Knowledge Management in innovative technology companies: The case of the energy sector

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This thesis is the result of the author's original research. It has been composed by the author and has not been previously submitted for examination which has led to the award of a degree.

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Abstract

Knowledge Management (KM) has been extensively researched for more than two decades, however the academic literature is still quite disjoined and fragmented. Companies keep facing repetitive KM-related problems that come at high cost, and the solutions that they find are often reduced to installing a new software package that is expected to facilitate knowledge flow across an organisation.

This research departs from a problem observed in practice – a failed KM project in an innovative company, and aims at understanding the reasons behind this failure. It then investigates KM within some of the most innovative companies in the energy sector in an attempt to address the questions found in practice and not answered by the academic literature. Subsequently it sets the following research goals, which help to address identified gaps in the literature: (1) to understand the KM journey that companies undertake, (2) to define the role of technology in this journey, and (2) to explore gamification as a possible contributing aspect of a developed solution.

The research adopts an iterative approach in a form of continuous dialogue between theory and practice, with multiple case study analysis as the research design of the main part of the empirical investigation. And as a result, it develops an organic roadmap of KM that depicts an evolution of KM in innovative companies at the example of the energy sector.

This research contributes of the body of knowledge by:

1. Describing a KM journey that innovative companies in the energy sector undertake in order to achieve excellence, and that consists of three phases: managing explicit knowledge, knowledge sharing and creating new knowledge.
2. Demonstrating that technological component (document repositories) is central to KM only in the first phase and becomes peripheral (with the most useful tool being wikis) starting from the second phase.
3. Opening a new area of research and suggesting that gamification might have a significant impact on KM that stretches far beyond motivation.
4. Questioning that maturity models are an appropriate framework to study the evolution of KM in an organisation.

The research contributes to practice by demonstrating that KM is a learning process rather than a one-time initiative and by creating realistic expectations from the technological support.

The extent of the contribution was discussed with the companies-participants of this study and the board of directors at Durham Energy Institute, being a validation of the findings.

Publications

Below is the list of published contributions of this research:

Journal papers

Shpakova, A., Dörfler, V. and MacBryde, J. (2017), "Changing the Game: A Case for Gamifying Knowledge Management", *World Journal of Science, Technology and Sustainable Development*, Vol. 14 No. 2/3, pp. 143–154.

Shpakova, A., Dörfler, V. and MacBryde, J. (in review), "Game of Thrones for Knowledge Management: Gamification for Knowledge Workers' Empowerment", *Management Learning.*

Shpakova, A., Dörfler, V. and MacBryde, J. (in review), "Gamified Innovating: A Conceptual Model", *Innovation: Organization and Management.*

Book chapters

Shpakova, A., Dörfler, V. and MacBryde, J. (2018) "Gamifying innovation and innovating through gamification, Knowledge, Learning and Innovation" in *Transformational Entrepreneurship*, ed. Ratten, V. and Jones, P., United Kingdom: Routledge.

Conference proceedings

Shpakova, A., Dörfler, V. and MacBryde, J. (2017), "The Organic Roadmap of Knowledge Management in Innovative Companies", *EURAM 2017: 17th Annual Conference of the European Academy of Management, At Glasgow*, UK, pp. 1–40.

Shpakova, A., Dörfler, V. and MacBryde, J. (2017), "Maturity Models as an Appropriate Approach for Knowledge Management?", *EURAM 2017: 17th Annual Conference of the European Academy of Management, At Glasgow*, UK, pp. 1–40.

Shpakova, A., Dörfler, V. and MacBryde, J. (2016), "The Role(s) of Gamification in Knowledge Management", *EURAM 2016: 16th Annual Conference of the European Academy of Management, At Paris*, France, pp. 1–39.

Shpakova, A., Dörfler, V. and MacBryde, J. (2016), "Gamification and Innovation: a mutually beneficial union", *BAM 2016: 30th Annual Conference of the British Academy of Management*, Newcastle-upon-Tyne, pp. 1–18.

Shpakova, A. (2015), "Mapping Innovative Companies by their Organisational Characteristics", *EURAM 2015: 15th Annual Conference of the European Academy of Management, At Warsaw*, Poland, pp. 1–33.

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1. Introducing Research

"If you have an apple and I have an apple and we exchange these apples then you and I will still each have one apple. But if you have an idea and I have an idea and we exchange these ideas, then each of us will have two ideas."

George Bernard Shaw

Peter Drucker was the first to talk about the importance of increasing the productivity of knowledge workers as the challenge of the 21st century, as he compared it to the need of increasing the productivity of manual workers in the 20th century (Drucker, 1969). And since then companies have started to realise the increasing importance of intellectual property, which is harder to evaluate, manage and even identify. Companies can own and manipulate their property and products, but do not and cannot have full control over the ideas, knowledge, skills and expertise of their employees, nor can they erase this knowledge from the employees' minds if they decide to leave (Handy, 2001), even though they certainly want to.

In chasing the intangible and ephemeral, the field of knowledge management (KM) emerged, and it meant to improve learning within organisations and accessing available knowledge, capturing and keeping expertise inside the company, and ultimately gaining competitive advantage and boosting innovation and personal creativity (Davenport and Prusak, 1998). The initial interest in KM came in waves (Lambe, 2008; Wiig, 1997). It exploded with the book by Nonaka and Takeuchi "*The knowledge-creating company*" (1995). But the excitement was followed by a wave of disappointment, as the expensive attempts to codify all the knowledge and store it in a document repository in the hope of it being reused later did not bring the expected results (McDermott, 1999). 60% of the global corporations have spent $4.8 billion on knowledge management initiatives and KMS implementation (Babcock, 2004), of which only 26% reached implementation stage (KPMG, 1998), and most of them failed at the end. A suggested underlying reason is that the companies failed to understand that knowledge is not static by its nature and cannot be separated from the knower (Fahay and Prusak, 1998; Polanyi, 1962). The emergence of social media tools generated a new spark of interest in KM, but then some researchers saw the KM term as being overused or misused, and preferred to rename or rebrand it as KM practices supported by social media (e.g. into social computing).

KM does not seem to be a hot topic anymore as evident from the decrease in search of KM-related terms in Google; a lot has already been written about it, but KM-related issues have not disappeared in most companies. Large, well-known and successful organisations that are featured in Fortune 500 have the resources to buy expensive software and initiate large scale

KM projects with the help of experienced practitioners. Their experience is described in numerous case studies, but most organisations stumble upon the same problems, and seem to not know what to do with the experience of large organisations and where to start. The example of the best in the field might be a perfect fit for a puzzled wonderer, or it might be not. Unfortunately, the literature does not suggest a clear answer.

1.1. Research Origins

During my Masters I had a chance to work in the R&D department of a French producer of medical equipment. One of the challenging tasks I was offered was adjusting a newly introduced Knowledge Management System (KMS), which was not adopted and did not gain any popularity in the research department, even though researchers had initially supported this project two years back. After a series of interviews, I discovered that the system was not supporting the everyday routines of the researchers, the company did not spend any resources on training, and the system itself was confusing, not engaging or user-friendly and had a number of technical issues.

I referred to the academic literature and tried to find recommendations on the design of a good KMS and implementation processes, but I found very little, and therefore my suggestions were based on my ability to listen to what the researchers wanted. This company had a clear idea of what the researchers needed and wanted at the beginning, and some of the problems the company was facing could have been foreseen and avoided, but despite the initial advantage the project was a failure. Many companies are in a much worse starting position, as they have only a vague idea of their problems and do not find support from their employees. Also the lack of any guidance on KMS selection and implementation seemed like a huge gap in the literature. For these reasons I decided to narrow down my desired area of research to the KMS types and to contribute to covering this gap. However, the research scope had to incorporate KM problems and needs in order to understand where KMS support might be needed.

The benefits of KM seem obvious, and ignoring the problems that are caused by poor KM practices can be expensive. Approximately $31.5 billion is lost annually by Fortune 500 companies due to their employees failing to share their knowledge (Babcock, 2004). And those companies that succeed in KM initiatives show better performance; for example, 20 companies that received the Global Most Admired Knowledge Enterprises[1] award in 2013 had their return on revenues 3.6 times and return on assets 4.6 times that of the median of the Fortune 500 companies (Teleos, 2013).

[1] Most Admired Knowledge Enterprises (MAKE) Award was created by The KNOW Network in 1998 and is supported by the Journal of Knowledge Management and Joint Intelligence Committee that acknowledges the companies for the best knowledge performance and their knowledge-driven strategy (Teleos, 2013).

On the other hand, given this evidence of the failure rate of the KM projects, surprisingly few researchers have attempted to draw a holistic view of the matter within the boundaries of an organisation. The goal of this research is ambitious and the following section narrates the way in which the research evolved.

1.2. Research Journey

The description of my journey should help the reader better understand the scope and the logic of this research as it unfolds. Table 1 presents different phases of the research with iterations between the literature review, empirical work and research design. The purpose of each phase and the relationship between the phases are presented on the Figure 1 and explained in more detail in Section 2.2.

Table 1. Phases of research.

Period	Work conducted
October'13 - April'14	Literature review of the areas of KM and KMS.
May'14	Interviews with 7 practitioners from technology-intensive companies with the focus on understanding KM related problems that they are facing.
June'14 - April'15	Literature review of the area of MM. Design of the study
May'15	Interviews with 3 knowledge and innovation management practitioners (referred to as experts) with the focus on validating the research ideas and investigating the current state of KM practice.
June'15 - October'15	Literature review of the area of gamification Recruitment of companies Refinement of the study design
November'15	Interviews with 5 Zappos employees regarding gamification aspects with the focus on understanding how gamification impacts KM.
December'15 - March'16	Survey and interviews with 6 companies with the focus on how KM evolves with time and what types of KMS support KM in its different phases
April'16 - September'16	Analysis of the results

My PhD journey started with reading the works of the most influential researchers in KM, like Polanyi, Prusak, Davenport, Tsoukas, McDermott, Sveiby and Swan, and by mapping the field of KMS, and the initial overview of the literature provided a good background understanding of the vast area of KM. The review also included the work of experienced practitioners, such as APQC[2] and Knoco[3] consulting companies, as a way to control whether any of the important aspects were missing from the overview of the literature. In order to narrow the scope of the research down I took the opportunity to conduct interviews with practitioners. Due to my genuine interest in innovation, and as innovation management is knowledge intensive and benefits from improved KM practices (Swan and Scarbrough, 2001), the initial search was

[2] https://www.apqc.org/
[3] https://www.knoco.com/

limited to the companies that design technologically complex products. The aim of the interviews was to better understand the context of their work and to explore KM related problems that they have. Most of the companies were from the energy sector, and therefore I have focused more on this sector. It seemed like a good place to look for innovative companies because the energy sector currently faces big challenges that drive innovation forward. But this aspect of case selection is discussed in more detail in Chapter 2 in the research design (Section 2.2.2) and Chapter 3 which aims at defining the research context (Section 3.6.2).

In order to make the cases comparable the context of the research was narrowed down to the Product Development Process (PDP), since the preliminary interviews with practitioners showed that it was very similar across the companies. In addition to that, I discovered the concept of Maturity Models (MM), during one of the interviews, as a way to examine the status and progress of KM practices in that company. The research about MM showed that this framework has been well established in some areas, primarily software development, and this success inspired others to adopt the framework in other areas, such as KM. Unfortunately, existing KM frameworks lacked a rigorous approach to development and were poor in details. It seemed that the MM framework could be adopted in KM, if designed properly, but it would also mean that the research could not focus on KMS types solely and had to connect them through prioritising KM practices and understanding how they evolve in an organisation. And only then one could understand how these practices can be enabled and supported by certain types of KMS.

Further research in this direction and initial contacts with the companies allowed me to get in touch with experienced knowledge and innovation management practitioners and to have their views of the current status of KM in the energy sector among others, and to explore the relationship between innovation management and KM. Apart from giving a deeper understanding of KM issues (not just surface problems that could be related to KM), the interviewees have also pointed out an interesting phenomenon that was emerging in some experiment-friendly companies – the use of gamification to change the corporate culture. These experiments sounded exciting and made me start reading about this new approach, which could shift mental perception and initiate behavioural change in many areas, e.g. sustainability. What began as a pet project at the fringes of my research soon became one of the main research streams and a direction to move forward beyond PhD.

Gamification appeared to be a new trend in a number of areas, such as education and marketing, but nothing has been written so far about the use of gamification for KM. However, gamification could potentially become the next wave of KM, amplifying the use of social computing. Therefore, this topic branched out as an additional area of my research.

When exploring gamification, I found the opportunity to conduct a case study about a company that developed a sophisticated system by integrating gamification elements in its

business processes and practices, and the interviews showed the ways in which gamification could be used to empower knowledge workers and to help them to be both more productive and creative. At the same time, I recruited six companies that agreed to participate in the main part of this research. These companies operate in a knowledge intensive area, and when given examples of the problems that they might be facing and the potential improvements that they could achieve by paying closer attention to KM, they could immediately relate to the problems and see value in this research. Some of them have already engaged in a KM-related initiative, others could only see KM-related problems inside their organisation, and the mix of these experiences made this sample interesting. The next sections of the introduction explain the essence of the research and the structure of the dissertation in more detail.

1.3. Research Approach and Aims

The previous section described the path of this research with intermediary findings that shaped further directions and set expectations for the reader. This section intends to define the point of departure and shed light on some of the aspects of the methodological approach in order to clarify the nature of this research.

In strategy making an iterative approach is called *strategic indirection*, which involves maintaining perceptual sensitivity to the surroundings and circumstances, which can "result in a spontaneous clarity of the situation at hand and thus the appropriate effort and action needed" (Chia et al., 2013, p. 65). Maintaining perceptual sensitivity implies adjusting actions on the way as opposed to following a pre-defined rigid plan, and in practice strategies are more likely to be built through strategic indirection of adjustments. Similarly, the research is rarely governed by one initial question, it arrives to interesting insights and takes a turn, though quite often researchers try to present it otherwise. This research follows this indirect path even more so, and therefore, this approach could be called *research indirection* (Dörfler et al., 2017), allowing the research aim and objectives to change as the research unfolds.

In the context of this research this approach implies a constant iterative dialogue between theory and practice, between academic literature and the reality of the practitioners' world. As a point of departure in this journey, the first round of literature review was driven by the initial research question, which was reformulated into three research questions after the preliminary investigation phase:

Initial research question: *What is the nature of dependency of the KMS types on the KM practices on the organisational level?*

Since such an iterative approach might appear somewhat non-traditional to the reader, and as affected the choice of methods in a similar way, the methodological framing is a cornerstone of this research, and therefore this thesis starts by explaining the variety of adopted methods and the ways in which they were brought together in order to make sense of the theoretical and empirical material.

As for the literature review, which is often regarded as a first major step in research, it was conducted in stages and different parts of it are presented in different chapters together with the results of the analysis of the empirical material, where they seem relevant. The first round of literature review that was driven by the initial research question raised a lot of questions, such as whether we understand KM related needs well enough in order to develop KMS recommendations, whether the level of commitment to KM can vary from one organisation to another and still bring fruitful results, whether it is easy to identify KM related problems, whether they are similar and the companies are able to see and identify them.

This led to an increasing scope of problems that could be included in this research, and in the attempt to narrow the scope down and understand better the nature of these problems, I complemented the literature review with a round of exploratory interviews with practitioners and a round of interviews with KM experts. All these iterations were necessary to formulate the research questions and understand the research context and scope, since the literature review alone could not meet these objectives. Therefore, Chapter 3, which investigates the research context, contains a mix of literature review and empirical findings and is dedicated to meeting these objectives.

The major aspect of the scope of this research that was not influenced by the preliminary investigation, but was rather a conscious choice, refers to the type of companies that the research was focused on. Innovative companies were chosen, because knowledge is seen as the most critical resource for innovation (Doz and Wilson, 2012; Leonard-Barton, 1995), and consequently, KM related problems are most visible in these companies, and by solving them these companies will benefit most. In order to find innovative companies, the energy sector was chosen as a representative industry because it constantly deals with technological challenges and ambitious goals (e.g. carbon emissions reduction targets 2020), and so it could be a promising place to look for innovative companies and observe KM practices. On the other hand, this industry is known for being risk averse, as it is an essential component of basic modern infrastructure, and therefore this research focused only on those companies that are involved in product development, as they are the ones battling with challenges and therefore having to innovate.

The outcomes of the preliminary investigation, which are described in Chapter 3, resulted in research questions that were formulated at the end of the preliminary investigation phase, namely:

1. *How do the KM needs of technology companies involved in innovating activities evolve with time in the context of PDP?*
2. *How can technology, especially with respect to KMS, be used effectively to support these needs?*
3. *What role might gamification play in the future of KM and innovation?*

Although these three questions appear to be from three different traditions: process view, computer science and organisational studies, I am looking at them from the process point of view. KM research originates in two fields: computer science and organisational studies, where the former takes a techno-centric approach, while the latter focuses on the people's practices and behaviour. This research takes a third lens – a process view, which was originally developed by the distinguished KM scholars Prusak, Davenport and Tsoukas, and which attempts to combine the two traditions and to take a more comprehensive view of KM.

Chapters 4 to 7 present four attempts to answer these three questions. The remaining section of this chapter guides the reader through the rest of the thesis and outlines the purpose and content of each chapter in more detail.

1.4. Thesis Structure

This chapter has introduced the research and created expectations, and the last part of the chapter guides the reader through this work. *Chapter 2* of the thesis describes the *Initial Methodological framing*, which justifies the philosophical paradigm that was chosen for this research and that shaped the approach to conducting the research. Then it describes the iterative approach to conducting the literature review and empirical study, which navigated the research in the direction that it took. It then justifies the choice of the research design being a multiple case study and outlines the main aspects of it. And finally, it describes the methods that were employed to collect and analyse the empirical material in the research, namely the interviews and the survey.

Chapter 3 investigates *the context of the research* through the first cycles of the iterative approach. Firstly, it provides the literature review of the main concepts that were employed in the research, namely: Knowledge Management with the emphasis on the knowing processes, knowledge workers and the interrelations between Knowledge Management and Innovation; and Knowledge Management Systems. Then it presents the findings of the preliminary interviews with product development and project management practitioners of high-end companies, the major themes that emerged from the interviews with knowledge and innovation management experts. And at the end it discusses the research context that was refined as a result of these cycles, and formulates the research questions that were the result of the preliminary investigation.

Chapter 4 presents an effort to *Build a Maturity Model for Knowledge Management* as the first attempt to answer the first research question. It starts with the literature review of the field of MM, then it continues by explaining the design of the questionnaire and the technicalities of using the chosen methods for analysis, and finally it presents the findings from the survey that was conducted as the first part of the multiple case study and the implications for the research.

Since the first attempt to answer the first research question was unsuccessful, *Chapter 5* – *Understanding the journey of Knowledge Management in a company* – presents the second attempt to answer it. It starts by elaborating on the methods that were used to analyse the interviews, then it continues with the overview of the results of the interviews with six companies as a part of the main empirical study that presents a KM model – the organic roadmap of knowledge management. Then it discusses the outcomes of the major findings by contrasting theory and practice, and explores other themes that emerged during different phases of the research, but did not fit in the main model such as the impact of culture.

Chapter 6 continues the analysis of the interviews and presents the answer to the second research question by *Locating Knowledge Management Systems on the roadmap of Knowledge Management*. Then it touches on the various aspects that were highlighted during the literature review, such as motivation and the issues of implementation and discusses them in the light of the empirical findings.

Chapter 7 – *The role of gamification in Knowledge Management* – answers the third research question. Firstly, it provides an overview of the emerging field of gamification, then presents an exploratory case study that speculates about the role that gamification might play in KM, and finally it discusses the impact of gamification on innovation, since knowledge and innovation management are inseparable from each other, as is shown in chapter 5, and therefore the findings of the positive impact of gamification on innovation only reinforce the opinion about the transformational power of gamification on KM.

Finally, *Chapter 8* presents the *Conclusions* by discussing the implications of the findings on research and practice, acknowledging the limitations of this research and suggesting further directions that the research might take as well as the future of KM practice.

2. Initial Methodological Framing

The first chapter introduced the research and provided the initial research question which was driving the research at the beginning. The main research question comes not from the literature gap, but from the contradictions between the reviewed literature and practice: trying to understand initially what could be the reasons behind the failure of the KM project in my MSc dissertation and to find guidance related to KMS selection and implementation. The research process driven by this type of contradiction is called a tentative problem solving process, and it is only natural to approach it by finding tentative solutions (through trial and error), which are then being selected by the environment (Popper, 1999) and create iterative cycles. The evidence of the existing contradictions between practice and the extant scholarly literature is presented in the next chapter, where I provide parts of the literature review, discuss the research context initial research framing. However, this dissertation adopted a somewhat non-traditional structure, where the methodological approach is outlined first. In this research a variety of methods was employed, and understanding the multifaceted nature of the research design would help to perceive the complexity of the analysis and findings in the following chapters and support their credibility.

