990).

The data collection phase started in the summer of 2018 and is currently ongoing. Following transcription and translation of the focus group and expert interviews, detailed content analysis is applied, and findings are compared.

Data collection methods

A focus group is a data collection method that provides large amounts of information on the perspectives and spontaneous body language from a range of individuals about issues raised in the group interaction (Rabiee, 2004). Primary focus group data were collected from six government and public organisations that control GNSS CORS infrastructure in Thailand. The six focus groups respectively comprise the Royal Thai Survey Department (RTSD), the Department of Lands (DOL), the Department of Public Works and Town & Country Planning (DPT), the Hydro and Agro Informatics Institute (HAII, a public organisation), the Geo-Informatics and Space Technology Development Agency (GISTDA, a public organisation), and the National Institute of Metrology, Thailand (NIMT, a public agency).

Each of the focus group interviews lasted between one and three hours. They were conducted internally: the participants were invited to discuss a given topic with three to six government officers who came from the same organisation. The detailed composition of each focus group was determined based on selected criteria covering the purposive specification and multidimensional aptitude of the participants. These criteria included, for example, age range, knowledge of the study area as well as other characteristics, organisational responsibility and decision-making power. As they had been carefully selected based on these criteria, the participants were comfortable expressing their ideas to the group members and researcher (Rabiee, 2004). Additionally, some of the participants were assigned as the representatives of their specific department, in order to substitute for any important decision makers who were unavailable for the focus group interviews.

Expert interviews constituted the second data collection method employed in this study. This particular qualitative technique requires skilful participants with a specific interest and expertise in the relevant area of research. Although a powerful technique if applied in the right manner and circumstances, the choice of experts is subject to a number of constraints; in particular, proficiency in the specialised research questions but also limitations in terms of time, availability and accessibility. Such factors tend to put a strict limit on the number of the potential participants (Baker et al., 2012).

Once selected, experts are requested to attend sessions with an interviewer who raises queries relating to specific topics and records the responses (Muskat et al., 2012). In our research design, the experts were two Professors and a Lecturer from three Thai academic institutions; namely, Chulalongkorn University (CU), King Mongkut's Institute of Technology Ladkrabang (KMITL) and Kasetsart University. They are all professionals in GNSS technology and related fields of research; and they participated in semi-structured interviews lasting between one and two hours.

Data analysis methods

Data collection was immediately followed by the start of the process of data analysis. Summaries and transcriptions of the focus group and expert interviews, including nonverbal communication as well as the way in which participants used words and the tone of their voice, were made in preparations for the next steps in the analysis (Onwuegbuzie et al., 2009; Stewart et al., 1990). In a qualitative research paradigm, the analysis aims to understand the meaning of a situation, rather than its literal truth, according to the purpose of the study. In the context of focus groups, transcribing interview data could yield many similar instances and phrases. There is then a risk that data selection and evaluation could become highly subjective. Therefore, an in-depth analysis of the interview data should be systematic, sequential, verifiable and continuous (Krueger and Casey, 2000; Rabiee, 2004).

Content analysis is a flexible approach that can be applied to quantitative data as well as qualitative data, either in an inductive or deductive investigation. Although its very flexibility and lack of straightforward guidelines for use have sometimes caused problems for researchers applying this analysis method, it is very well suited for delicate and multifaceted context

analysis. Moreover, a deductive analysis is capable of testing existing assumptions or differentiating between phenomena relating to dissimilar categories and different times (Elo and Kyngäs, 2008).

Based on our prior theoretical knowledge from the literature review, we have used our initial conceptual framework (in Figure 1) to apply deductive content analysis to the massive set of data from both the focus group interviews and expert interviews. This has been done through a systematic process, in which data consisting of the use of words, tone of voice, gestures, facial expressions and body positions have been examined in connection with the research questions. The quotes have been classified into a 'relevant category' and 'not so relevant category' and duplicate quotes have been grouped as per their similarities. The data preparation step has been repeated until all was in readiness for the data interpretation stage (Rabiee, 2004).

Findings

Outline of data analysis

After the preparation stage, we have analysed our data in accordance with the seven criteria of Krueger (1994) and Rabiee (2004); including actual words used and their meaning, context, internal consistency, frequency or extensiveness of comments, intensity of the comments, specificity of responses, and big ideas.

1. Consider the actual words used and their meaning

The word most frequently mentioned in the interviews is 'business model', which the participants considered as a framework for the collaboration. The participants seemed to believe that this word constitutes the main guideline for the direction in this collaborative project and that it will influence multifaceted factors of the cooperation, including the policy or regulation that will be adopted accordingly.

2. Consider the context

The researcher did not ask about the importance of the CORS technology. However, the participants expressed that this technology is necessary to ascertain the quality and ease of their work. Thus, the expansion of GNSS network is required. However, they are taking additional technology into account at the same time, in order to prevent obsolescence of traditional technology effect.

3. Consider the internal consistency

The individual participants' steadiness in viewpoints and position was firmly retained; the viewpoints of others rarely impacted their individual perspectives. Some changes happened solely when new information emerged from trustworthy members who are directly responsible for the matters related to that information.