The initial findings made me step back and look at the issues related to KM in general and to seek answers both in the literature and in practice iteratively, and through this iterative approach the research question evolved in new directions. One of the suggested solutions, maturity model for KM, proved to be not viable (it was trialled and proved to be an error), and this realisation led to searching for new approaches. Due to the iterative nature of this research the dissertation starts with explaining the methodological approach, since it is believed to be the cornerstone of this research process, whereas parts of the literature review are included in other chapters where it seems appropriate.

The methodological approach evolved with time, and the diversity of empirical material that emerged through this research necessitated a variety of methods that were used to analyse it. At the beginning action research was chosen as a working research approach, but numerous literature gaps and deficiencies did not allow for accumulation of prior experience and to suggest improvements that could be implemented and tested in one company and contribute to the academic research at the same time. Instead it seemed more logical to compare and contrast the findings in the literature with the experience of practitioners. Therefore, the research continued in iterative cycles: going back and forth, and looking for questions and answers in research and practice.

With the results, the research revealed the need and the opportunity to build a model of KM evolution in an innovative organisation. This aim could be achieved either by conducting a longitudinal study of one organisation or by collecting input from several companies, which were likely to be on different levels of maturity. The former was hardly possible due to the

limited time of a PhD; therefore, the research design transformed into a multi-case study analysis.

This chapter intends to guide the reader through the methodological design of this research, starting from the philosophical framing that shaped the choices of the design and methods in use. Then it will describe the research design in more details. And finally, it will discuss the variety of methods used to collect and analyse the empirical material. The discussion of each method is maintained at a generic level in order to give the reader a better understanding of the nature of this research, and more specific details, such as the software used and the specifics of applying each method, will follow in the next chapters where appropriate. One important aspect of that affects methodological framing - research context, is discussed in Section 3.6, as it was a result of several rounds of empirical investigation and therefore can be reviewed only after the discussion of the insights if the investigation in the same chapter.

2.1. Philosophical framing

The ontological and epistemological assumption lie at the foundations of any research, they create awareness about the constraints of the world of our thinking (Tsoukas and Chia, 2011) and define the approach to seeing the data and methods being used (Easterby-Smith et al., 2012). Not only does it help to shape the methodological approach, but it also raises questions about the nature of the concepts employed and their meanings, which otherwise might prevent the researcher from deriving sensible conclusions from the empirical material (Tsoukas and Chia, 2011).

The topic of my research overlaps with the field of organisational studies and information systems (IS), and the differences in the dominant philosophical approaches can potentially disharmonise the research. Organisational studies have been enriched with the plurality of equally accepted views and perspectives (Walsh, Meyer, & Schoonhoven, 2006), whereas the prevailing approach in IS research comes from the positivist paradigm with its hypothesis being tested, concerns about the representativeness of a sample, and quantifiable measures of variables (Orlikowski & Baroudi, 1991), though there is a shift towards perceiving the reality through the social and organisational context, and understanding the phenomena through the meanings assigned by people (Orlikowski & Baroudi, 1991).

A similar struggle occurred within this research. On the one hand, in this research I attempt to bind together fragmented literature that assumes a degree of generalisability of the findings, but on the other hand I recognise my direct involvement in the data, where they are being collected and interpreted through dialogue with the participants. What I hear is the interpretation of the participants, the projection of their experience narrated through the stories and understood through the lens of my own experience (McAdams, 1997). And if different people are interviewed or the same people share their stories a year later, the stories would be different, because the context has changed and their experiences have

changed too. This however does not disqualify my interpretation, but on the contrary, it proves the authenticity of the stories of the participants (Sims, 2005). But by trying to objectify the reality one simplifies the construct, which might become distorted and therefore useless in its simplicity, and conditioned with this understanding, I can consciously recognise the ontological and epistemological assumptions of the research.

Ontology refers to the philosophical question about reality (Hatch and Cunliffe, 2013), where a researcher makes a meaningful choice about their position on the scale from seeing reality as a concrete structure (objectivist paradigm) to accepting it as a projection of a human mind (subjectivist or interpretivist paradigm) (Cunliffe, 2011). As discussed before, I understand and accept the subjective components that are brought to this research, and the interpretations of the participants that are embedded in the data, and therefore I chose the symbolic interpretivist paradigm (Table 2), which explores "the variety and layers of social meanings created and enacted by organisation members through language, symbols, interactions and so on" (Cunliffe, 2011, p. 649).

Table 2. Characteristics of symbolic interpretivism. Adapted from: (Cunliffe, 2011; Hatch and Cunliffe, 2013).

	Characteristics of symbolic interpretivism
Core ontological assumptions	Reality as symbolic & linguistic, meanings & interpretations. Contextualized in a social site. Objective existence cannot be known apart from our subjective awareness of it.
Epistemology	All knowledge is relative to the knower (actors, interpreters, sensemakers) and can only be understood from the point of view of the individuals who are directly involved in it.
Research approach	Ethnomethodology, aesthetics, symbolic interactionism, hermeneutic, syntagmatic or pragmatic. Detached or involved researcher. Inductive. Interpretive procedures.
Research methods	Dramaturgy, story analysis, discourse & conversation analysis, symbolic analysis, grounded theory, content analysis, action research. Semiotics. Semiotics.

Following the question of reality, epistemology is concerned with the question of the approach to this reality (Hatch and Cunliffe, 2013), and subjective reality can be approached only through my own knowing and interpretation of the knowing of the actors (participants). Thus in this empirical study I am mostly interested in the meanings the individuals assign to particular events, symbols and dynamic changes, and sense-making of the reality around them as opposed to the meanings created and assigned in the existing literature. The chosen paradigm shapes my methodological approach, which will be described in more detail as the chapter unfolds.

2.1.1. Ethical considerations

The participants of this research included engineers, project managers and KM practitioners of companies in the energy sector and other technology-intensive sectors, and merchandise and customer support specialists of an online retailer. The participants were not asked to provide any personal or commercially sensitive information, and the information obtained was only related to knowledge sharing practices in the companies and software that was used to manage documents and support these practices. Therefore, the ethical committee of the University of Strathclyde Business School granted an ethical approval to this project.

The only type of information that could be classified as potentially sensitive, and therefore pose risk to the participants, was related to the dynamics of the project teams and problems associated with it, e.g. the criticism of established practices or practitioners, or the lack of practices in the organisation. In order to address this issue, the participants were informed that all the interviews would be anonymised, the names of the companies would not be affiliated with any characteristics of KM practices or any examples to illustrate the findings, be it good or bad examples, and that no one would have access to the empirical material except for the investigator. The participants were asked to familiarise themselves with the rules of conduct of this research and were asked to sign a consent form, thereby agreeing to be recorded and accepting the rules.

2.2. Research Design

At the beginning of this chapter it was mentioned that an iterative approach to this research resulted in employing multiple case studies as a research design, and the chosen philosophical framing influenced the selection of methods that were used to collect and analyse the empirical material. In particular, the data were primarily collected through interviews, which were then analysed using a variety of methods: Gioia's method was used to establish second order themes to analyse the interviews in details, Data Flow Diagrams and Concept mapping were used to structure the interviews and making sense of rich in context. I have considered also using field observations as another approach to gathering data about the knowledge workers, but this method required greater access to companies which I did not have, therefore, the interviews were chosen as the most sensible method of gathering data. Interviews were complemented with a survey, which served as an input for the interviews during the primary investigation and intended to become a backbone structure for further analysis, which was however shown to not be applicable after the analysis of the survey was completed. The survey was analysed using two methods as well, which complemented each other: Machine learning algorithm and Correlation analysis. All these methods are presented in this chapter, preceded by the discussion of the iterative research process and multiple case study design, and followed by the approach to synthesising the results.

2.2.1. Iterative research process

The research process cannot be standardised, otherwise, like qualitative methods (Cunliffe, 2011), it would be reduced to a technique. But there are four common phases: research design, data collection, data analysis and data interpretation. They are not necessarily linear; one might follow a cyclic or spiral track when progressing through the research, but they all take place.

An iterative approach to these phases is quite common in qualitative studies, being either implicitly embedded in the research, which unrolls organically, or explicitly acknowledged and praised by the researchers as the research approach (Stierand, 2015; Stierand and Dörfler, 2012b), and iterative learning is a key characteristic in qualitative research (Keegan, 2009). The interpretivist paradigm suggests that a researcher tries to understand a subjective meaning of the matter, but the subjective dimension can be grasped only through engaging in a dialogue with that matter area (Laverty, 2003) and understood through introspection (Stierand and Dörfler, 2012b).

This research organically evolved in an iterative way (Figure 1) being a dialogue between the theory and practice. As was mentioned in the introduction and will be explained in more detail in Section 3.6.1, a high-end sector was chosen partially because of my prior experience with this sector, and as a result I had a certain level of pre-understanding of the studied context, which can both help to interpret the meaning (Stierand and Dörfler, 2014) and to pre-condition with biases (Stierand and Dörfler, 2012b). Dialogic approach allows the researcher to deconstruct these pre-understandings as well as exploit them (Finlay, 2012), and in this research the dialogic approach has been utilised through simultaneously analysing the interviews and verifying the suggestions during the first round of interviews, as well as prompting suggestions and assumptions during the interviews with the experts.

In addition, practice-based research requires an insider with a shared background to help understand the meanings (Gioia and Chittipeddi, 1991; Handley et al., 2007), and produce original contributions (Stierand and Dörfler, 2014). This role might be fulfilled by a researcher who shares the same background (Stierand and Dörfler, 2014), but my background knowledge of the context was not sufficient to become an insider of my own, and therefore the experts and the participants of the principal investigation that have provided feedback on the preliminary findings have become the insiders by sharing their interpretations of my findings.

This research was not designed in an iterative way from the very beginning, but it rather evolved in iterative learning cycles organically, and the discussion above justifies that these cycles are natural to qualitative interpretivist research.

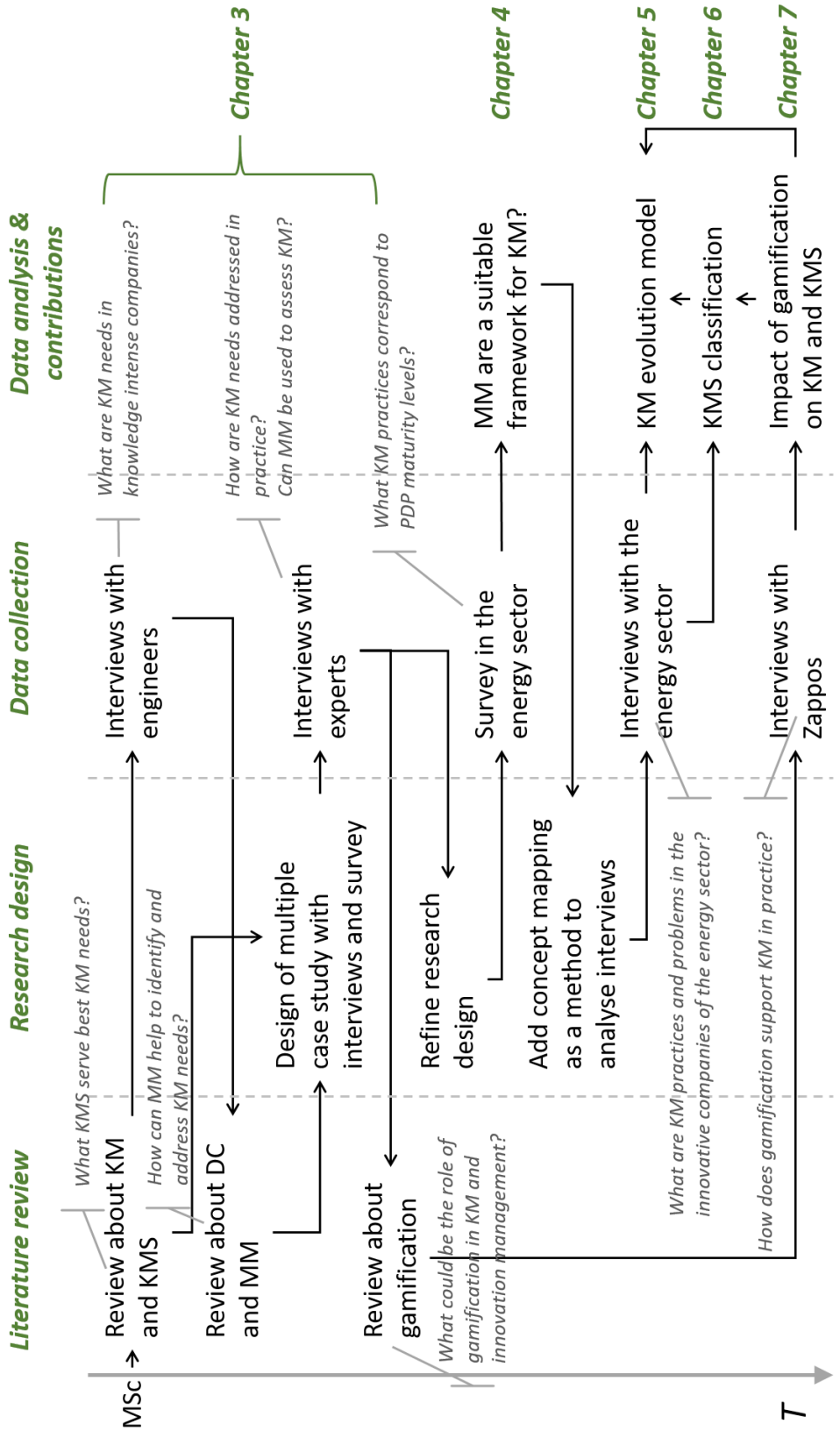


Figure 1. The map of the research.

The initial literature review was conducted in an attempt to find the answers to the questions raised during my prior experience. But the literature review revealed multiple literature deficiencies and KM challenges that are discussed in Sections 3.2.6 and 3.1.4 respectively, and as a result the scope was widened beyond the boundaries of one PhD. As an alternative approach to narrowing down the scope, it was possible to conduct a series of interviews with practitioners from the companies that are knowledge intensive and driven by innovation. Product development process (PDP) was considered as a representative area in an organisation that could serve as an innovative context for this investigation, and therefore the practitioners that were asked to participate were primarily engineers involved in product development. The interviews updated my understanding of the world of KM and KMS with their current problems, and set the priorities to focus on as well as suggested directions for further research. For instance, such aspects of KMS as system architecture and interface design were left aside, while the approach of building a maturity model as a framework for structuring recommendations was put at the core of the research scope.

During the next phase of the literature review the research was shaped in greater detail and an external validation seemed useful in order to evaluate the suggestions. In order to do that it was possible to find and arrange interviews with experienced knowledge and innovation management practitioners. Their extensive experience allowed me to perceive them as experts of the field, therefore their opinion was considered highly valuable and shaped significantly further research. The interviews with experts opened up various issues (discussed in Section 3.4) and suggestions that were not discussed and could not have been potentially discovered with practitioners. In particular, the experts were discussing extensively issues related to motivation and culture, providing multiple examples of new ideas management as a part of KM, and mentioned gamification as an approach that several companies have tried and that demonstrated interesting results. It was not possible to incorporate all the issues that were covered in the scope of the main research, but gamification was taken on board as a curious direction to look at further, and another cycle of literature review followed in order to understand this concept in detail.

Since the primary area of research focuses on the maturing of KM in the organisation and finding appropriate KMS for different stages, the progress can be understood either by conducting a longitudinal study with one organisation or by finding several organisations with similar characteristics and with different levels of involvement in KM, and observing the practices in relation to the parameters that could indicate the maturity. The former requires large resources, such as access to an organisation for a long period of time, and since improving KM can take years and does not necessarily reach the higher level due to various external factors (e.g. cost optimisation and consequent deprioritising of non-core business related projects), conducting such a study within the boundaries of one PhD research would not be possible. The latter was a viable alternative, but it had its own disadvantages. For instance, it can provide a more superficial understanding of the practices that take place in

each organisation as opposed to an organisational ethnographic study in one company, and this in turn creates the risk of misinterpreting the levels of maturity. However, approaching empirical material with a variety of methods and therefore being able to see different insights in it helped to mitigate these risks and to draw a more holistic picture of the studied problem. The rest of the chapter discusses the design of the principle investigation that was the result of the iterative cycles, and the methods that were employed through the course of the study.

2.2.2. Multiple case study

The need for case studies arises when one tries to understand a complex social phenomenon and/or have a holistic and real world perspective (Gummesson, 2006). This method has been widely adopted by many disciplines from medicine to behavioural and organisational studies and even economics, which is traditionally seen as a bay of quantitative research (Yin, 2014). Case studies are traditionally associated with the exploratory phase of the research, and this method was indeed employed in the complementary gamification research for that purpose. However, case studies have been successfully used for the descriptive and experimental types of research of an emerging field as well (Eisenhardt, 1989; Gummesson, 2007; Yin, 2014), and the principal investigation with the energy companies is more likely to be descriptive.

Case studies started as observing an event or phenomenon in one unit of analysis (e.g. one company), but they are also used for studying multiple cases, and in this instance some researchers differentiate between multiple case studies and cross-case analysis, arguing that multi-case studies aim at describing several cases, while cross-case analysis aggregates and synthesises the findings (Stake, 2013). However, it is hardly possible to imagine someone engaging in a multiple case study just to describe the cases separately. Therefore, Yin (2014) rightly suggests that cross-case analysis and multiple case studies should not be distinguished as two different methods. Instead, they are two different names of the same research approach, where the former potentially emphasises the comparison over other ways of looking at the data. And similarly, a multiple case study could be seen as a variation of a broader category of case studies.

The dominant methods of data collection for case studies are interviews and observations; however, observations are much harder to conduct in an organisational setting for the reasons that were described so vividly in the study of multinational consulting companies (Karjalainen et al., 2015) and will be discussed in more detail in Section 5.1.1. Therefore, as was mentioned before, observations were excluded from the scope of the research methods in this study. Interviews can be a source of rich and diverse empirical material, and became a dominant method in this research. Additionally, interviews were complemented with the survey, which aimed at giving a preliminary understanding of the processes in the company and gathering a diversity of views on these processes from different employees, which could be addressed during the interviews. Yin (2014) suggests five research approaches and forms

of research questions that each approach addresses, and according to him the case study addresses the questions of how and why, but in order to answer these questions, one needs to know the answers to the question what, which can be either based on assumptions or addressed through the survey. The survey can draw a big picture of the processes and their status before the interview. Apart from that, the theoretical foundations for the case studies were based on prior research and assumptions (with regards to the link between process and KM maturity), which could be tested through the survey as well.

The process of conducting a multiple case study is similar to the process of a single case study with several extra steps that are required to aggregate and synthesise the insights from multiple cases, and the major steps are presented in Figure 2. Of the whole procedure the steps that require a closer review within this chapter are the case study design and preparation and collection of the empirical material as well as the first step in the analysis.

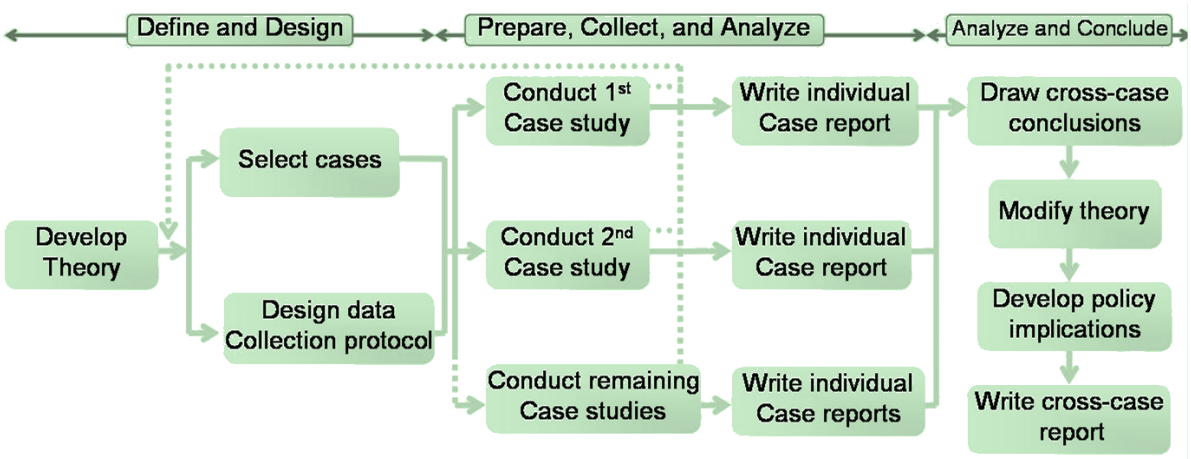


Figure 2. Multiple case study process. Source: (Yin, 2014).

After the theoretical basis for the case study has been developed, the study needs to be designed, which includes case selection and defining such components as the questions that need to be answered, the propositions if any, the unit of analysis, the logic that links data to the proposition, and the criteria for interpreting the findings (Yin, 2014). The choice of the type of the companies has already been justified in Section 1.3 of the introduction and will be elaborated further in Section 5.1.1. With regards to the number of cases, Stake (2013) suggests using 4-10 cases in a multiple case study analysis, which will provide enough richness of empirical material, and is a reasonable amount to handle. And the introduction to Chapter 5 demonstrates that I came to a similar conclusion by approaching this question from a different point of view.

The interviews address the questions of how and why certain KM practices are conducted or not conducted in the context of PDP and project management. Therefore, the case study research has two units of analysis: the company and the practice. Observing the practices across the companies defines their meaning and purpose, while the companies indicate the status of each practice and their priorities. Therefore, the data analysis follows the logic of

cross-case comparison, and the synthesis even more so. As for the final component, unlike the statistical analysis, which quite often addresses this question by calculating the level of significance and comparing it to the threshold level of 0.05 or 0.01, qualitative studies do not have such a benchmark. Instead, the insight can be compared with the theory and rival explanations, which become the criteria for interpreting the findings (Gummesson, 2003; Yin, 2014).

With regards to conducting the case studies, the interviews and the survey were the primary methods, and each of these is reviewed in more detail in the following sections of this chapter in terms of both data collection (the themes explored, the duration, the mode of conducting) and analysis (the used methods), and in Sections 4.2 and 5.1 preceding the overview of the results. However, it is important to note the overall approach to data analysis. The procedure above suggests individual case reports; each case was analysed individually while all the interviews were analysed in aggregation, and this phase took the form of writing a general report for all the companies-participants with one section which was customised for each company individually. Therefore, the common part of the report corresponds to the following step of the procedure: cross-case study conclusions. The final steps of this procedure refer to linking the insights back to the theory, and therefore can be best demonstrated in action at the conclusions of the following four chapters.

Case studies approach has been criticised for a lack of rigor as being retrospective and relying mostly on the opinions of interviewees (Hakim, 2000), but a case study is a fundamentally different research design, and therefore should not be judged as a poor version of an experiment (Robson, 2002). Many subjects, e.g. neurology or geology, do not rely on statistical methods and experimenting, but they are not criticised for being less rigorous because of that, so similarly organisational studies should not be (Yin, 2014). The issue of rigor was being addressed by using triangulation to get an assurance that the right meaning has been obtained from the information interpretation following the positivist tradition (Stake, 2013) by approaching the problem area from different angles (methodological, theoretical, investigators) (Denzin, 1989), with the ultimate goal of achieving the same results and therefore to get the “truth” with the possibility of further generalisation. It served as an instrument to justify qualitative research in a world dominated by numbers (Langley and Abdallah, 2011), and lies at the extreme of the objectivism paradigm. But triangulation should not be in the agenda of the case study research, because case studies are interested in particularisation, not generalisation (Gummesson, 2003; Stake, 2013), and with interviewing being one of the primary methods of case study applying triangulation is not sensible, because the same results will not be achieved due to different interpretations. In this research a variety of methods are used, but one should not think that by diversifying the portfolio of methods I attempt to triangulate the results. The methods are not used to verify the results of each other in this study, but rather to contribute to the overall picture in the same way as missing pieces contribute to the puzzle.

However, the theoretical insight (rather than the direct research findings) produced as the result of this analysis should have a sufficient degree of generality or universality so that the results could be transferred to a similar context or situation (Robson, 2002; Stierand and Dörfler, 2012a). To anticipate the discussion of the main objective of this research in the next chapter, it is important to note for the reader that the resulting model of KM that is meant to meet this objective was developed for a specific type of company. However, the potential to transfer the findings of the research to companies with similar qualities from other industries would be one of the implications of this research, therefore implying a certain level of generalisability. The rest of the chapter will guide the reader through the different methods employed in this research.

2.3. Literature review

Traditionally any research starts with the literature review, since identifying the problem (a "conflict" in the literature or between literature and practice) and suggesting a solution (contribution to knowledge) can only be built on prior knowledge, which is derived to a large extent from prior literature on the topic (Popper, 1999). Sometimes a literature review becomes a stand-alone method (a systematic review) and makes a contribution by reporting the evidence of evaluating, analysing and synthesising the contributions of the literature in a studied field (Denyer and Tranfield, 2009). But in combination with other methods it is predominantly used to acquire understanding of the field and of the key research issues in it (Hart, 1998).

In this research, as was shown in Figure 1, the literature review was conducted iteratively, with KM and KMS being the initial areas of research and other areas being added as the research progressed. For that reason a systematic review, which was originally under the consideration, was not used at the end. The review started by reviewing the field of KM with the main focus on organisational knowledge, types of knowledge, knowing processes and knowledge workers, and was complemented with the field of KMS. Due to the large amount of available literature in KM the review started from the books and papers of the gurus in this field: Polanyi (personal knowledge), Tsoukas (organisational knowledge), Davenport and Prusak, Sveiby (KM in practice). With regards to KMS the initial research included all the areas concerning KMS typology, design, implementation and use in order not to eliminate potentially useful topics that could shed light on the working research question.

The search was mainly conducted by searching through the databases Google Scholar, Suprimo, EBSC and Web of Knowledge using relevant keywords, and the main focus was on the papers and books with the highest citation rate or published most recently. This strategy was combined with the "snowball" technique of "unrolling" the most interesting references from the most relevant articles.

The literature review was subsequently influenced by the first round of interviews with the practitioners, and complemented with the concept of maturity models that were seen as a tool for structuring the findings. And after the second round of interviews with KM practitioners, which aimed at receiving feedback about the emerging ideas and having a practitioner's view on the current state of KM, the literature review was enriched with the concept of gamification as a potential future development in KM.

2.4. Interview design

Interviewing is one of the most widely used methods of collecting empirical material in qualitative research (Crouch and McKenzie, 2006), ranging from being a single method to being used as part of an ethnographic study. The interviews vary from *structured* to *unstructured*, where *structured* interviews resemble face-to-face surveys and are mostly used to ensure the structural validity of the data, which will be further analysed using statistical methods. On the other hand, *unstructured* interviews tend to be an open discussion with a clear idea about the aspects that should be covered and a few prompt questions to start the conversation (Saunders et al., 2011). The findings might be very rich, since the interviewees are more engaged, but the level of usefulness depends highly on the respondent, and the results are very difficult to analyse afterwards. However, in reality researchers rarely use either of these extremes, but instead they employ a *semi-structured* setting, where balancing between highly structured questions and unstructured dialogue allows the abstraction of the deep insights from the interviewees and makes the interviews comparable at the same time (Chapman, 2001). Finding the ratio between predefined questions and an open discussion helps on one hand to open the door to new knowledge that the researcher can explore later and include into further interviews' questionnaires, and on the other hand to generalise and extract common patterns from the interviews.

The level of structuring depends on various factors, such as the area of expertise of the interviewee. For instance, it is much easier to have an open dialogue with KM practitioners and only give hints about the areas of interest in KM, than with engineers, who when asked about their everyday routines, will not know what information they are expected to share. Therefore, the questions for the latter should be better defined and contain more clues and hints. The degree to which the field is established also plays a role. The field of KM is fairly well conceptualised and the studies are likely to be less exploratory and more theory building and testing. Consequently, the questions for the interviews and the research design are more specific, since the researchers have a better idea of what they are looking for. On the other hand, exploratory studies, such as the role of gamification in KM, step into a virgin territory, and further analysis can lead in any direction, therefore bounding the interview with too many predefined questions can only create a risk of losing new opportunities.

These considerations influence the extent to which the questions for the interviews are predefined, and also show that I cannot apply the same level of structuring to all the interviews. Following this logic, the interviews with KM experts were highly unstructured with a few prompts about their experience to start the conversation. Perhaps for that reason these interviews lasted longer (90-120 min) than the interviews with practitioners (40 to 60 minutes). The interviews with the company that has experience of using gamification were also relatively unstructured, since this is an exploratory study and intended findings are unclear. On the other hand, the interviews with practitioners can and should be better structured, because the area of research is better defined, and because their routines that are of interest are performed semi-autonomously, and the types of problems that they are facing and that I am most interested in are frustrating but are outside the core focus of their job. All the interviews were conducted face-to-face or via phone/Skype, if face-to-face meeting was not possible. More specific details about the design of the interview for each stage, e.g. the themes explored, the number and duration of interviews, are included in the methodological section in the following chapters: initial interviews with practitioners and interviews with experts in Sections 3.3 and 3.4, main interviews with practitioners in Section 5.1.1, and gamification interviews in Section 7.2. The next section describes methods that were used to analyse the interviews.

2.5. Interview analysis

Since interviewing was the main method used in collecting the empirical material on all the phases of the research, the interviews were very different in nature. The first exploratory interviews were mainly focused on understanding the internal processes of the companies, and therefore a process mapping method was employed – Data-Flow Diagrams, which are explained in more detail in this section. Alternatively, I considered using organigraphs (Mintzberg and Heyden, 1999) to have a more structured approach to analysing potential problems that the companies interviewed are facing, but it was not used because the level of detail about the internal processes was considered insufficient.

In the second phase the interviews with experts were highly unstructured, and rather than applying a formal method to analyse them, it was more beneficial to follow the stories, the concepts, and the opinions of the experts and make sense of the content-rich interviews. And finally, on the third phase the interviews were intended to explore current KM practices in companies, past experiences and future directions of the development. These interviews were more structured and homogeneous on one hand, and very rich in context on the other hand. Therefore, the analysis employed the method of Concept Mapping which allowed the capture of the richness of the materials and to reveal hidden patterns and reinforcing loop, and one of the two established methods of analysing qualitative interviews, Gioia's method, which allowed exploration of the richness of the empirical material and to draw a more

holistic representation of KM. As was mentioned before, concept mapping was employed after the survey analysis provided unexpected results, as an alternative approach to structuring interviews. I also considered other mapping methods, in particular, causal mapping and cognitive mapping, but the interviews captured the state of KM practices, rather that tried to understand the causality of certain activities, therefore, concept mapping was considered more appropriate. Regarding the interpretation of the interviews, Gioia's method is the only well-established method that allows analysing rich in context material without losing its richness, therefore, no other alternatives were considered.

The same method was employed to analyse the interviews for the gamification case study. The interviews were relatively unstructured, since the topic of gamification could not be openly discussed with the interviewees, but I was looking for specific themes in these interviews, and so employing this method was made possible. However, while the codes and themes for the main interviews emerged through the process of analysing, the codes for these interviews were well defined before the analysis started. The rest of the section will review the methods in more detail.

2.5.1. DFD

Data-Flow Diagrams (DFD), also called bubble diagrams, work-flow diagrams, or functional models, are used to understand the flow of a system's processes and study the system's design issue. They help to focus on the important features and to verify the understanding of the system's environment (Yourdon, 1989). This tool is widely used because it provides a graphical representation of the system, easy to communicate and understand, and to analyse if all the necessary processes have been defined (Kendall and Kendall, 2005).

DFD consist of the basic elements, like the processes, the flow of information or data (or movement of chunks of information), the storage (or collection of information and data at rest) and the terminator or external entity (Kendall and Kendall, 2005; Yourdon, 1989). However, other elements can be used as well, e.g. a decision point is often represented in the form of a diamond.

DFD can be logical (reflecting the way a business operates and describing the business events) and physical (representing the system design that will be implemented), however, this research is mostly interested in the logical flow. The resulting diagrams fulfilled two purposes: they allowed comparison of the processes, and this comparison will be discussed in more details in the following chapter, and they were used to verify the interviews and confirm that the process and meanings were captured correctly.

This method was used to map and compare PDP of the companies interviewed during the preliminary investigation, and the results of these interviews are presented in the next chapter as one of the components that shaped the main objective of this research.

2.5.2. Making sense of rich interviews

Making sense of rich material was used to analyse unstructured interviews with experts, but describing this method in a structured manner similar to all the other methods is impossible for the following reasons.

Sensemaking became of interest in management studies, and the idea of sensemaking process in its broader sense originates in pediatrics as an attempt to explain unexpected, rare events that are often undermined. The phenomenon of ignored rare events was observed and further elaborated on in the example of Battered Child Syndrome, involving hidden leg, arm and rib injuries, the severity of which was often underestimated by both the parents and pediatrists, who did not have these types of injuries as an established diagnosis, and therefore preferred to ignore it rather than to appear paranoiac. But when the first examples of this phenomenon were published in journals, and later discussed at conferences, the number of reported cases grew exponentially (Weick, 1995).

And although the meaning of sensemaking might seem intuitively familiar to us, scholars have very different views of what it actually is. Feldman (1989) defines it as an interpretive mechanism, that leads to a variety of opinions, but does not necessarily result in action. On the contrary, Thomas et al. (1993) and Malhotra (2001) see it as a process of information interpretation which leads to further response or action, which can be seen as a knowledge application, because the interpreted information becomes knowledge (Malhotra, 2001). Gioia and Chittipeddi (1991) argue at the same time that this process has a more constructive than interpretive nature, and this correlates with the definition of Ring and Rands (1989) of sensemaking as a construction of cognitive maps of their environment. The last two groups of scholars see sensemaking as an individual process, while Weick (1995) argued that it is a social construct, because it is shaped by and evolved over time under the influence of the social surrounding. Similarly knowledge, when it stops evolving, becomes an opinion (Davenport and Prusak, 1998).

Weick (1995) presented the sensemaking process through analysis of the statement of Wallas (1926) ‘How can I know what I think until I see what I say’, and a lot of researchers admit that they are able to understand a matter only after they start writing it down or talking it through. He also argued that in the organisational contract sensemaking takes place in occasions of ambiguity (too many interpretations) or uncertainty (ignorance of any interpretations), or as Starbuck and Milliken (1988) broadened the definition, in the case of an event that violates perceptual framework.

When approaching rich in context empirical material, it is easy to neglect opinions and ideas that violate a neat pattern resulting in the application of a well-structured method (Weick, 1995). The cognitive processes involved in the process of sensemaking are too complex and

too fluid to be fully understood and to be articulated (Roszak, 1994), and so we can only speculate about the making sense of rich material and can never describe it in a structured manner. Therefore, making sense of rich material by analysing pieces of material without trying to attach them to a common structure is the only method left to get useful insights from unstructured interviews (like the interviews with experts).

Sensemaking should be called an approach rather than a method of analysing qualitative methods. To an extent it is a part of every qualitative method, since interpretation of empirical material involves making sense of the meanings behind the words. And the following two methods that were employed to analyse semi-structured interviews are a perfect example of it.

2.5.3. Gioia's method

Similar to the question of a sample size in a qualitative research, the approach to analysing qualitative materials lacks well-established rules and norms; however, two methods have emerged for qualitative studies: Eisenhardt's (1989) theory-building from multiple case studies and Gioia's method of second order themes (Gioia, 2004; Gioia et al., 2013). Both approaches have been praised and become widely popular among the scholars in qualitative research. The choice of the latter as a guiding template was mainly defined by the ontological paradigm of this research (Langley and Abdallah, 2011).

Eisenhardt comes from a post-positivist perspective and the method aims to develop testable propositions derived from a distinctive comparison of the cases, and validating the findings through triangulation as a way to "clean" the findings from biases of an observer and participants. For this reason this approach was criticised as contradicting the interpretivist nature of case studies (Ahrens and Dent, 1998). The Gioia approach is on the other hand driven by building a grounded theory from practice that fills the gap in the literature. A researcher is interested in the context, understanding and meanings of the participants, which is rooted in the interpretivist assumptions, and tries to find the logical connections in the contextually rich empirical material on a timeline by drawing conclusions on the second order themes that emerge from the data. Similarly, I am interested in the opinions and understanding of the informant, but my research is different from the classical Gioia approach in several ways. Firstly, the classical Gioia approach is based on in-depth immersion with a single case and deep understanding of the rich context around it, while I am interested in the progression of KM in the company, and therefore, in interpreting the current state and underlying conditions in different companies that are likely to be engaged in KM in varying degrees. Secondly, Gioia's grounded theory is built entirely on the practical experience and interpretation of the acquired empirical material, because this theory covers a gap in the literature, and thus, the literature cannot inform the researcher about the phenomenon. But this research does not cover a gap, it rather deals with deficiencies. I developed initial

assumptions and input about the investigated phenomenon, and approached the empirical part while being informed about the matter. As a result, the theory is derived from both the literature and practice.

As mentioned above, Gioia's method is often presented as a "recipe" for analysing qualitative empirical material (Langley and Abdallah, 2011), but Gioia himself uses it adaptively depending on the context. Similarly, in this research it is used as a standalone method for analysing the interviews in the exploratory gamification case study, and in combination with concept mapping (described below) to analyse the interviews that are part of the multiple case study analysis.

2.5.4. Concept mapping

Concept mapping is capable of structuring rich qualitative data. This technique is an extension of the SODA-style cognitive mapping technique, which models a person's thinking through graphic representation (Eden, 1988), and emerges through unidirectional links that represent the causal relationship between the concepts (Laukkanen, 1994). SODA-style cognitive mapping is widely used for strategy making, where the visual representation helps the participants to actively negotiate their goals. In research this approach is not focused on finding common goals for the participants, but rather explores the studied phenomenon, where the visual problem structuring can help to learn more about it and lead to insights (Pyrko and Dörfler, 2014). It should also not be mistaken for mind mapping that might result in similarly looking graphs.

Cognitive and concept mapping help to structure rich in context empirical material. Concept mapping is however not concerned with the hierarchy of the nodes (such as the goals, issues and options) and action-oriented concepts, only with the relationship of the means-outcomes, because I am interested in capturing a state rather than analysing a problem. It is also important to note that such map would not produce a complete picture of the studied problem (a state of KM in one companies), but rather an imperfect representation based on the perception of participants about the problem (all the interviewees within one company). The analysis was conducted using Decision Explorer software[4].

I did not originally intend to use this method, but after having received unexpected outcomes from the survey analysis I started looking for a new way of structuring the interviews, which could become a backbone of Gioia analysis. Concept mapping contributes to Gioia analysis because it allows us to see each interview and a group of interviews for each company as a whole, whereas code analysis 'slices' the empirical material and concentrates on the repeated emerging themes.

[4] http://banxia.com/dexplore/

Figure 3 presents a sample concept map for one of the companies. The concepts that were mentioned by different interviewees of the same company include those related to KM (in teal colour), KMS (in purple colour) and their everyday work (in black colour), such as aspects of project management. The numbers next to the concepts are given by Decision Explorer in the order of adding the concepts to the map for the sake convenience. An arrow between two concepts indicates a unidirectional connection, i.e. what concept comes first and what follows. In some cases it might imply causation, e.g. *weekly meeting* (39) lead to the *visibility of work* (38). In other cases it might indicate a flow of work, e.g. *project pool* (6) is stored in the *document repository* (7). By following a chain of concepts we can see how they are related, e.g. an *engineer* (2) gave a *passive agreement* (12) to have a *target* (11) on generating *ideas* (3), which follow the process of *development* (5) of a new product, which ends with *lessons learnt* (29) sessions, which are then summarised in *1 page highlights* (30) and added to the *project pool* (6), which is in turn stored in the *document repository* (7). However, these concepts might have been mentioned in different conversations, and putting them together on one map allows us to see what the state of practices in this company is.

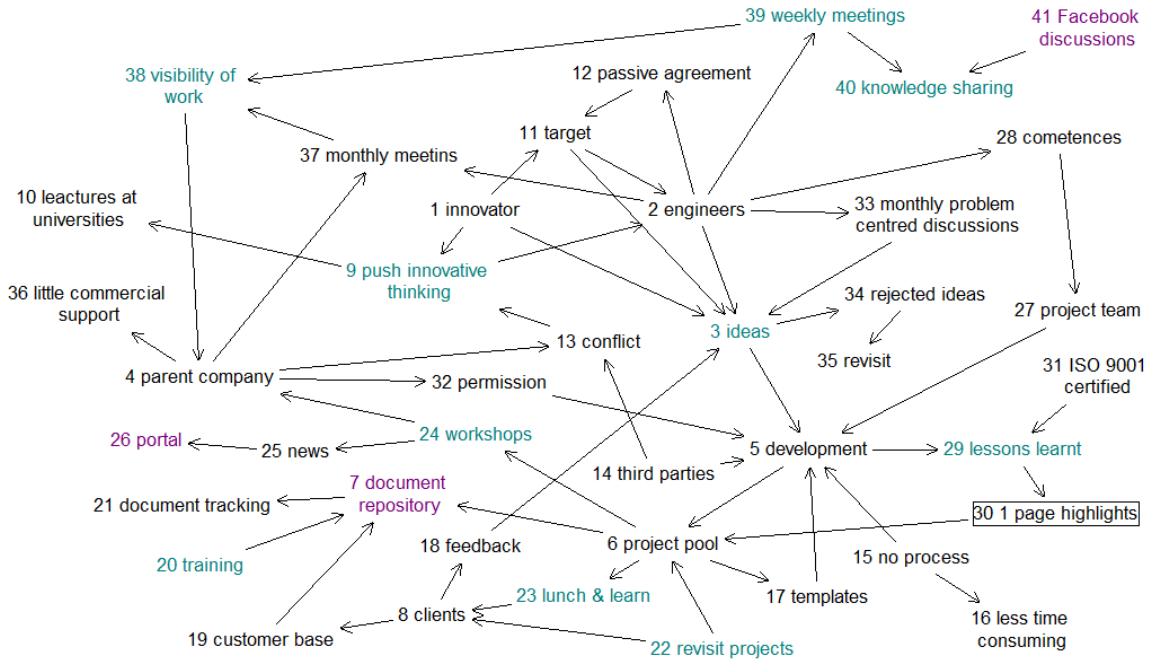


Figure 3. A sample concept map.