4. Consider the frequency or/and extensiveness of comments

The most frequent words occurred in discussions is 'who', with reference to the context, 'who' means 'which organisation'. The questions about 'who' arose in many instances: either who should be the project leader?, who should be the national data centre?, who should manage the central network?, who should process the CORS network?, who should provide the services?, who should take responsible for the marketing strategies?, who should deal with the private sector or foreign countries?, and who else should be able to own the CORS in Thailand?. The participants responded to the question about 'whether collaboration on GNSS CORS in Thailand should be done' that 'everyone (organisations) wants to get involved in this collaboration as it is a great opportunity to gain advantage from the shared infrastructure'. 'Many of them want to be the leader of an association; however, who is the most appropriate one?'

5. Consider the intensity of the comments

This stage has aimed to perceive the profound feelings of the speakers about their comments. When the directors or managers from the prominent organisations stated that they agreed with the collaboration, it means that their organisations would love to join the created community of CORS as important players and could leave the coordination once the conditions are of no further interest. Conversely, the comments from less-powerful organisations are thereunder. They have more positive feelings about this collaboration than the powerful ones.

6. Consider the specificity of responses

The replies from the members that related to individual experience have been considered as contradictory hypothetical situations. For instance, an officer who graduated from Japan recommended to use the Japanese business model as a guideline of the cooperative project rather than Australian business model; whereas an IT specialist commented about cell-based technology to replace or supplement the CORS technology.

7. Find the big ideas

Making provision for overall discussion matters requires a temporary pause to increase the ability to assess the massive amount of resources thoroughly and go through the variety of information efficiently. As a consequence of this step, the big picture of the discussion would be asserted.

Data interpretation

A preliminary interpretation of the results by manually comparing and contrasting the interview data can be summarised as follows. First, the comments in respect of the given topics reflect a considerable shift in attitudes towards the collaborative project. There are several issues that the interviewees concerned about listed below.

1. Whether public collaborative innovation relating to GNSS technology will come into effect?

The lack of the obliging power of the laws and regulations supporting the actions has decelerated the team forming process. Further, a change of the government could cause unpredictability and uncertainty in the policy of CORS management.

2. Which government agency (between the one who has the maximum number of the assets and the one who has core responsibility for state surveying) should be the project leader?

The Royal Thai Survey Department who is responsible for the national mapping was the most frequent mentioned organisation in this point. Nevertheless, the Department of Lands who have the greatest amount of CORS sites in Thailand was named as well.

3. Which organisation should be the national data centre?

Should the project leader be the national data centre? If yes, they would be the central unit for the CORS management in Thailand. On the other hand, the national data centre should be able to make profit or make the contract with private sector or foreign countries. Therefore, the Royal Thai Survey Department, which is a Special Services Group of Headquarters, Royal Thai Armed Forces, might not be applicable to this aspect.

4. What should be the shape of the cooperation design?

As regards the interests of the structure of the cooperation between government organisations, the regulations or an Act of Parliament to permit government authorities to share internal information with other parties had to be granted beforehand. In addition, the restrictions on resource sharing and the relationship between organisations should be clarified.

5. What business model should be selected?

They need to judge between Japanese business model and Australian business model (or other business model) which one is the most pertinent to be followed?

6. What technology should be installed for the overall network configuration?

Multiple type of hardware and software have been established, the configuration for the central network need to be chosen in advance. Once the data streaming start, the network setting should be ready to go as well.

Second, the interviewees demonstrated the strong desires for concrete out-turns with respect to rational doubts that are mentioned above. The following are crucial needs they pointed out.

1. *Regulations or policies*

They greatly desired the effective regulations or policies for inter-organisational cooperation so that each organisation is allocated a suitable role.

2. *Authority*

An appropriate authority is demanded of each office. In order to the flexibility and possibility in working on this project together, particular authority should be given to specific collaboration members. Therefore, they will know the extent of their legitimate rights in performing tasks or duties and protect them from any charge and trial as the result of proceeding with the plan under the government policies.

Contribution

The ultimate goal of our research is to support the adoption of the policy framework for strengthening the GNSS CORS collaborative innovation in Thailand. This will include the development of a viable business model to formulate budgetary guidance and resolve budgetary issues.

From a theoretical perspective, our research contributes to a better understanding of the roles that each of the stakeholders should play in a collaborative innovation effort, taking account of their different levels of power and interest. Collaborative innovation holds considerable promise in breaking individual policy deadlocks, minimising system-wide investment costs and improving public service quality. However, Bommert's (2010) contention still holds: there is an urgent need for empirical research, typically in the form of in-depth case studies, to substantiate such potential benefits. Our research aims to make an original contribution to fulfilling this need.

Conclusion

The study of GNSS CORS technology management in Thailand is now under way to establish a final stage of analysis and interpretation which are an extremely time-consuming process due to a huge amount of data. After that, we will endeavour to adopt the policy framework for this technology management which require a great thoroughness. Therefore, the relation between the cooperative government organisation and the power of stakeholders should be identified precisely prior to the policy adoption. However, the vital role of political leadership, politicians, and politics that influence public value production in the society are greatly significant to take into account (Bryson et al., 2017). As a result, further study would extend to focus on the political power issues that could impact the GNSS CORS collaboration management in Thailand.

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