This map also allows us to see which concepts are well connected and therefore are likely to be more influential and important. By observing KM and KMS related concepts it was possible to see whether they evolve with time or remain unchanged. However, visual analysis does not always reveal all the influential concepts, and therefore it was combined with the centrality analysis, which calculates a score for each concept of a number of other concepts that it impacts directly and indirectly. As shown in Section 5.2.1, not all the most influential concepts can be identified visually, and therefore the centrality analysis is an important step

in the analysis using Decision Explorer. The analysis is elaborated in more detail in Section 5.1.3, preceding the discussion of the findings. Survey design

The meaning of a survey has changed with time from being a tool for evaluating something in detail (e.g. a house survey) to becoming a universally used method of collecting and analysing data through questionnaires (Marsh, 1982). Nowadays it is one of the most popular methods in organisational studies and other disciplines, and it can be split in three broad categories: descriptive, explanation-driven and experimental. These types are seen as the progression of a study, starting from measuring the variables to explaining the dependencies, which can sometimes be done by experimenting (Hyman, 1960). The survey, therefore, can suit a broad range of research objectives. However, as well as popularity this method has drawn criticism as well, most of which is a reaction to poor design or inadequate conceptualisation, rather than fundamental flaws (Marsh, 1982). But it is important to note that surveys come from a positivist perspective and will never be able to capture the complexity of meanings (Blumer, 1954). However, even this criticism could be reduced to misuse of the method.

Designing a survey consists of certain steps, which include stating the aims of the survey, operationalising the variables, conceptualisation drawn from the literature, stating the hypothesis, choosing research instruments, piloting the survey, defining the sample, conducting the field work, processing the data, analysing the data, testing hypothesis and writing a research report (Oppenheim, 2000). The sample related issues have already been discussed in previously, and the analysis related questions will be discussed in the following section, while this section will focus on the design and data gathering issues in more detail.

In this research surveying was a complementary method of collecting the data and served two purposes: understanding PDP and project management processes in the company in more detail, and assessing these processes and KM practices, which would allow the development of a backbone structure for the subsequent analysis of the interviews.

The first aim of the survey could be best achieved by asking the respondents open questions which allowed them to describe the processes succinctly. The second aim of the survey was primarily driven by the hypothesis that KM practices have an impact on PDP and the project management process, and therefore the correlation could be established on the maturity level of the latter. And this aim can be achieved primarily through defining the variables, which can be of four different types: experimental, dependent, controlled and uncontrolled (Oppenheim, 2000). Experimental and dependent variables refer to the causes and results respectively, and within the context of this survey the cause will be operationalised through the KM practices and KMS types, and the results through the parameters of the maturity level of the studied processes. This assumption is based on the hypothesis that business processes improve with improved KM, and is explained in more detail in Section 4.1.2. The experimental variables were based on the previous attempt to build a similar model for KM, while the

dependent variables were taken from the model for assessing business processes developed by Carnegie Mellon SEI (2002).

The objective to build a KM maturity model was not achieved at the end, because the results of the survey analysis showed little connection between the parameters of process maturity and KM maturity. However, these findings also contribute to the body of knowledge because that suggest that MM might not be an appropriate approach for KM, and are described in Section 4.4. These findings also led to the adoption of a new method for the interviews' analysis, the concept mapping, which was discussed in the previous section. And the methods that were used in the survey analysis and helped to achieve these results are discussed below.

2.6. Survey analysis

There are numerous ways to approach the analysis of the survey, and in this study two methods were used: machine learning with a knowledge-based expert system and correlation analysis. The aim of the survey was to investigate the relationship between the parameters that indicate the maturity levels of the processes and KM, as well as the types of KMS that support these processes, and both of these methods can be considered appropriate. In addition to that, both methods can yield results with a relatively small sample and do not require specific structure to be embedded in the survey design in advance. Employing other methods would require a larger samples, which was hardly possible in the conditions of this research. Yielding a larger sample would require changing an approach to finding companies and would take this research in a different direction. Therefore, other methods were not considered. The chosen methods are complementary to each other, but this link will be discussed in more detail in the Synthesis part in the following section as well as the in Section 5.1.3.

2.6.1. Machine learning

In the literature review it was discussed that not all the knowledge can be formalised, recorded and codified; however, explicating the knowledge lies at the core of academic research. This research approaches this topic mainly through interpreting the meanings of the practices shared by the participants, but in the case of structured data explicating the knowledge could be conducted with the help of machine learning. In this case using a modified version of what is known as the ID3 algorithm (Quinlan, 1986). With this approach the knowledge is formalised as a decision tree; visualising the decision tree helps reduce the perceived complexity for the user (compared to other machine learning algorithms), while at the same time keeping it equally powerful (Quinlan, 1986). This particular approach was implemented using the Doctus[5] software, which works with a relatively small data set and

[5] http://doctuskbs.com

utilises varying types of parameters (continuous and descript), and allows to learn from the data non-incrementally (thereby making the input order unimportant), and complex non-linear patterns can be observed (in contrast with the more usual linear approaches).

This type of machine learning is also called case-based reasoning (CBR), to distinguish it from a related rule-based reasoning (RBR), whereby the attributes and their values (variables and their ranges) as well as the relationships between the values (in the form of 'if… then' rules), are elicited from the experts and applied to individual cases to obtain an evaluation. This form of representation creates transparency and helps to understand the rules behind the evaluation (typically a decision), and can also be used in delegation, to empower others who do not have the knowledge of the experts to make decisions of the same type (Baracskai et al., 2005).

However, sometimes the experts do not want to or cannot elicit the rules, and then the rules have to be derived from the cases they had experience with; thus of the term for this type of inference is inductive or case-based reasoning (Baracskai et al., 2001). It is important, however, to distinguish this approach from CBR, where a metric is introduced, and any new case is evaluated based on the distance from the previous cases. To distinguish it from this latter approach, I use the term machine learning, as case-based reasoning in knowledge-based expert systems is carried out using a machine learning algorithm. This method reveals the rules that might be less obvious as well as identifies 'informative' patterns of attributes, and therefore it can be used for research purposes as well, such as evaluating questionnaires, particularly when the small sample size does not allow the use of statistical methods, and the answers are qualitative (including categorical ones, such as Lickert scales and yes/no questions) although quantitative (continuous) attributes are also handled.

This method was employed, because the maturity model as well as KM practices and KMS types consist of many parameters, and this method could reveal the relations between them and prioritise more informative over less informative parameters for different outcomes (e.g. different levels of maturity). The details and practicalities of using this method in this research are discussed more closely in Section 4.2 before discussion of the survey results. And the following part discusses correlation analysis as a complementary method to machine learning.

2.6.2. Correlation analysis

Correlation is defined as "a relationship existing between two quantitative variables when there is an overall tendency for increases in the values of one variable to be accompanied by the increases in the other variable (a positive relationship), or for increases in the first to be accompanied by decreases in the second (a negative relationship)" (Cohen et al., 2013, p. 76).

I have considered using more advanced statistical methods, but since no specific design was embedded into the questionnaire and the sample size was relatively small, complex statistical methods could not be used. Instead it was possible to look at the descriptive statistics and linear bivariate correlation between the pairs of explanatory variables. What makes correlation analysis complementary to the analysis obtained from machine learning is that it identifies the relations between pairs of individual parameters, while machine learning finds the chains of parameters that explain a chosen status of the output parameter. In other words, the former can help identify the most important parameters in particular aspects, whereas the latter suggests patterns of parameters that can have a significant influence on a chosen parameter.

The variables that were included in the survey are given either a value on the Likert scale or a binominal value. In both cases the values of the variables are numeric and show the progression, which opens up an opportunity to complement the analysis obtained from the machine learning algorithm, with a statistical method as an alternative approach to looking at data.

The analysis was performed using SPSS. More specific details with regards to the use of both method and supporting software are provided in the methodological approach in Section 4.2. The remaining part of this chapter discusses the ways in which these diverse methods are brought together.

2.7. Synthesis

This research relies predominantly on qualitative methods, but it has also embedded a complementary quantitative part, employing therefore a mixed methods approach. Mixed methods can be combined with a different level of integration. For instance, qualitative data could be used complementary to quantitative and be quantitised or converted into a magnitude or count. Different types of methods could be used to compare the data and spot the discrepancies. Or they could be integrated into a multidimensional research design, where different methods play different roles in a mixed methods combination (Miles et al., 2014). This research resembles most closely the last case described.

Section 2.2 has described the iterative approach employed in this research, which unrolled in phases with a quantitative part being one of them. Each phase was used to answer the questions raised by the previous phase, as well as opening the horizon for new questions. During the preliminary investigation the DFD method allowed to compare PDP of different companies described by the participants, and therefore to set the research context. This way MM became a working framework – a skeleton for the future model. During the interviews with experts making sense of rich empirical material opened up a variety of areas for discussion and further research, one of which was pursued and added to the scope of this study.

The synthesis of the analysis of the survey and interviews during the principle investigation was based on the study of Weinberg (1992), which suggested that process capabilities can progress only with people's capabilities starting from the second level of maturity (out of five). The process maturity has been relatively well conceptualised and successfully employed in a number of areas. Therefore, by identifying the level of process maturity of each company it was assumed that this company has reached at least the same level of people's capabilities maturity, one major part of which is KM. And by describing the KM practices of this company through the analysis of the interviews it would be possible to describe the maturity levels of KM. The links could be found by employing machine learning and complementing it with the correlation analysis. By choosing different parameters that correspond to a certain level of maturity, it should be possible to see which of the KM practices and KMS types lead to a higher outcome of these parameters. And by testing each parameter the same way and comparing the results we should see the changes in KM practices. However, this did not prove to be the case and the results of the survey analysis did not allow me to build the initial structure for the model and to populate it with detailed findings extracted from the interviews. Therefore, the missing component was replaced with the insights from concept mapping, which allowed identification of patterns and to explore them in greater detail through the interview.

This chapter has presented the range of methods employed in this research and described the ways in which they were used, and the following chapters share the specifics of applying each method, and show these methods in action with the findings and implications that followed as a result of the data analysis and interpretation.

3. Investigating the Research Context

The previous chapter explained the research design and provided justification for the choices of methods that were made. Some of the methods are already used in this chapter, in particular in Sections 3.3 and 3.4. The outcomes of this chapter help to shape the context of the research, which becomes increasingly relevant in the multiple case study, the results of which are discussed in Chapters 4, 5 and 6.

The initial research was driven by the working research question that came from my Masters' project, which was concerned with the types of KMS and the requirements of KMS that would serve KM needs better. And in an attempt to find answers to this question the literature review included all the major aspects of KMS: the typology, selection, implementation and use of KMS, and the aspects of KM that could help to understand this problem area. In particular, KM was reviewed from the perspective of knowing processes, since understanding these processes in an organisation could help to identify the areas where KMS support is needed. Then KM was reviewed from the perspective of knowledge workers in an attempt to understand the ways in which their job differs from the job of others, because they are the ones who are involved in the knowing processes and need support from KMS. And finally, since the research originated in an innovative company, and I wanted to maintain the focus on innovation, the literature review also investigated the role of KM in innovation and innovating. Discovering this relationship could help to understand the specifics of KM in innovative companies and subsequent changes in the KMS requirements. All these aspects are covered in the literature review of this chapter.

The interviews with practitioners and KM experts that followed the literature review contributed to understanding the problem rather than answering the initial question, which was concerned with the nature of dependency of the KMS types on the KM practices on the organisational level. The results of these interviews are presented after the literature review as a response to the ideas that came out of it. This chapter initiates the dialogue between theory and practice in search for answers to the initial question, and this quest results in defining the research context and formulating the research question that powers the remaining part of this study. Additionally, this chapter lays the theoretical foundations for the principal investigation that aims at answering the first and the second research questions regarding the KM needs of innovative companies and the ways to support these needs with technology. The reader will be introduced to a large number of concepts throughout the chapter which might read like a long prelude to the main part of this research, but this long introduction is essential to progress the argument forward.

3.1. Review of Knowledge Management Literature

The understanding of KM has evolved quite significantly throughout the past decades (Swan and Scarbrough, 2001). During the 90s the dominating paradigm was KM as information processing, where the main purpose of KM was seen as a procedure to identify a knowledge gap in (Gopal and Gagnon, 1995) or update of (Anthes, 1991) a knowledge database, or as knowledge processing with the use of advanced technologies (O'Leary, 1998). But this technology centred approach proved unsuccessful.

The paradigm started to change towards people-oriented, when KM was seen as a means of improving a company's performance (Pan and Scarbrough, 1999) or as a process / practice such as creating and applying knowledge (Gurteen, 1998), and technology had a complementary and supportive role. Unlike the previous approach which originated in computer science, this approach is routed in organisational studies.

In this research I do not take either the computer science or organisational studies view, but rather a process view of KM, which originated from the contributions of Davenport, Prusak and Tsoukas. This approach reflects the merger of the two streams, where KM is perceived as a strategy with its practices embedded into the business processes that lead to a better performance (Bassi, 1997; Davenport and Prusak, 1998), or as an effort to encourage knowledge increase and dispersion to create value (O'Dell and Huber, 2011), which involves cultural and behavioural change (Davenport and Prusak, 1998). Following this discourse, it is logical to concentrate on the process and people perspectives of KM. Therefore, this literature review covers the concept of knowing process and discusses why knowledge sharing is one of the knowing processes and central to the field of KM and this research in particular.

KM includes the term *knowledge* and so far we do not have a commonly accepted definition of it. Scholars tend to disagree on whether knowledge can be detached from the knower (Nonaka, 1991; Popper, 1972) or not (McDermott, 1999; Polanyi, 1962; Russell, 1948). The first view attempts to objectify knowledge for rational acting, but this view contradicts the inseparability of knowledge and power (Alvesson and Kärreman, 2001). It also dismisses such types of knowledge as skills and intuition (Dörfler, Baracskai, Velencei, et al., 2010). Following these contractions, the second view argues that knowledge is fundamentally routed in human experiences, therefore even the knowledge that can be articulated only becomes a mere representation of what the knower knows, and can be acquired by a knowledge seeker only through interpretation using their own experiences (Davenport and Prusak, 1998). Therefore, knowledge is constructed in social context and converted into action through the process of knowing (Polanyi, 1962). This makes knowledge a potential or a capacity to act (Sveiby, 1997), where knowledge is comprised of framed experiences, values, contextual information and expert insights, allowing the knower to incorporate new experiences and information into this framework (Davenport and Prusak, 1998). Grasping the complexity of this working definition allows the reader to understand why managing knowledge proved to be so hard.

The dominant unwritten assumption of the majority of KM studies places KM on the organisational level. Tsoukas (2008) distinguishes three levels within each organisation: representation, human practices and actions. *Representations* stand for abstraction, codification and rules that are formed when one tries to organise human activities, to structure, generalise and formalise them, to assign types of action to the types of events and to create a canonical image of the organisation and its predictability, without which the organisation cannot be formed. Representations are described without context and are an imperfect generalisation because they exist in the open system, where new conditions can occur.

Human *practices* are narratives in their nature (Tsoukas, 1989a) but are bound by rules and are extended in time; engaging in practices is usually driven by an attempt to achieve the standards of excellence which exist in the organisation. But the scope of practices can step outside the organisational boundaries, creating a plurality of organisations and practical wisdom. Applying the rules combined with this practical wisdom in a particular context in real time leads to *actions*/*interactions* through the process of re-contextualising and improvising.

The definition and description of organisational knowledge might look too abstract and detached from the core of this research, but recognising different levels of knowledge, as well as the levels of organisation suggested by Tsoukas, might help in analysing the interviews and understanding the experiences that the interviewees were sharing.

3.1.1. Knowing processes

In light of Tsoukas's representation of organisation we can see that up to this point this research mainly referred to KM in the context of practices, which can be observed in the course of the interviews through actions, but the discussion of the knowing processes brings us to the first level of an organisation, since the knowing processes are an attempt to capture an abstract representation of observed practices and actions.

The literature does not provide a clear definition of a knowing process or a commonly accepted and exhaustive classification of knowing processes. Some authors understand KM as a simple process of transforming information into knowledge (Sarvary, 1999) or as a process of converting tacit knowledge into explicit and back (Nonaka, 1991). But this representation diminishes the richness of knowledge, which cannot be easily manipulated, for example intuition, and the variety of processes that go beyond the information transformation, such as interactions between knowledge workers and creativity-related processes.

Similarly, classifications of knowing processes employ very different approaches. Some of them are derived from practical experience (Davenport, 2005a; Davenport and Prusak, 1998), others are deducted from different characteristics of knowledge (Goodman and Darr, 1998;

McIver et al., 2013), but the majority result in combining earlier classifications (Chinowsky et al., 2007; Kotlarsky et al., 2008; Liebowitz and Beckman, 1998; Van der Spek and Spijkervet, 1997). Since we cannot find a satisfying classification of knowing processes, it is worth looking at various classification in order to observe commonalities, which in turn suggest the processes that are considered important by the majority of the scholars. Identifying these processes subsequently helps to prioritise the themes to concentrate on during the interviews.

Of these approaches, deriving knowledge processes from the characteristics of knowledge risks leaving certain types of knowledge and associated knowing processes outside the framework simply because they do not fit the logic of the dimensions. While the list of processes derived from practices does not have this limitation, the authors of these frameworks focused on the more important processes from their point of view, rather than developing a holistic picture. The classifications that are based on the previous attempts are likely to duplicate the mistakes of their predecessors. However, all the classifications that I have identified in the Table 3, can still be useful – comparing them reveals the processes that are common and central to all of them. One such process is *knowledge sharing* (Chinowsky et al., 2007; Liebowitz and Beckman, 1998; Park and Kim, 2006; Tiwana, 2000), which is sometimes defined as *distribution* (Davenport, 2005a; Van der Spek and Spijkervet, 1997), assimilated with *transfer* (McIver et al., 2013; Ruggles, 1997) or is seen as complementary to it (Kotlarsky et al., 2008).

Table 3. Taxonomies of knowing processes.

Reference	Classification
(Davenport and Prusak, 1998)	Generation (acquisition, rental, rental, fusion, adaptation), codification, coordination, transfer
(McIver et al., 2013)	Storage, transfer, learning, organising, gathering, assimilation, use, application
(Holsapple and Joshi, 2002)	Acquire, select, internalize, use, generate, externalize
(Liebowitz and Beckman, 1998)	Identify, capture, select, store, share, apply, create, sell
(Chinowsky et al., 2007)	Creating, acquiring, sharing, applying
(Becerra-Fernandez et al., 2003)	Discovery, capture, sharing, application
(Van der Spek and Spijkervet, 1997)	Developing, securing, distributing, combining
(Tiwana, 2000)	Acquisition, sharing, utilization
(Davenport, 2005a)	Creation, distribution, application
(Jackson et al., 2006)	Acquisition, sharing, combination, creation, application, revision

(Kotlarsky et al., 2008)	Creating, sharing, transfer, coordinating, reuse
(Sarvary, 1999)	Organisational learning, knowledge production, knowledge distribution
(Ruggles, 1997)	Generation, codification, transfer

Some of the gurus of KM consider knowledge sharing the essence of KM (McDermott, 2000), and its presence in all the classifications of knowing processes only reinforces this view; therefore, knowledge sharing could become a central theme of a further investigation of this research, and the rest of this section explores its various forms and characteristics.

Knowledge sharing refers to sharing task-related information to help others, or collaborating with others in order to develop ideas or implement policies (Cummings, 2004; Srivastava et al., 2006). As was mentioned above, knowledge sharing is used with different names in different classifications. Some authors point out the differences between knowledge exchange / transfer and knowledge sharing, e.g. knowledge exchange involves active seeking of knowledge by one of the parties as opposed to knowledge sharing that might happen spontaneously (Wang and Noe, 2010). But knowledge sharing goes beyond knowledge transfer or exchange, since it might lead to creating something new (Velencei et al., 2009), being an example of thinking together (Pyrko et al., 2017). However, this review does not aim to discuss the nuances of these processes, but instead it will use knowledge sharing as an umbrella term for different types of knowledge exchange / transfer / sharing and elaborate more on different forms instead, as well as discussing the necessary conditions and barriers to knowledge sharing.

Knowledge sharing can occur impersonally (through electronic means of communication or captured knowledge in the form of documents) or face-to-face (Cummings, 2004), which demonstrates that knowledge capturing, a process that was included in many classifications, only exists for knowledge to be shared and eventually to be applied or reused. This illustration proves the central role of knowledge sharing as a knowing process, which binds other processes together, and justifies the choice of it for further investigation.

The literature suggests that face-to-face knowledge sharing happens five times more often than impersonal knowledge sharing (Cross et al., 2001), and researchers provide alternative explanations, such as knowledge workers simply having more opportunities to share knowledge in person (Bordia et al., 2006). However, such a difference in preferences might have much deeper roots. Tacit knowledge can only be shared in person (McDermott, 2000), and since it constitutes a large part of knowledge, its sharing requires synchronous interaction. Another reason could be the essence of knowledge sharing, which is guiding through one's own thinking and using one's own insights in order to be able to help the knowledge seeker, and in order to achieve that one requires knowledge about the other party

(McDermott, 1999). We are much more likely to know the other party through personal communication than when the communication is established impersonally, and that is probably the reason why trust is an essential prerequisite of knowledge sharing (Davenport and Prusak, 1998); therefore the technology quite often only reinforces the established connections, meaning that virtual teams need to form connections in person before interacting electronically (McDermott, 1999). However, the relationship between knowledge sharing and trust is more complicated and multidimensional.

Trust is often seen as a prerequisite for knowledge sharing, and its influence extends to all the areas of our life. If the interviewees do not feel trust towards me, they are unlikely to be open and share their experiences during the interview, which will in turn affect the quality of the empirical material. In Section 7.3 the reader will see how trust was reinforced with the help of gamification in the studied company, which demonstrated how important trust was for them. The degree to which trust affects the work of knowledge workers depends on the ambiguity of the task environment (Dirks and Ferrin, 2001). Trust exists in different forms: it can be trustworthiness of beliefs, willingness to be vulnerable by sharing and trusting risk-taking behaviour (Sankowska and Soderlund, 2015). Seeing trust from different sides helps to understand why trust is so essential – it benefits both the sharer (willingness to share and become vulnerable) and the receiver (trustworthiness of beliefs and risk-taking behaviour). It can also explain the reasons behind instances of lack of sharing, e.g. shared knowledge is only accepted if the sharing party is respected (Konstantinou and Fincham, 2011) – trust in the other party sharing knowledge and risk-taking behaviour. However, trust is only the prerequisite, and we also need to look at the motives.

Explored motives that drive people to share knowledge vary in the literature. One explanation is related to reciprocating behaviour, which creates reinforcing loops of knowledge sharing (Constant et al., 1994), and this might explain why what appears to be altruistic is purely calculative in the longer run (Douglas, 2000). Other researchers found that workers tend to share knowledge when they consider it to be useful to others as opposed to the expectation of personal gain (Chiu et al., 2006; Siemsen et al., 2007). The explanation for these differences might have many roots, such as the corporate culture (Alavi et al., 2006). For instance, in the competitive culture, knowledge is seen as a competitive advantage and needs to be well defined before being shared, leading only to necessary sharing without which the job would be impossible to complete (Konstantinou and Fincham, 2011). The issues of corporate culture in relation to knowledge sharing have been raised multiple times during the interviews and are discussed in more detail in Section 5.4.2.

Similarly, the barriers for knowledge sharing reflect the same contradictions. Some researchers found that knowledge is seen as a source of competitive advantage (Connelly et al., 2012) and the way to progress to a senior level, which in turn creates a need for sharing and preparing a successor (Konstantinou and Fincham, 2011). But other studies show that the

most frequent reason for not sharing is lack of time (Alavi and Leidner, 2001; Hew and Hara, 2007). Among other barriers are fear of "losing face" (Ardichvili et al., 2003; Voelpel et al., 2005) and lack of encouragement from managers (Sveiby, 2007), which proves that the reasons for sharing as well as not sharing depend highly on the context.

With regards to the latter the research on rewards for knowledge sharing is another source of controversy, partially because the studies on this matter are mostly based on surveys, making it impossible to derive alternative explanations (Wang and Noe, 2010). But the motivation aspect will be reviewed in more detail in the following section.

If we look back at the essence of knowledge sharing, it requires not only knowing the other party but also understanding the needs of the other party, in other words, understanding the level of depth and the type of knowledge required by the other party. While most researchers discuss knowledge sharing as a generic process, one study classified different types of knowledge sharing through an analogy with restaurants (Velencei et al., 2009). In this classification the first type – *knowledge buffet* – offers a collection of 'ready-made' articulated knowledge, the knowledge broker allows re-contextualisation and customisation of knowledge from the second type - *a-la-carte* available options, the third type – *recommended by the chef* – creates new knowledge through sharing, and finally, the fourth type – *the coffee room* – creates conditions for transpersonal knowing processes, which aim at identifying problems.

The first knowledge restaurant is equivalent to knowledge / document repositories, which is reviewed in more detail in the following section, and is the only place where codified or articulated knowledge can be used and codification strategy (Hansen et al., 1999) and impersonal knowledge sharing can happen. The other three types of knowledge restaurant require personal input from the knowers, where the 'a-la-carte' restaurant might use both search results in the knowledge repository and creative ideas from the research space of the 'recommended by the chef' knowledge restaurant for further development. And finally, the research space uses the output of the 'coffee-room' knowledge restaurant which enables grasping the essence, identifying problems and posing questions.

This section helped to identify the knowing process that became the focus of the subsequent interviews and main study. And the view of the levels of knowledge sharing proved useful during the analysis of knowledge sharing practices of the companies interviewed, as it helped to better understand different forms of knowledge sharing that occur in the corporate environment, and their ultimate purpose, as well as to shed light on the missing components. The following section covers the concept of knowledge workers, one of the central concepts in KM, because by managing knowledge one in reality manages the people who obtain this knowledge (Davenport and Prusak, 1998).

3.1.2. Knowledge workers

When discussing the topic of KM one cannot avoid touching on the topic of knowledge workers, since knowledge cannot be detached from the knower (Polanyi, 1962), and therefore it is the work of the knowers that one is trying to manage. This research is conducted in the context of PDP, which is perceived as knowledge intensive and relying on knowledge workers more than anything else. Therefore understanding who they are and what sets them apart might help to understand the context of this study.

The influence of knowledge workers on the new economy was first emphasised by Peter Drucker (1969), who said that:

> *"The most important, and indeed the truly unique, contribution of management in the 20th century was the fifty-fold increase in the productivity of the MANUAL WORKER in manufacturing. The most important contribution management needs to make in the 21st century is similarly to increase the productivity of KNOWLEDGE WORK and the KNOWLEDGE WORKER."* (Drucker, 1999, p. 116)

Since then researchers and practitioners have been trying to define the term. They approached the definition by describing the nature of tasks that knowledge workers are dealing with, as unstructured (Scarbrough, 1999), non-routine (Reinhardt et al., 2011) or symbolic-analytic (Reich, 1991) tasks, or by characterising their skills and competences as rapid learning and flexibility (Scarbrough, 1999) or non-linear and creative thinking (Reinhardt et al., 2011). These definitions seem quite broad and vague, and they can definitely generate debates on whether certain professions should be classified as knowledge work or not. For instance, is a jewellery shop keeper a knowledge worker? Their job is mostly routine, but giving a customer good advice regarding the most suitable item for a given occasion might require creativity and non-linear thinking. But this job is hard to characterise as symbolic-analytic service.

Davenport (2005a) gave a more elegant and simple definition by describing knowledge workers as those who think for a living. This definition incorporated skilled manual workers such as plumbers, whom Drucker considered knowledge workers as well. Nevertheless, Davenport, like others, mainly focuses on highly paid employees, whose primary task is to manipulate knowledge and information.

Despite trying to develop a definition that would fit all types of knowledge workers, the researchers understand that knowledge workers are different by the nature of their interactions with each other, and by the essence of their work, and categorising them helps an organisation to understand how their work can be evaluated or improved and how they can be managed, if they can at all. It was possible to find three frameworks, presented below.

Davenport (2005a) characterised workers based on the level of collaboration they require and the level of complexity of their work, which he defined as the level of judgement and

interpretation needed to complete the work (Figure 4). The four groups of knowledge workers are: transactional workers (e.g. call centres), integration workers (e.g. software developers), expert workers (e.g. medical practitioners), and collaboration workers (e.g. investment banks). Different groups require different levels of collaboration support, while the level of standardisation of their work is possible to a certain extent. Researchers and developers that are involved in product development are likely to be integration or collaboration model depending on the level of complexity of the product that they are developing. Both groups rely heavily on collaboration, which is reflected in knowledge sharing, and this observation reinforces the focus of this research on knowledge sharing that was discussed in the previous section. On the other hand, we can see what aspects of work are missing and therefore could disadvantage knowledge workers. For instance, the work of transactional and expert workers tends to be more individual-activities oriented and can create isolation, but they could benefit from collaboration no less than the other two groups. This aspect becomes relevant in Section 7.2.2, when we discuss the role of gamification in KM.

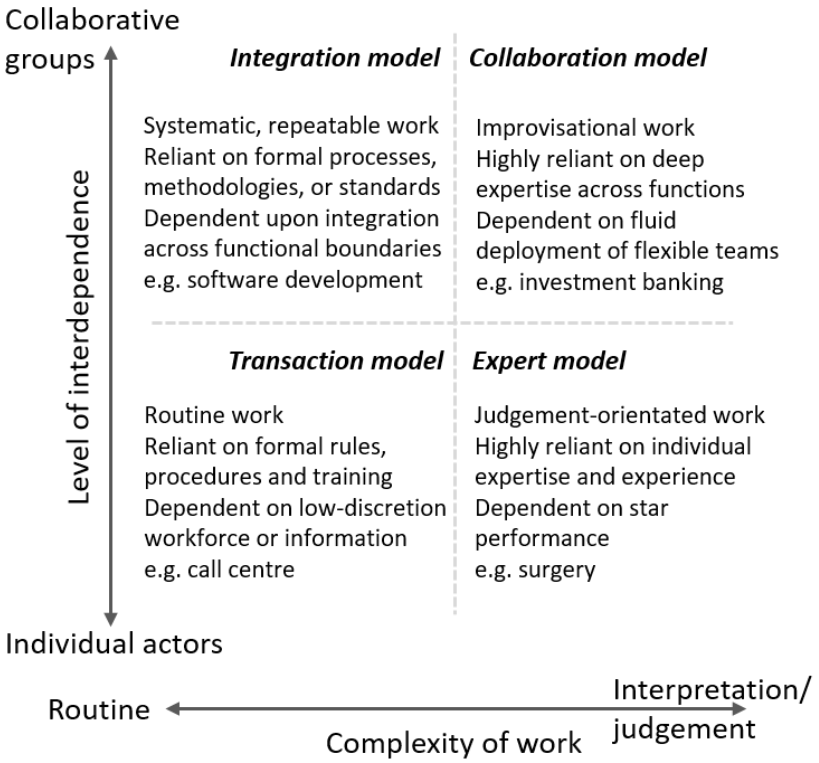


Figure 4. A classification structure for knowledge-intensive processes. Source: (Davenport, 2005a).

McIver et al. (2013) looked at knowledge in practice for organisational workers from the perspective of knowledge tacitness and learnability, where learnability is defined by the amount of time and effort required to absorb the knowledge (Figure 5). The enacted information category includes relatively easy to learn structured knowledge and could describe the work in call centres, while the accumulated information category similarly

consists of structure information, which is however much more difficult to learn, e.g. the work of an engineer. Both apprenticeship and talent & learning know-how rely on highly tacit knowledge, but the former can be learnt through the apprenticeship (a social worker), while for the latter the knowledge is very difficult to transfer (an artist). This classification covers a broader range of workers, including knowledge workers as well as those doing manual work, and identifying the right category can help define the level of standardisation that can be applied to the particular work. This framework is less likely to demonstrate the disadvantages of different professions, but instead, it suggests ways in which certain knowledge can be best acquired.

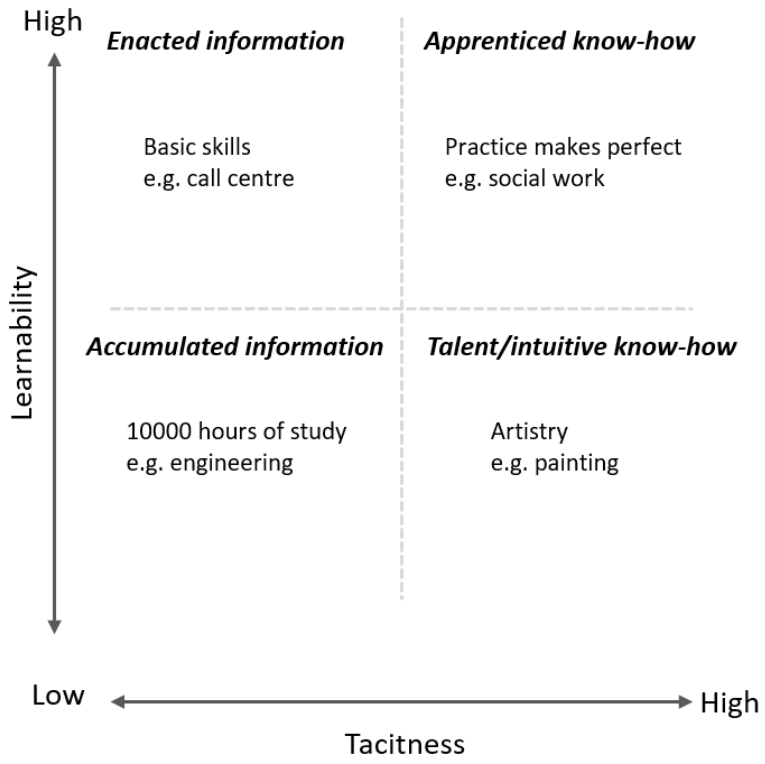


Figure 5. Knowledge in Practice types for organisational work. Source: (McIver et al., 2013).

Unlike previous frameworks, the classification of Davenport and Prusak (1998) does not attempt to categorise different types of professions. Instead, the researchers described the roles they observed in every organisation. By looking at the involvement of knowledge workers in the knowing processes the researchers defined two main roles: the *knower* and the knowledge *seeker*. These roles are idealistic, and in reality most of the time the knowledge workers share both of them. Their interaction can be seen as an act of knowledge exchange and takes place only if both parties know about the existence of each other. In all other cases a third role becomes crucial for the successful transaction to be complete – *the connector* (Davenport and Prusak (1998) call it a broker). Connectors have an imaginary knowledge map in their heads; they are curious about different areas of expertise in different parts of the

organisation and are able to direct the knowledge seekers. This role can be assigned formally (a librarian) or evolve informally due to the natural curiosity and communication skills of the connector. These knowledge workers are very often undervalued in organisations and viewed as time wasters.

But finding the source of knowledge and connecting both parties is not always enough. A dedicated knowledge worker role is required to address the problems of knowledge sharing that were discussed in the previous section, namely a *knowledge manager or Chef Knowledge/Learning Officer* (Davenport and Prusak, 1998). Knowing processes are often more sophisticated than a simple transaction, (e.g. the processes inside communities of practice), and therefore the responsibilities of the knowledge manager are much broader and include creating and promoting a knowledge sharing culture within the organisation, advocating KM initiatives, influencing the development of the company's vision and developing incentives to stimulate knowledge sharing. In some companies this role is dedicated to a specific person (Grant, 2013). In other companies with a more informal structure the knowledge workers share the responsibilities of the role of knowledge manager and organise themselves.

Wenger et al. (2009) suggested a fifth role – *technology steward*, which can be a partial responsibility of a knowledge manager if he obtains the required competence, or it can be a shared responsibility of other knowledge workers with more advanced knowledge of technology compared with others. These roles were designed to make practitioners aware that they exist, as well as to recognise and acknowledge the workers in these roles (especially the connectors), and to identify the roles that might be missing.

These classifications provided an initial understanding of the type of workers I was likely to interact with during the interviews and gave hints to the nature of their work and types of problems that they could be facing. But the frameworks proved to be particularly useful in the gamification case study presented in Section 7.2, as they suggested a new way of looking at the interviews and interpreting the empirical material.

3.1.3. Innovation and Knowledge Management

Many authors see knowledge not only as an important resource for a company (Grant, 1996), but also as the most critical resource for innovation (Doz and Wilson, 2012; Leonard-Barton, 1995; Nonaka and Takeuchi, 1995). As was mentioned in the introduction, this research is focused on innovating companies as the place where KM issues can be best observed. And in order to understand better the specifics of these companies one needs to understand the nature of innovation first. Apart from that, understanding the role that innovation plays in an organisation might help to better determine the companies to sample. Therefore, the aim of this section is to define innovation for the purpose of this research and to explore the link between innovation and KM.

Innovation is viewed in the literature from two perspectives: as an output and as a process (Crossan and Apaydin, 2010). Both perspectives take a retrospective approach. The former attempts to define it (Daft, 1982; Utterback, 1974) and understand the characteristics of the known innovation examples, in order to be able to identify future innovation (Christensen, 1997; O'Reilly and Tushman, 1996), and even establish the connection between the organisational architecture and the level of innovativeness of the company (or the capacity to produce innovative results) (Miles et al., 1978; Mintzberg, 1980; Tidd et al., 2005). The latter is concerned more with the process of defining a problem and finding a solution (output) (Lam, 2005; Swan and Scarbrough, 2001) as well as implementing it further (Van de Ven, 1986). In order to analyse the relation between KM and innovation, we need to review each of them in more detail.

Innovation as an output

The earliest definition of innovation was provided by Schumpeter in 1920s who emphasised the idea of novelty in it, which is driven by creativity (Hansen and Wakonen, 1997). Various other scholars developed his ideas further and stressed the importance of new idea diffusion (Holland, 1997) or successful implementation and commercialisation (Hobday, 2005; Klein and Knight, 2005). They also viewed innovation as a final product within the boundaries of a product/service, or a process, or a new business model, originally defined by Schumpeter, which was later called a structuralist approach (Swan et al., 1999).

Researchers have been trying to find ways to impact innovation as an outcome, and within the structuralist camp these attempts led to trying to establish a link between the organisational architecture and innovativeness of the company (or the capacity to produce innovative results) (Miles et al., 1978; Mintzberg, 1980; Tidd et al., 2005),

Innovativeness defines the degree of newness of the innovation, but it can also be applied to the organisation. And organisational innovativeness defines the ability of the company to innovate (Ettlie et al., 1984) consistently (Subramanian and Nilakanta, 1996) or to adopt innovation (Damanpour, 1991), the tendency to produce innovation (Wang and Ahmed, 2004), and what is also important, the willingness to do so (Hurley et al., 2005; Lumpkin and Dess, 1996).

Some scholars state that innovativeness is the outcome, not the cause (Garcia and Calantone, 2002; Riivari and Lämsä, 2013), but then we cannot influence the innovative potential of the company by improving the process. On the other hand, they contradict themselves by arguing that a highly innovative product does not necessarily make the company innovative - but what does then? It would be more appropriate to say the opposite, that companies with a high degree of innovativeness do not necessarily develop highly innovative products. Therefore, innovativeness is both the cause, which may facilitate innovation, and the effect, which we can measure by the output.

Numerous studies have been trying to establish the correlation between various organisational parameters or key performance indicators and the level of innovativeness of a company, and the reviews of these studies revealed several issues. The first issue is related to the determinants that are expected to indicate how innovative the company is likely to be, and they include the age, size, structure, profits, exports, etc. (Damanpour and Aravind, 2006). But some parameters can arguably be called the co-determinants, for example, profit and exports; the relation of these parameters with innovation is rather complex. If profit is taken as an indicator, it can be the result of an already existing innovation, but it can also be a determinant for future innovation, if it is invested in further research; therefore, as a determinant it is not very reliable. Other parameters, such as age and size, are independent and therefore seem more suitable for the analysis, but the researchers have little agreement on the categories within each parameter. For example, the definition of a young organisation varies from less than 6 years (Evans, 1987) to 8 years (Gopalakrishnan and Bierly, 2006) or 10 years (Laforet, 2013), or is quite often absent.

The second issue is related to the determinants of the level of innovativeness. There is no commonly accepted method of evaluating the level of innovativeness of organisations. One of the most common ones is counting patents, but this indicator disadvantages such types of innovation as process and business model innovation. Other scholars evaluated the level of innovativeness by R&D expenses, and involvement in R&D activities, assuming that it leads to more new products developed. This way of measuring innovativeness is related to tracking the patent activity but is not limited to that, but investing more in product development does not necessarily lead to better outcomes.

The third issue is related to the inconsistency of the results, given that other parameters are the same, which could also be caused by the limitations of the parameters discussed above. For example, with regards to patent activity, some studies demonstrate that older companies tend to have a higher patent rate (Sorensen and Stuart, 2000), while others show that the patent quality decreases with age and size (Balasubramanian and Lee, 2008). The authors link this to the industry lifecycle, but it contradicts the findings of McGahan and Silversman (2001) who did not observe any correlation between industry maturity and the level of patenting. With regards to R&D expenses, a number of studies have shown that the introduction of innovation decreases with age (Hausman, 2005; Huergo and Jaumandreu, 2004), while others showed the opposite (Sorensen and Stuart, 2000).

For other parameters, such as organisational structure (Lam, 2005; Mintzberg, 1980; Tidd et al., 2005) and strategic approach (Dörfler, 2010; Miles et al., 1978), the classification of innovative companies was developed on a contextual level, and was not, and moreover cannot be, tested empirically, partially because, as mentioned before, these types are hard to find in their pure form, and any judgement of what structure the company should be referred to will be idiosyncratic. And when coupled with the complex and subjective

phenomenon of innovation and tested empirically, this judgement will produce unreliable results.

As an implication for this research, seeing innovation as an outcome helps to clarify the definition of innovation, and discussing the notion of innovativeness contributes to understanding the criteria based on which an organisation can be considered innovative. Understanding these criteria in turn helps to approach the first research question of identifying KM needs innovative companies by selecting the right companies. But the contradictory nature of the findings in relation to the organisational parameters makes one question whether limiting the company sample by organisational parameters helps to achieve sample representativeness. Representativeness in the statistical sense is based on the assumption that the limiting parameters are independent (normal distribution in the Central Limited Theorem). But as was demonstrated in this review as well as other studies, the correlation between various parameters and the level of innovativeness of the companies contradicted each other. Some of these contradictions can be explained by the influence of other parameters on the level of innovativeness, such as industry (Damanpour and Aravind, 2006). But instead, the research might benefit more if we look at the relevant rather than representative companies and see the phenomenon of innovation as a multidimensional construct with the network of parameters indirectly influencing each other.

In order to approach this question, we need to look at the activities of the company, and therefore, it is worth seeing *innovation as a process*. PDP activities that this research is focused on can be seen as an operational level of innovating process, and reviewing the literature on innovating helps to maintain the focus on innovating, which is essential for the first research question. Apart from that, as was mentioned before, by taking this perspective one creates a mental model, that will shape their actions; consequently, one needs to have a clear understanding of what the process involves and how it operates (Tidd et al., 2005).

Innovation as a process

The research on innovating process evolved in two main streams: as a stage-wise model (invention – development – testing – commercialisation) (Rogers, 2010) and as a random process (Burgelman, 1983; Van de Ven et al., 1999). The advocates of the latter compared it to a journey, while the supporters of the former originally saw it as a linear model with demand pull or technology push at its starting point. The linear model dominated for a period of time and was widely adopted, because it gave seemingly clear answers to the difficult question of how to manage innovation. Rothwell (1992) later characterised technology push and demand pull as the first and second generations of innovation models. The other three generations constituted the combination of the first two connected through feedback loops, the integration model involving suppliers and customers, and the system integration model relying heavily on networks. Though the models grew in complexity, which was partially

enabled by advancements in information technology, the basic process framework remained the same (Tidd et al., 2005).

A number of researchers criticised the linear approach for being too simplistic and noted that the innovation process is always accompanied by a degree of uncertainty. Instead they saw innovation as a random process with sources of innovation coming exclusively from outside (Hannan and Freeman, 1993; Tushman and Anderson, 1986). According to this approach innovation is only a matter of chance, and therefore little can be managed, and the only way to increase innovation capabilities is to be exposed more to external random events. Though supported with convincing examples, this approach provides little help to practitioners and does not explain the continuous success of companies with a long history of innovation, such as Procter & Gamble, Siemens and Rolls-Royce (Tidd et al., 2005). These living examples prove that the innovation process can be formalised and managed to a certain extent.

Other researchers agreed that the innovation process is never linear, and therefore it should not be strictly formalised, but instead they saw it as a journey, and observed common patterns, such as *initiation*, *developments* and *implementation* or *termination* (Van de Ven et al., 1999, 2000) or *search, select, implement,* and *capture* (Tidd et al., 2005). These models look similar, but have different purposes. The model of Van de Ven et al. (1999) attempts to capture what happens in the real environment and what characteristics each stage has, creating a tree of sub-stages, and reflecting its fuzziness and uncertainty, and therefore inability to control everything. In particular, the initiation phase consists of gestation or long-lasting change that prepares the ground (quite often associated with technology push or demand pull), the shocking event that triggers the initiation of the project, and the development of the plan that formalises the project. The phases of the development stage are open to interpretations but have common characteristics, such as the shift in performance criteria or a set-back to make adjustments. This model represents what is likely to happen, and instead of giving a call for action it advises on what to expect, and therefore what events cannot be facilitated.

The model of Tidd et al. (2005) on the contrary should be seen as a framework for thinking, rather than a description of a physical process, therefore it can be complemented with other innovation routines that are not necessarily part of the innovation process and do not occur in every company. And due to its flexibility it was widely adopted both in the literature and in practice (Figure 6).

Figure 6. Innovating process. Source: (Tidd et al., 2005).

The innovating process perspective is relevant to this research for two reasons. Firstly, it demonstrates that if a company is involved in innovating activities, its experience is relevant to this research. Secondly, innovating process is a knowledge-intense activity, and therefore it is a perfect area of a company where KM practices can be observed and where the effects of improvements in these practices are most noticeable. This review helps to set the research context, which will be discussed in more detail in Section 3.6 of this chapter. In order to explore innovating process as a knowledge intensive activity, this section continues by reviewing the relationship between innovation and KM. Apart from that, this section becomes relevant in Section 7.4, which answers the third research question about the role of gamification in KM and innovation, and the concepts reviewed above help to explain the findings in literature and practice.

Knowledge Management and Innovation

Just like the perspective of innovation, the relation between innovation and KM is twofold: new knowledge as the core of an innovative idea, and knowledge and knowing processes as enablers of innovating. In this respect this research takes a meta-theoretical lens: innovation, KM and gamification (as is demonstrated in Chapter 7) can take both a process and a substance approach. Though this research is primarily focused on the process approach, both lenses in each of the fields are inseparable from each other and intertwined with each other. KM as a process supports innovating process, but new knowledge as a substance lies at the foundation of innovation as a substance. Gamification can be an element of innovation as a substance, and can facilitate innovating process, e.g. by facilitating the creation of new knowledge or by supporting KM in the form of improved knowledge sharing.

With regards to new knowledge, the ability to create new knowledge and therefore a basis for a new idea is strongly related to creativity. And the topic of managing new ideas has been raised during the interviews numerous times. Researchers have been exploring the link

between creativity and the ability to create new knowledge by studying experts solving problems (who are believed to have a richer and more contextual knowledge basis about the subject matter). And they found that experts tend to find a solution faster because they can see shortcuts by projecting their experience (Rosenblatt and Thickstun, 1994), they can also see the problem more deeply and frame it by identifying the basic cause (Shirley and Langan-fox, 1996), or they can foresee future trends which proved to be as accurate as the results of marketing research (Lew, 1987). What is more interesting is that group dynamics can facilitate group creativity that goes beyond the sum of the ideas of individuals (similar to the group knowledge), and this type of creativity is fostered by diversifying the expertise in the group, which in turn leads to higher innovation output (Leonard and Sensiper, 1998).

Though creativity is usually associated with innovation as an output, group creativity (as was discussed above) shifts the focus towards innovation as a process (Dörfler, Baracskai and Velencei, 2010; Stierand et al., 2014). And advocates of this innovation perspective emphasised the central role of knowing processes such as the process of learning and creating to sense new ideas and develop them (Arikan, 2009; Lam, 2005; Swan et al., 2000), as well as engagement between people within the organisation to stimulate knowledge dispersions, which in turn can improve the innovative capacity of the company (Doz and Wilson, 2012; Van de Ven, 1986).

This section laid the initial theoretical foundation for this research, and some of the framework under review provided the underlying structure of the subsequent analysis of the interviews during the principal investigation that aimed at answering the first research question. The remaining part of this section discusses the main challenges in KM that have been discussed in the literature and that provided ideas for themes to discuss with practitioners and experts during the preliminary interviews.

3.1.4. Knowledge Management Challenges

Unlike the rest of the section, this part does not focus on an aspect of KM. Instead, it discusses, based on the literature, the challenges that practitioners are facing, since this research is strongly driven by the problems found in the world of practice. It discusses the problems that practitioners have control over as well as the problems that lie outside their area of influence, and as a result, this helps the reader to enrich the context around this research.

One challenge that lies within the control of KM practitioners is related to the implementation process. Quite often KM initiatives start with a pilot project, and on the one hand, the pilot project acts as a safe playground for experimenting, learning and improving the initiative. But on the other hand, due to the small scale, these initiatives demonstrate modest results. As a consequence, the projects get deprioritised and limited to the implementation of an IT system

(Liebowitz, 2001), in which the major expense is the cost of the system bought from a vendor. As a result, an IT system is not being used and the whole project can be considered a waste. But avoiding this system is difficult as well, because an adequate technological infrastructure helps to integrate fragmented flows of articulated knowledge and information through the organisation (Duncan, 1972; Teece, 1998).

Researchers and experienced practitioners advocate that a company should spend from 80% (Roszak, 1994) to 90% (Liebowitz, 2001) of the effort on training, cultural change and change management, or in other words, only 10-20% of the total budget of an initiative on technology for it to be successful. This ratio acknowledges the importance of knowledge, whereas in technology-centric initiatives knowledge is objectified and assimilated with information (Gherardi, 2006). This distinction becomes even more critical in more knowledge intensive areas, such as R&D. Even successful KM initiatives experience difficulties implementing new practices in this area (Voelpel et al., 2005), and this is the area which this research is most interested in. R&D deals with more highly contextual knowledge, which is therefore more difficult to share and disseminate without losing its complexity and context (Doz and Wilson, 2012).

The right balance between technology and soft aspects of a KM project also acknowledges the importance of a cultural change, as companies face numerous non-technical issues through the course of an initiative, such as knowledge hiding and hoarding (Connelly et al., 2012) and power distribution issues (Gray, 2001; Markus, 1983). Though these problems are still very real, the researchers observed that the younger generation is more open and willing to share knowledge (PriceWaterHouseCooper, 2007), and so these issues might become less important in the future, especially in industries that tend to employ younger people.

The last remark leads to the second issue that is partially out of control of KM practitioners. One of the biggest challenges large organisations are facing now is the loss of experienced workers. The generation of the “baby boomers” is close to retirement, and these companies find it difficult to discover new young talents (Grant, 2013; Teleos, 2013). This issue is particularly relevant to the energy sector (Grant, 2013) and might have been the reason of the huge emphasis on codification in many companies. This issue was also brought up by several participants during the interviews. The companies have been trying to extract the knowledge from the “wizards” of their craft in the form of manuals, reports or learning materials, but their efforts could bring only limited results, because this knowledge is highly contextual and therefore is quite often impossible to articulate. Some companies started apprenticeship programmes (Ryan et al., 2007) as an alternative way and probably the only way to transfer this knowledge (Levitt and March, 1988), and this initiative could bring valuable results in the longer team, but its effectiveness is very difficult to evaluate.

To conclude, KM is a fuzzy and fairly unstructured area, where practitioners quite often try to handle problems by implementing a piece of technology, since technology is easier to define, understand and justify. Though this section was primarily focused on KM problems, it was impossible to isolate them from the problems related to or caused by technology. Sometimes technology does more harm than good, but it is difficult to imagine any KM project that would not involve an IT system. Any properly designed and implemented system accelerates and enhances KM initiatives; therefore, the next section reviews the field of KMS in more detail and attempts to understand the reasons behind high failure rates.

3.2. Review of Knowledge Management Systems Literature

The literature on KMS is much more scattered and fragmented than KM literature, and so, it is worth including various aspects of it into this review in order to cover the field, even if they are seemingly loosely related to the main objective of this research. Following the initial research question regarding the connection between KMS types and KM practices, the review covers existing frameworks. The frameworks identified in turn help to derive a list of KMS types and to discuss the benefits and drawbacks of each of them in more detail. One of the KM challenges that were discussed in the previous section refers to the implementation problems, which are particularly relevant to KMS, since KM initiatives are usually accompanied by technology and the implementation process is built around it. Therefore, the review also covers the researchers' stand on the implementation of KMS and motivational aspects, which affect the subsequent adoption and successful utilisation of the system. Understanding this area better also contributes to designing the principal investigation in order to answer the second research question about the nature of support that technology should provide to KM. And finally, the review analyses the deficiencies in the literature that sharpen the design of the principle investigation.

3.2.1. Overview of KMS

Knowledge Management Systems (KMS) refer to the class of Information Systems (IS) for managing organisational knowledge (Alavi and Leidner, 2001). It is important to note that in the KM literature KMS are regarded as a technological component of an initiative, rather than a system in a more generic sense, e.g. a system of KM as a group of participants, practices and tools that interact with each other and form a system. Therefore, in this research KMS is used interchangeably with technology and refers only to the software tools.

Though not all KM initiatives involve integration of KMS, the majority of the initiatives are built around the implementation of new technologies, and this happens for several reasons. The projects that involve a tangible component (such as an IS) are easier to justify and advocate, and therefore to have budget allocated (Davenport and Prusak, 1998). And this happens partially because a tangible component is easier to understand than the soft aspect,

like cultural and organisational change (Davenport and Prusak, 1998; Myers, 1995). Apart from that, various classes of IS (e.g. ERP systems) have been supporting knowledge workers and have substantially improved the performance of companies in the past. This success led to overreliance on technology and belief in its magic properties and ability to solve any problem.

The issues listed above do not imply that IS are useless in the area of KM, on the contrary, they can be of great help, but overemphasising technology neglects other important aspects of the initiative. The abundance of different types of KMS and the lack of understanding of what they are, contribute to the high failure rate of KM projects. Choosing the right system, and also not creating false expectations from the system, might be one of the defining key success factors, and this section discusses where the literature stands in this issue.

One study revealed that 68% of the mistakes are repetitive, and many of them could be avoided if relevant experts were involved on time, but 74% of the respondents believe that the organisational knowledge is not accessible (Gazeau, 1998). A lot of the KM initiatives are driven by this problem and aim to capture organisational knowledge in a form of best practice (Goodman and Darr, 1998; Voelpel et al., 2005), and sometimes internal benchmarking brings substantial results, if these practices are indeed applied and reused. For instance, Xerox estimated a payoff of $1.2 billion from applying best practices in key areas (O'Dell and Grayson, 1998). Fewer companies focus on mistakes, but those that do, find it useful as well. For example, Honda keeps a record of unsuccessful development ideas, recognising that they might have high potential in the future (Davenport and Prusak, 1998), while ConocoPhillips gives a special award for sharing painful lessons learnt (O'Dell and Huber, 2011).

All these attempts aim at codifying knowledge that can be articulated, and though there are a number of problems associated with the codification strategy, it remains one of the main purposes of technology-centred KM initiatives. The literature on KMS mainly consists of case studies and researchers rarely explicitly define the purpose of KMS, but those who do, define three purposes: (1) the coding and sharing of best practices, which was already discussed, (2) the creation of corporate knowledge directories, and (3) the creation of knowledge networks (O'Dell and Grayson, 1998; O'Dell and Huber, 2011), both of which supplement the first aim.

With regards to the second and the third purpose, which have not been reviewed yet, knowledge directories are created mainly to locate or map the knowledge. Knowledge mapping can be achieved with little or no use of technologies in a form of a map, like the map of the best practices and internal expertise in Chevron (O'Dell and Grayson, 1998). Or it can take the form of yellow pages, like a profile database with the background, skills and expertise in Hewlett Packard (Andreu and Ciborra, 1996). With the emergence and increasing popularity of social media, commercial Facebook-like tools found their way to the corporate environment as well. And in these systems knowledge maps can evolve more informally through the internal social network, where information concerning expertise is gathered

gradually, as with Eureka in Schlumberger (Lank et al., 2008). This way of knowledge mapping represents a dynamic bottom-up approach, where employees are invited and empowered to manage their profiles and connect with each other, which results in a network map. As opposed to a static top-down approach of profile libraries social networks create a social environment inside the company. However, it is also very time-consuming and is more likely to work in very large organisations, where the benefits of maintaining and using the system outweigh the effort required.

The second and the third objective of KMS partially overlap, where KMS do not form knowledge networks and communities per se, but they can become a catalyst by creating an environment that encourages and eases their formation and evolvement, for example, with the help of corporate social networks (O'Dell and Grayson, 1998; Wenger et al., 2009). Dynamic and informal profiles allow connections go be made more easily, and therefore enable the creation of a network. They can also simplify the coordination of communities if they emerge. Visualising the networks in turn can serve as a way to map the knowledge, thus mutually reinforcing both objectives.

Up until this point the review mainly viewed KMS as a tool for codifying knowledge, which, as discussed earlier in this chapter, has limited potential for success. In particular, best practices are highly contextual and contain a tacit component, which is difficult to articulate and fit into the rigid standardised templates (Goodman and Darr, 1998). Although the context surrounding the case is important, one needs to find the balance between the level of contextualisation and generalisation to make the practice applicable and meaningful to others. And moderating the quality might lead to polarised results: too rigid rules discourage participants (Goodman and Darr, 1998), whereas too much freedom turns the repositories into junk yards (Brown and Duguid, 2000). Apart from that, maintaining the repository as well as a good profile library and knowledge map is very time-consuming.

Unfortunately, the literature that aims to define KMS as a class of IS does not expand the discussion much further, but various solutions to some problems certainly exist and are described in numerous case studies. Therefore, the following review of different KMS frameworks and types might help to draw a more holistic picture and create a bigger range of purposes and applications that KMS can serve.

3.2.2. KMS frameworks

The literature on KMS tends to focus on one or just a few types and examine them retrospectively by analysing the areas of use in the case studies and sometimes by focusing on the drawbacks of those types. Analysing case studies is a good way to start exploring the field, but unfortunately too few attempts have been made to aggregate different types of technology that support knowledge workers and to develop recommendations with regards to these types. The three frameworks that were found are the frameworks of Davenport

(2005a) and McIver et al. (2013) for different types of knowledge workers, and the framework of Wenger et al. (2009). The first two have already been covered in the previous section and will be complemented with suggested technological solutions in this section. The third framework was developed for the communities of practice and their activities and therefore does not cover all the areas of KM, but is still worth reviewing, since these recommendations contain high level of details. This section will start by reviewing each of the frameworks, and then will continue by comparing and contrasting them, trying to derive a complete list of KMS types that will be discussed in more detail afterwards.

Davenport (2005a) drew his framework on the basis of the typology of knowledge workers discussed in the previous section, and distinguished two levels of technology support: individual and organisational. On the individual level technology, such as emails and chats, aim to increase the productivity of the workers, whereas technology on the organisational level supports a large number of workers, and therefore, its effectiveness is more difficult to measure. The types of technology are further classified based on the level of complexity of the work (Figure 7), which was discussed in more detail in the previous section.

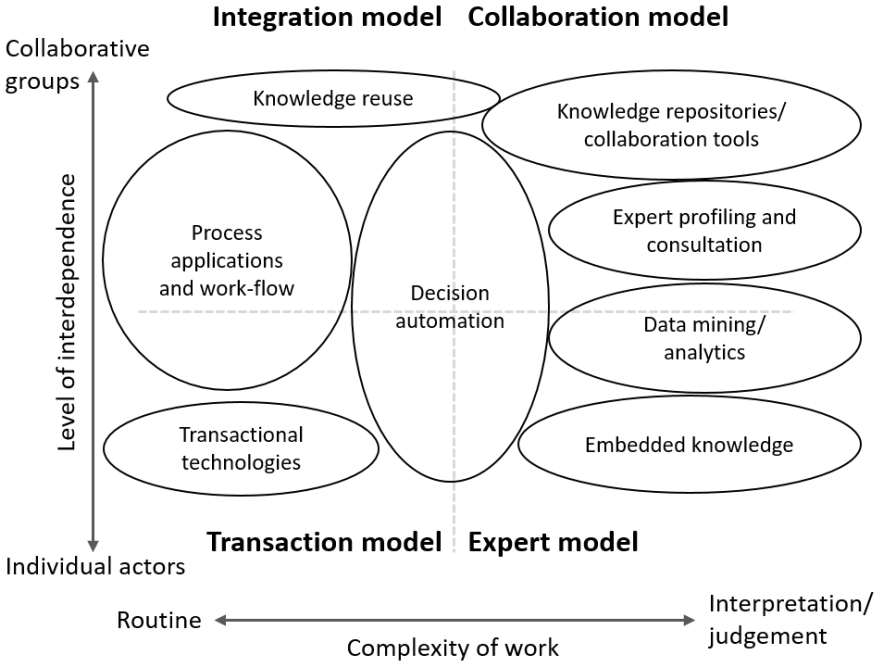


Figure 7. Organisational technologies for different types of knowledge work. Source: (Davenport, 2005a).

In particular, the transactional workers require technologies that simplify and support their routine, such as giving relevant information on time in a call centre, but they do not need to collaborate with their colleagues on a regular basis. This however does not mean that they would not benefit from it. But as the work becomes more collaborative, it needs to be supported with different technologies, such as project management tools or product design reuse for lower-level engineering. These technologies allow them to mainly coordinate the output, which their colleagues are capable of understanding without their help. As the work

grows in complexity, at the expert level the workers can benefit from the use of knowledge-based systems, such as patient diagnostics support, and analytical applications, such as data mining. And finally, if the work of experts also requires collaboration, straight-forward knowledge reuse is problematic, because their work is so complex in nature. Instead knowledge workers need technologies that will help them to connect with each other and receive a timely input from each other.

Similarly, McIver et al. (2013) base KMS classification on their typology of knowledge workers, which was also discussed in the previous section, but unlike Davenport they classified the types of technologies through the knowing processes and knowledge in practice types, which knowledge workers are most likely to be involved with. In this way some of the types of knowledge workers share the same processes, and thus the same types of KMS. The classification distinguishes 4 processes and 8 sub-processes, three of which – learning, assimilation and application – cannot be supported by the technology. For the rest the authors provide categories that are similar to that of Davenport (Figure 8).

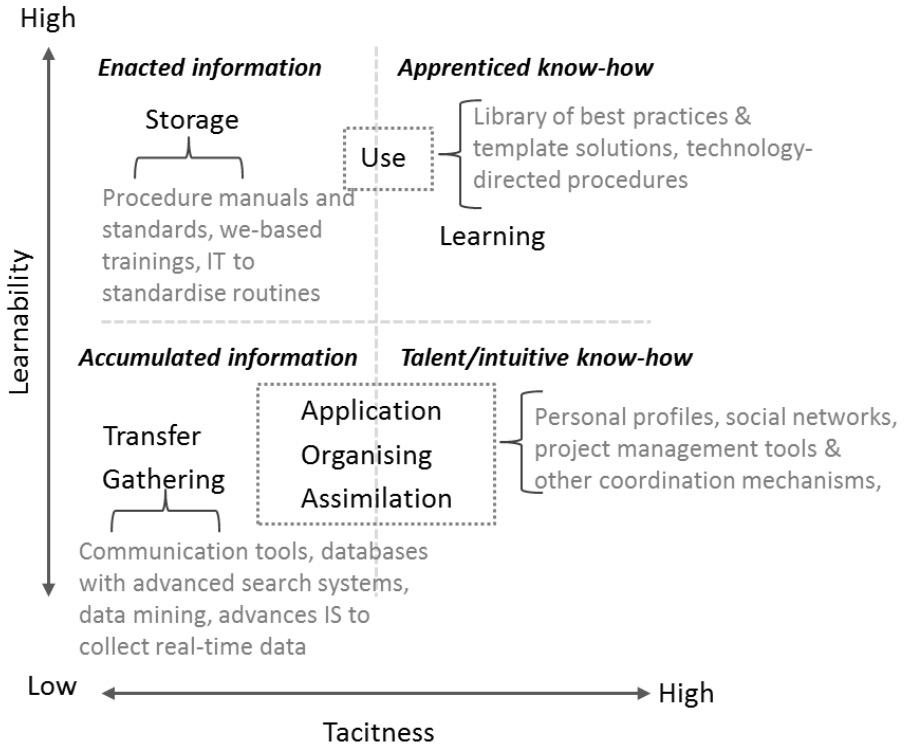


Figure 8. Knowledge in practice for organisational work and related processes. Adapted from McIver et al. (2013)

As was mentioned in the previous section, transactional workers and enacted information workers overlap significantly in both frameworks, and so do the technology solutions, such as web trainings and IT to standardise routines. Integration workers are not separated in this framework, but the solutions that Davenport considers useful to them are suggested for two groups of high learnability workers through knowledge using (e.g. libraries of best practices). Similarly, both accumulated information workers and expert workers can benefit from various

advanced analytics tools, whereas the tools that Davenport finds useful and specific for collaboration workers (e.g. social networks) are suggested for two groups with low learnability of the skills through common processes of application, organising assimilation of knowledge.

What this framework also shows is that with the increased level of tacitness of acquired skills it is increasingly difficult to find a type of technology that would support this work, which is in line with the observation from the overview of KMS. For example, in the groups with higher learnability the library of best practices is considered useful. But for the apprenticed know-how group the context around the best practice becomes increasingly important, and at the same time it is increasingly difficult to share more context, so simply providing storage facilities is not sufficient. In this light both frameworks complement each other and indicate the limitations of the technology.

The framework of Wenger et al. (2009) presents a classification of the tools that are useful for communities of practice (Figure 9). Just like Davenport, they use individual vs. group activities as one of the dimensions, and add two other dimensions, of the synchronous vs. asynchronous working mode and of the focus on the discussion with other participants as opposed to the creation of new contents.

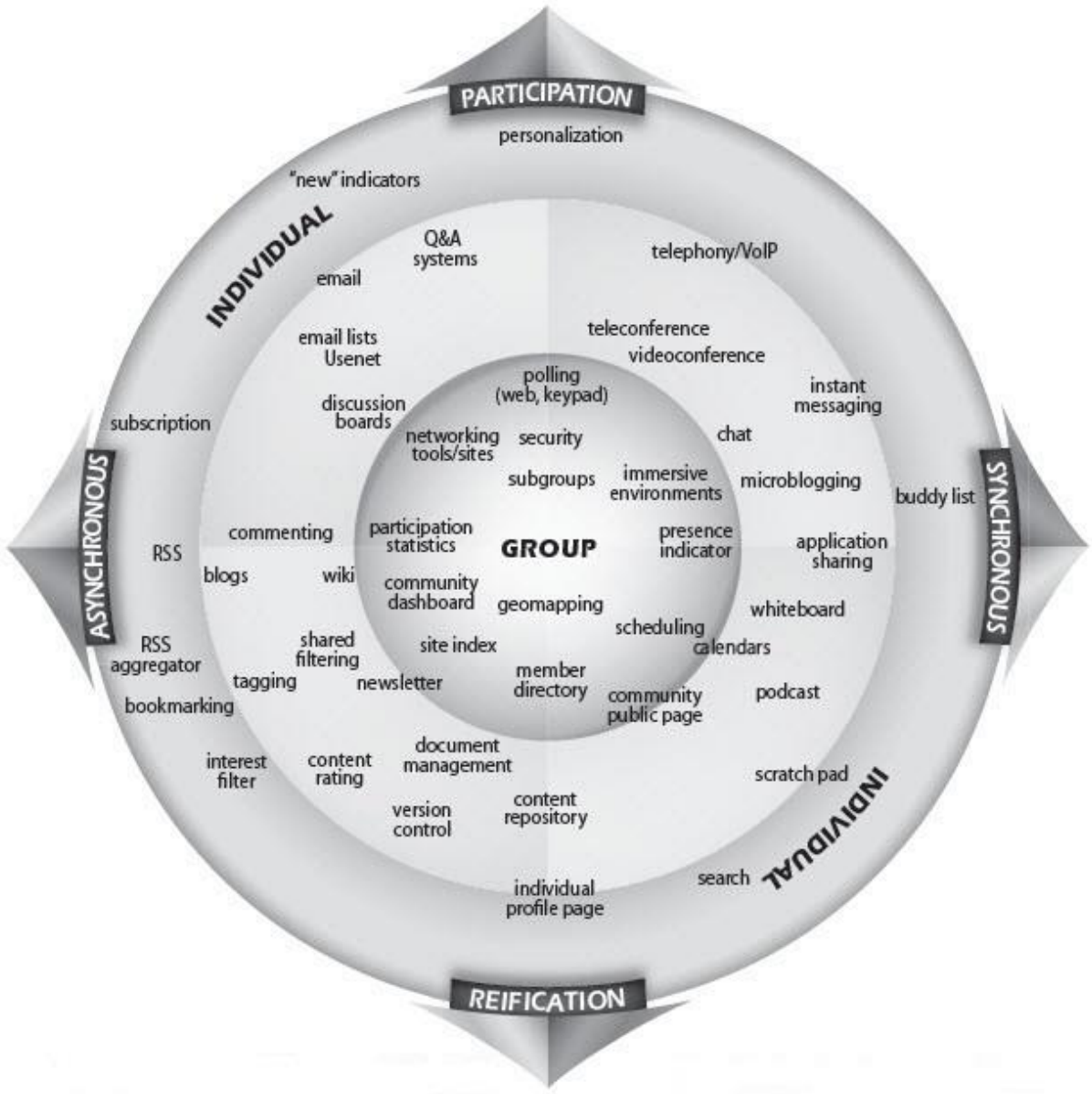


Figure 9. The tools landscape. Source: (Wenger et al., 2009).

In this framework the authors classify different types of tools, such as blogs and wikis, and added functionality, such as tagging or search, which can be used only when coupled with one of the tools. From the concentration of tools in certain areas one can see that most tools are developed for group work, and even individual tools, such as interest filter, assume indirect involvement of others (e.g. in creating contents). This classification is unique and can become complementary to any type of knowledge workers.

The similarities between the first two frameworks, which were developed using different approaches to classifying knowledge workers, increase confidence in the recommendations suggested by the authors. However, the categories that the authors provide blur the boundaries of KMS with other IS. Therefore, it is reasonable to ask whether we should consider any system that supports knowledge workers a KMS. For instance, decision

automation and data mining tools support highly knowledge-intense types of works, but they also tend to be either industry or even company specific, and therefore difficult to apply in a different context. Therefore, should they be studied in the scope of KMS? Similarly, embedded knowledge systems (e.g. expert systems) contain the body of organisational knowledge, and therefore, according to the definition of KMS, should be categorised as one (Alavi and Leidner, 2001), but they are unique to each company. Due to their specific nature these systems might not face the same implementation and motivation issues, since their benefits are more obvious and the effects are more distinct and transparent. Moreover, these categories of systems might be understood completely differently by different practitioners. These systems were included in the initial scope of this research so as not to eliminate the possibility that they might provide an answer to these questions. However, none of the participants identified them with KMS, and thus the analysis of the results in Section 6.1 contributed only to better understanding of the generic tools, such as repositories, social networks and collaboration tools.

Davenport's model (2005a) defines the following types of KMS: knowledge repositories, which also allow knowledge reuse, collaboration tools, business analytics, which support data mining, knowledge-based systems, which support decision automation, process and work-flow applications, expert profiling, which can be considered an old version of social networks, and so are covered within the corporate social networks type, and transactional technologies. The last group is very work-specific and cannot possibly be covered within this report, so it is not reviewed. McIver et al. (2013) suggest the same tools, some of which have different names, for example, coordination tools which serve the purpose of work-flow application, and this name will be adopted in this research. The authors also emphasise the importance of search engines, and this tool is reviewed as well. And finally, Wenger et al. (2009) emphasise WEB 2.0 tools along with collaboration tools, content repository, search engine and numerous features of these tools.

To summarise, KMS are split in the following categories: knowledge repositories, collaboration tools, coordination tools, social computing, which include forums, blogs, wikis, portals, podcasts and corporate social networks, knowledge-based systems, and analytical tools. The functionality of some of them might overlap but not significantly, and the following part of this section reviews each of them in more detail. Identifying these types was quite important, because they contributed to understanding of what KMS comprise of. These types was prompted during the preliminary interviews in order to observe the nature of connection between KM and technology. Then these types were tested in the survey and discussed during the principal interviews in order to answer the second research question regarding the support that KM practices require.

3.2.3. Types of KMS

The KMS frameworks developed by Davenport (2005a) and McIver et al. (2013) are based on the typologies of knowledge workers in order to ensure that they cover all areas of knowledge work. But because of that KMS recommendations are too generic for an individual company. The framework of Wenger et al. (2009) is much more detailed, but it was developed for a specific area of application – communities of practice – therefore its transferability to other areas would need to be further examined.

At the beginning of this research I intended to develop a holistic and detailed picture of KMS for innovative companies, but when the research context and scope were refined, the focus shifted towards understanding KM needs and identifying supporting technologies for innovative activities of companies in a particular sector. This change is discussed at the end of this chapter. In both cases it was required to review different types of KMS in more detail in order to the understand differences and similarities, and the types defined in the above frameworks served as a starting point in the following review. This review aims to understand how various KMS types (technological tools) are pictured in the literature, which would allow comparison of the preconceptions about these types with what is observed in practice.

Knowledge repositories

Knowledge repositories are usually the first step that companies take when starting a KM project. Knowledge repositories are often associated with document storage, electronic libraries, or databases of best practices, knowledge bases, previous experience or intelligence about the suppliers / partners / competitors, while other times they are seen separately from document repositories. Therefore, it was interesting to check if companies see the difference as well. Knowledge repositories are often to blame for technology-centric initiatives that failed, and are even labelled junkyards, when used inappropriately (Brown and Duguid, 2000; McDermott, 1999; Sveiby, 1996). Also implementing such a system is costly, e.g. Shell reflected that while 85% of their knowledge management budget was spent on building the database, only 15% of the value is gained from their use, and the other 85% comes from the interpersonal discussions (Grant, 2013).

On the other hand, it is much harder to estimate the cost of not having a centralised repository, and there are examples of successfully using such systems as well. For instance, Ernst & Young has built its operations around a codification strategy by collecting a database of best practices and reusing them in future projects, in addition to creating a database for small and medium enterprises, where other companies can find examples of solutions to similar problems (O'Leary, 1998).

Yet, creating a high quality repository is challenging. For instance, if a company intends to create a database of best practices, the coordinators of this database need to find a balance between making the revision process too rigid and therefore discouraging contributors

(Goodman and Darr, 1998), and relaxing the rules, and therefore risking turning the database into a junkyard, and discouraging the users of the system (McDermott, 1999).

But controlling the quality of content is only a part of the solution, since the input needs to be retrieved, and, leaving the motivational aspects aside, with the increased number of inputs it becomes increasingly difficult. Some companies solve this problem by dedicating a support team that helps users to navigate the database and find relevant solutions (Braganza et al., 2009; Davison et al., 2013), but not many companies have such resources as Schlumberger or IBM.

An alternative to rigid and expensive solutions could be Web 2.0 tools, like wikis. They offer agility and flexibility combined with the regulated structure and could be a more user-friendly alternative to traditional repositories.

Web 2.0 tools, also called social computing or conversational technologies (Wagner and Bolloju, 2005), emerged during the last decade, moving from the category of alternative technologies for youngsters to potentially useful tools for a wider audience. These tools are distinct from others, because they are self-organising, easy to use, interactive, low-cost and user-friendly (O'Dell and Huber, 2011). They were rather experimental (except for the forums) during the first decade of the 21st century (Davenport, 2005a), but more and more companies started adopting them for the corporate use, tailoring the available tools to the enterprise needs and taking various concerns, such as privacy, into account (O'Dell and Huber, 2011).

But the potential of these tools is not only limited to a more convenient way of storing articulated knowledge – they are praised outside the working environment for providing an alternative way of interacting. As companies came to realise the importance of informal interaction, the popularity of corporate social computing increased. Therefore, it is worth looking in more detail at the following tools and their possible application for KMS and use inside organisations: forums, blogs, wikis and corporate social networks.

Forums

Forums are among the earliest adopted social computing tools (Wagner and Bolloju, 2005) and are widely used to address problems and urgent requests raised by colleagues. For instance, Siemens implemented forums for urgent requests where service support technicians of sales representatives seek a solution to problems from their peers on the other side of the world. And this system proved to be very popular and successful (Voelpel et al., 2005).

Forums became popular mainly due to their simplicity and extra features, such as rating of posts and reading statistics, and the pull principle of sharing knowledge made them superior to simple mail lists, which rely on the push principle (Wagner and Bolloju, 2005). They are usually organised around topics or chronologically, and although the latter might be helpful

in some cases, it might create redundant topics since newer information is prioritised, and consequently “sticky” popular topics can be lost (Wagner and Bolloju, 2005).

One of the major problems associated with implementing a forum is gaining and sustaining momentum by creating a stable and sufficient number of active users so that those who are willing to share get feedback, and those who are willing to learn keep coming back because the space remains active. And this experience was shared by some of the participants as well. According to various estimations the percentage of non-contributing members or so-called lurkers (those who are reading only) varies from 45% to 90 % (Nonnecke and Preece, 2000), and of the remaining 10% only 1% are heavy contributors, creating up to 90 % of the posts (Jakob Nielsen, 2006). Various attempts to change this distribution have not produced sustainable results, and therefore this fact has to be accepted as inevitable.

Blogs

Blogs started as a tool for online users to keep their records chronologically and later became a powerful topic oriented tool to reach a targeted audience and generate discussions around specific issues (Hsu and Lin, 2008). In the corporate environment more and more companies start using corporate blogs mostly as a PR tool or a channel for corporate communication, while others use it as a discussion platform or a project management tool (Grudin, 2006).

Blogs became quickly widespread mainly because they are relatively lightweight and unstructured, easy to publish and access an entry (Wagner and Bolloju, 2005), thus, lowering the barriers for sharing. Built chronologically, they enable efficient search and information retrieval through tagging and can generate fruitful discussion through the commenting functionality (Cayzer, 2004; Grudin, 2006; Klamma et al., 2007). Overall, blogs as well as forums are good at ‘contextualising knowledge conversationally’ (Davison et al., 2013). The president of Sun Microsystems Inc. Jonathan Schwartz believes that blogs are the most effective way of communicating after face-to-face meetings, but do not have the scalability constraints of the latter (Cone, 2005). And enriching them with various technologies, such as Semantic Web and Research Description Framework Site Summary can turn them into a powerful KMS tool (Cayzer, 2004; Jung, 2009).

Wikis

Wikis are probably the most interesting Web 2.0 tool for KM, for the reasons discussed below. Wikis started rising together with blogs, the most famous wiki probably being Wikipedia – an online encyclopaedia. Wikis are sometimes considered a replacement to blogs or a different form of them, but their nature is different. They have a predefined structure, which requires categorising content before sharing it (Grudin, 2006). They do not archive content in a chronological order and do not emphasise ownership of the posted content. They are quite often a collective piece of work, because the content can be edited multiple times by any user with access to it, which can be both an advantage and disadvantage (Boulos et al., 2006). It

can encourage those who are afraid to be criticised or do not want to put themselves forward because they are modest or afraid that what they post is not important (Ardichvili et al., 2003), but it can discourage those who wish to be recognised, or it can diminish the quality of the content, if the contributors have a low level of expertise (Wagner and Bolloju, 2005). However, the changes can always be traced back to an individual, which creates peer pressure and puts one's reputation at stake, and a number of studies have shown that fears of poor quality of the contents in wikis are unjustified. On the contrary, the contents tend to be quite accurate and up to date in communities of active users, which creates a phenomenon of dynamic knowledge – it is recorded, but constantly updated (Lambe, 2008).

Wikis can serve as an efficient and a low-cost tool for obtaining required information and learning (Boulos et al., 2006), and are a viable alternative to a database of best practices (Wagner and Bolloju, 2005). Some companies adopted them as an alternative interface solution, for example ConocoPhillips developed a system called OneWiki that enables one point of access to the extensive knowledge library, and allows the conduct of basic research before addressing project-related questions to the experts (O'Dell and Huber, 2011).

The three tools described above promote knowledge sharing in a more informal way, but Wagner & Bolloju (2005) suggest that they are tailored for different purposes. Forums are more suitable for helping to look for a solution to issues, while blogs encourage innovation, and wikis work best as educational materials and a tool to share best practices. And all three tools can be incorporated in Corporate Social Networks.

Corporate Social Networks

After the rise of Facebook and LinkedIn predominantly large organisations started implementing similar networks on a corporate level. For instance, Luis Suarez, the Chief Engineer of IBM in Spain, introduced a corporate social network (CSN) - Blue Pages - as an alternative way of communication in the organisation, after one of the students told him that the younger generation was not overwhelmed with emails because they were using other communication channels. As a result of this initiative, the amount of emails he received was reduced by 97% (Clapperton and Vanhoutte, 2014; O'Dell and Huber, 2011).

Some researchers see CSN as a next generation of profile library, being a combination of a profile library and instant messenger, and though they could offer the advantages discussed previously, the functionality of social networks or virtual private networks goes beyond a simple connection of profiles. CSN offer a gradual organic development of the networks in an organisation, visualising the connections between the departments and the division and identifying the connectors, and their importance has already been discussed. For instance, 3i, a venture capital and private equity firm, implemented a corporate social network called InterAction to bridge the subsidiaries and make specialists more accessible. And when they

needed to find a specialist with personal connections to the company they were planning to acquire, they identified a colleague in a foreign subsidiary through InterAction, who helped secure the necessary introductions and allow the acquisition to progress (Davenport, 2005a).

With easier communication, social networks enable people to reach others in an informal way, whom they are not able to meet in person, and as people are five times more likely to search for information from other people (Allen and Henn, 2007), this tool turns to be their favoured communication channel (O'Dell and Huber, 2011). Online discussions can spur new ideas which are then moved offline turning into new projects, and one of the interviewees during the preliminary investigation has shared such experience in his company.

The four types of social computing tools discussed above are not the only available ones. For example, podcasts are a powerful tool for education purposes, allowing the users to listen to or watch educational materials whenever it suits them (Boulos et al., 2006). But these tools are very task-specific, and therefore will not be reviewed in great detail.

Coordination tools

Coordination tools, such as project management, product lifecycle planning and others, are widely used by many companies, since most companies realise the practical need and adopt them. Though some companies experiment with new tools, for example blogs for project management due to their simplicity and narrative form of representation (Grudin, 2006), the market offers many decent solutions, which have proven their effectiveness. Therefore, there is no need to review them in more detail. However, these systems are interesting as an integral part of KMS and are a potential source of valuable information for further analysis, such as lessons learnt.

Collaboration tools

Collaboration or infrastructural technologies accelerated business in the twentieth century and are one of the most widespread types of technology. These tools improve access to knowledge and enable employees to work together (Gold et al., 2001). They include telephones, mobile phones, emails, video and audio conferences and others. These tools proved effective, and are therefore widely adopted, but overreliance on them also becomes a problem. On average knowledge workers spend 20% of their time on emails, and sometimes feel overwhelmed (Davenport, 2005a).

A more recent alternative to emails – VOIP (e.g. Skype) – partially reduces the email overload. Some companies even find that employees are more likely to use instant messengers for immediate collaboration, rather than face-to-face meetings and phone calls, even with their peers sitting next to them. What is also interesting is that 80% of these conversations are work-related (Davison et al., 2013).

Though collaboration tools are fairly well established and seemingly do not need much attention, they were left in the scope of KMS tools in order to understand the degree to which companies relied on them.

Search Engines

Search engines cannot be applied as an independent system, but the efficiency of other tools such as wikis, social networks, forums and portals depends on them. Many companies view them mainly as an instrument to navigate through large knowledge repositories, which tend to grow exponentially (Daniel, 1998). But search engines are also used to locate experts in large companies (Marwick, 2001). For example, IBM developed a search engine for their internal use that would help to locate knowledgeable colleagues, suggest connections, visualise social networks around a particular area or a particular person and learn from previous search requests to customise the search results. For IBM the search engine was a cornerstone and the key to success of all the implemented KMS (O'Dell and Huber, 2011). But unlike IBM, not every company has the capacity and resources to develop its own search engine, therefore ready solutions are provided by companies whose core business is to search (Google, Yahoo, etc.), and incorporated into the KMS.

Portals

Portals have a wide range of applications, but this research is interested in corporate portals specifically. Corporate portals or intranets have been in use for a long time and before the emergence of social media they were used a single point to access (Dias, 2001) or to promote gathering, sharing and dissemination of information (Detlor, 2000). And what distinguished them from the ordinary corporate website was their ability to be tailored to specific user needs and therefore to filter the information displayed to the users (Benbya et al., 2004). Nowadays other tools slowly replace corporate portals as the first point of entry for employees, but most companies still have a corporate website with high level news, a pool of generic (e.g. HR related) documents and links to specialised systems.

Knowledge-based systems

Knowledge-based systems refer to a broader category of systems that are designed to help make more informed decisions, and represent a sophisticated tool for knowledge capturing. This category includes embedded knowledge systems, which provide relevant information to users when they are occupied with their everyday tasks (Davenport, 2005a), e.g. giving advice to doctors regarding the allergies of patients, other medications they are currently taking, or if they have a chronic disease (Davenport and Glaser, 2002). It also includes decision support systems and expert systems, which overlap with soft artificial intelligence, and part of which is based on symbolic representation algorithms, such as case-based and rule-based reasoning. These systems contain a knowledge component and are only used when the decision makers choose to do so. These subcategories of knowledge-based systems are used in different

settings, the former is mostly designed for knowledge workers with a lower level of collaboration and replaces peer advice to a certain extent, while the latter can be used in a wide range of applications (Davenport, 2005a). Unfortunately, decision support systems are often seen as automated decision making tools, but computers can make decisions only for a well-defined problem, and as problems become fuzzier and more complex, decision-making systems fail to bring much value and should be used to advise only (Roszak, 1994).

Expert systems have been praised for reducing the time for making a decision and increasing the accuracy; they are also used as an educational material that provides instant feedback (Turban, 1988), they narrow the gap between experts and non-experts and reduce the dependence on experts by capturing their knowledge (Liker and Sindi, 1997). But they also have a number of serious limitations.

Quite often it is difficult for the experts to articulate their knowledge due to its tacit nature, and it is even more difficult to keep the system up to date (Davenport and Glaser, 2002). Since the system is retrospective in its nature (Liebowitz, 1998), if the conditions change, it will be of no use unless it is updated. Apart from that, different experts might have different approaches to the same problem, yet all of them might work (Turban, 1988). But most of all, these systems are unique. Knowledge relevant for one organisation and embedded in the system can hardly be applicable for others, which makes building such a system costly and time consuming (Davenport, 2005a; Davenport and Prusak, 1998; Liker and Sindi, 1997).

This type of system was included in the review since it is based on expert knowledge, and therefore symbolises KM in a form of knowledge capturing, but as the interviews showed participants did not associate them with KMS and could not provide any examples apart from specialised software packages that helped them to make specific calculations. And it was somewhat unsurprising that KMS research is largely focused on finding ways to make better use of generic tools, while research in the area of knowledge-based systems is more focused on the methods that are used to build such a system for a specific case, which lies outside the scope of this research.

Business Analytics

With the enormous rise of available data within organisations, making sense of it became more important to achieve a competitive advantage. It lead to the development of a new class of system – business analytics systems, which process data to 'understand and analyse business performance' (Davenport, 2006, p. 7). The technologies available on the market range from simply providing access to the required data to reporting, and start with the most common application, Excel, to complex business analytics systems such as BusinessObjects, or analytical modules of SAP and Oracle. Business analytics is not a KMS type of primary importance, but rather a stand-alone product, which is quite often associated with KM. This

type of system is quite specific to the individual needs of different companies, and therefore it is hardly possible and not necessary to review all of them within this review.

The above review suggested the types of KMS and their areas of application that could be discussed during the preliminary interviews, which attempt to answer the preliminary research question and the results of which are presented in the next section. The list of types was also included in the list of independent variables in the survey in order to test whether the use of particular types has an impact on the level of maturity of the business processes of the participating companies in the multiple case study with the aim to answer the second research question. But the design of the questionnaire is discussed in more detail in Section 5.1.2. The remaining part of this section shifts the focus from the description of KMS to their implementation and use.

3.2.4. KMS implementation

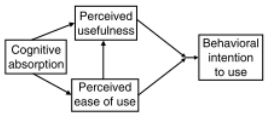
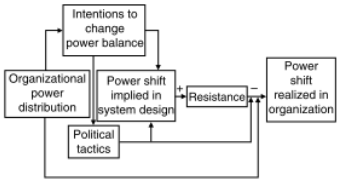
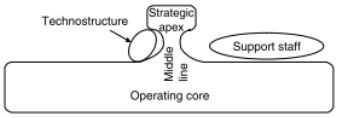
KMS implementation is a largely overlooked area of KMS research with no commonly accepted approach developed so far. Some researchers suggested a sequence of general steps to follow, which are based on a single case study of a large organisation. For example, Voelpel et al. (2005) developed a 5-step process based on the implementation project of the ShareNet system in Siemens, which includes the concept phase, global rollout, reaching momentum into the system, expending group-wide, and consolidating and sustaining performance. Similarly O'Dell and Huber (2011) described the KM initiative in IMB in three stages: a decentralised stage, during which the initiative is customised to specific needs and users get used to the new system; a centralised stage, required to optimise the resources; and integration of knowledge management processes in everyday activities. And Wenger et al. (2009) give advice regarding the planning phase, technological considerations and practical implementations of the platform in different types of communities of practice, which are based on their extensive experience of working with the communities and therefore is not grounded in one case.

In other studies, researchers do not focus on the implementation process, but rather discuss the social aspects that contribute to success, which are reduced to motivation and are discussed in the next section. One of the reasons behind the lack of attention to these issues might be the default assumption that KMS is an IT system, and it can be implemented in the same way as any other IT system. This assumption is groundless, but reviewing different approaches to IS implementation can improve the understanding of the issue.

IS implementation offers many theories to choose from, such as the theory of technology acceptance, which is based on aspects of perceived ease of use and usefulness of the technologies (Davis, 1989). This theory was widely used in other researches (Myers, 1995;

Straub et al., 1997) and its parameters were utilised among others as one of the motivation factors of blog use, tested by Hsu & Lin (2008) and described in the next section. Other theories focus on the social aspects, for example a political variant of interaction theory (PVIT) looks at user resistance at the group level (Stieger and Aleksy, 2009). Lapointe & Rivard (2007) aggregated different theories and created a three-level model which defined the success of the IS implementation project. The researchers distinguished the individual, group and organisational level of IS implementation (Table 4) in parallel with the organisational level (Crossan et al., 1999) and demonstrated the influence of these levels on each other with the example of the case studies of IS implementation in three hospitals. In particular, when one level failed to explain the observed case, the mismatch could be explained by the driving forces on the other level.

Table 4. Success Factors of IS implementation model. Source: (Lapointe and Rivard, 2007).

Model	CA	PVIT	OC
Depiction			
Theory	Cognitive absorption is a determinant of perceived usefulness and perceived ease of use, which influence behavioral intentions.	When a system implies a loss of power from a group of actors, this group will resist implementation.	Design parameters, which characterize an organizational configuration, will influence organizational IS adoption.
Unit of analysis	Individual	Group	Organization
Key concepts	Cognitive absorption, ease of use, usefulness, intention	Power, interests, tactics	Design parameters
Dependent variable	Intention to use as a proxy for use	Group-level resistance to implementation	Adoption of innovations in terms of emergence and routinization
Questions	Why do individuals use an information system?	Why do groups of actors engage in resistance behaviors toward a system?	What explains the propensity of an organization to experience emergence and routinization with respect to an information system?
General propositions	Ease of use and usefulness will influence individual use.	When the actors in power resist, the system will not be adopted.	Most design parameters of a professional bureaucracy favor the emergence of innovations but hinder their routinization.

At the individual level the researchers adopted the theory of cognitive absorption (CA) (Agarwal and Karahanna, 2000), which incorporated the theory of technology acceptance. At the group level they adopted PVIT theory, described above, and observed the distribution and change of power between different groups with the IS implementation. And at the organisational level they derived the theory from the model of organisational configurations or structure in 5's of Mintzberg (1980), which explains the organisational characteristics to different organisational types and associated barriers of organisational change, and which has already been discussed in the innovation part of the KM section.

The implementation process did not become a primary focus of this research, but it is an essential part of any KM initiative. And the literature review demonstrated significant gaps that exist in the literature. Some theories and models from related fields could be borrowed

and potentially used in the field of KMS, e.g. the model of Lapointe and Rivard looks transferrable, but more research needs to be done in order to give a definite answer. In order to contribute to this area of KMS, one would need to study the implementation process in action. Alternatively, interviewing practitioners about past projects might potentially harvest useful insights, but when thinking about such one-time projects retrospectively, the interviewees are likely to forget important details, unless they are consultants who have been involved in many such projects in the past. Therefore, this question was addressed to the experts, and through it is not directly related to the research questions, their experiences suggested directions for further research.

3.2.5. KMS and motivation of knowledge workers

The motivation of knowledge workers has not become the primary topic of this research either, but is difficult to avoid when discussing knowledge sharing and barriers to knowledge sharing, KMS and the reluctance to adopt new tools. This section aims to provide an overview of this field and highlight different aspects of it that one needs to be aware of, since motivation is often brought up by both researchers and practitioners.

Motivational factors have been extensively researched in KM and KMS literature, and reviewing the whole body of literature would require a separate chapter. Instead this section focuses on the dominant motivation theories and technology-related aspects of motivation, and attempts to contribute to the understanding of the interaction between end users and KMS. And in order to do so, the review has to refer to the barriers to knowledge sharing and KMS adoption as well, these being the other side of the coin.

The barriers to knowledge sharing and consequent KMS adoption range from the fear to lose influence and power, or lack of time (Connelly et al., 2012), and the frustration with technical issues, as was described in the research origins in Section 1.1. And therefore it would be logical to split motivation factors into soft aspects (or social factors) and technical aspects.

Soft aspects

Soft aspects depart from the self-determination theory being an approach to human motivation and personality, and exploring inner growth and psychological needs (Ryan and Deci, 2000). Figure 10 presents the continuum of the types of motivation split into three categories, two of which are widely explored in KM literature – extrinsic and intrinsic motivation. Extrinsic motivation ranges from the external rewards to gaining status and perceiving achievements of goals as rewards, but quite often the latter are labelled as intrinsic motivation factors in KM literature (Jung et al., 2010). Sometimes it is difficult to draw a line between the two, but internal motivation is always driven by a sense of curiosity, exploration and enjoyment, competence and autonomy, whereas extrinsic motivation is always related to the external environment or distinct goals, e.g. status (somewhat external) only has a value

because it is recognised by others. Sometimes extrinsic motivation is complementary to the intrinsic one, at other times it might be detrimental to good internal impulses, and what is more important, removing damaging motivating factors will not restore damaged intrinsic motivation.

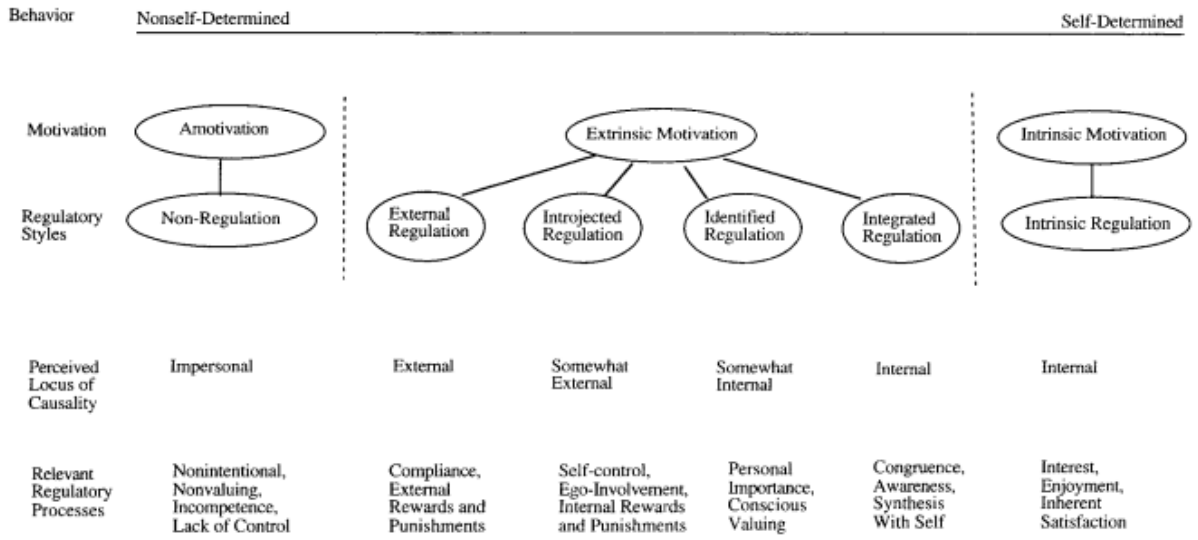


Figure 10. Self-Determination continuum with corresponding types of motivation. Source: (Ryan and Deci, 2000)

With regards to KM, research has been predominantly focused on extrinsic motivators, since it is possible to change and control them. External motivators in the form of rewards demonstrated mixed results from a positive effect (Grant, 2013; Voelpel et al., 2005) to a negative effect (Vassileva, 2012; Voelpel et al., 2005) to a neutral one (Hsu and Lin, 2008). There might be multiple reasons for that, some being the differences in a persons' preferences (Vassileva, 2012) and the nature of the rewards, e.g. billable hours spent on learning (Grant, 2013) are perceived differently from redeemable bonus points (Voelpel et al., 2005).

When examining Somewhat External factors, such as positive recognition and status of the expert, researchers came to more coherent conclusions. It was found that recognition and accountability were more powerful motivators than external rewards (Kankanhalli and Tan, 2005; O'Dell and Grayson, 1998; Paik and Choi, 2005) or reinforced significantly the external rewards (Wang et al., 2011). Similarly, being able to build reputation and have the status of an expert was found the most powerful motivation factor among all those examined (Ardichvili et al., 2003; Bordia et al., 2006; Davenport and Prusak, 1998; Hsu and Lin, 2008; Lank et al., 2008), e.g. when experts could choose between retaining bonus points as an indication of their expertise and exchanging them for goods, many of them chose to retain the points (Voelpel et al., 2005).

The other two types of extrinsic motivation – Somewhat Internal and Internal – are not explored in the literature, and this might partially affect the results and priorities that are set among the factors in existing studies.

With regards to intrinsic motivation the results would be obviously positive, and several researchers found that the sense of belonging to a community (Hsu and Lin, 2008) or to a group of people bound with personal ties (Wang et al., 2011), or the sense of *altruism* and enjoyment of helping people (Ardichvili et al., 2003; Hsu and Lin, 2008; Kankanhalli and Tan, 2005) drive knowledge sharing. But this type of motivation is also very fragile and can be coerced irreversibly by an attempt to influence external extrinsic motivation. Knowledge sharing driven by internal motivation occurs in an environment of mutual trust, and thereby face-to-face knowledge sharing happens more naturally and more often, because it is easier to develop trust in this setting (Bordia et al., 2006), which complicates the adoption of KMS.

Technological aspects

Technological factors are studied less extensively, probably because any IT system is expected to be user-friendly and easy to use. But the importance of these aspects has been stressed in the previous section during the discussion about the different levels of IS implementation. A number of studies have found that technology factors have either a positive impact on KMS adoption (Hsu and Lin, 2008), or cause resistance to change if they are difficult to use or confusing (Sultan, 2013). Interestingly, technology can also generate a sense of enjoyment (the conditions that trigger intrinsic motivation), and perceived enjoyment was also found to be an important motivational factor (Hsu and Lin, 2008).

All these factors were reviewed separately, and very few studies attempted to examine their influence on each other, which certainly exists. E.g. a user-friendly interface might affect positively the adoption of a new system, but as was shown in the IS implementation framework of Lapointe and Rivard (2007) in the previous section, the sense of belonging to a community and therefore operating in the same IS might override the resistance to use seemingly difficult software and lead to adoption. And similarly, a user-friendly system does not guarantee success, if the power of a group is threatened. Therefore, more research needs to be done, where these factors will be reviewed in groups, with their relations and effects being examined in the longer run in the context of KM.

As subsequent sections in this chapter show, this topic was often brought up even without interviewees being asked about it. Therefore this section overview primarily served the purpose of informing the reader and myself about the subject matter and preparing for potential directions that the conversations might take. The review becomes particularly relevant in Section 7.3 that answers the third research question about the role of gamification in KM and innovation as it helps to understand how gamification influences KM in particular. This review also demonstrated that attention is not equally distributed among all factors, and this literature deficiency might give higher importance to some factors at the cost of others. Following this point, other KMS literature deficiencies will be reviewed in the next section,

contributing to the understanding of the initial research question and inability to derive answers to it from the existing literature.

The literature deficiencies are derived from the review of four KMS aspects that were covered above. Of these aspects KMS frameworks were the key area, the review of which covers all the sources that could be found. The subsequent topic of KMS types is derived from the KMS frameworks and covers each type in detail sufficient to understand the purpose of each type. Regarding the other two aspects, the review of KMS implementation covers all the sources that could be found, and the review of motivation goes in depth ample to understand the problem matter and to demonstrate the contradictions that exist. Since motivation is in the primary focus of this research, further analysis was not deemed necessary. Therefore, the literature review of this section is considered sufficient to advance the argument further.

3.2.6. Literature deficiencies

The field of KMS is full of challenges and misconceptions, many of which were highlighted in this chapter. The aim of this section is to summarise the deficiencies that were identified in the literature, and demonstrate which of these deficiencies were addressed with the research questions.

Most of the research is based on the successful experience of large companies. On the one hand, these case studies allow observation and examination of a wide variety of knowledge management practices (Gold et al., 2001), but on the other hand, they create a distorted picture by not discussing the context in which these findings are relevant and applicable. Numerous factors can constitute the context, which in turn affects KM related needs of a given company and therefore the selection of KMS types that can support these needs. For example, the industry in which the company is operating might influence the organisational structure. Organisations like NASA deal with complex projects that require a diversity of expertise and flexibility in rearranging teams (Hardash et al., 2014), while service providers rely on their large network of skilled workers, who predominantly work in the field and therefore do not have an opportunity to interact with their colleagues almost at all (Voelpel et al., 2005). Another factor that is related to industry is the generation profile of the industry. For instance, it was mentioned before that oil & gas industry experiences a problem of aging employees close to retirement age, and, as a consequence, they are focused on trying to retain their knowledge (Grant, 2013), whereas many industries such as retail and IT observe an influx of generation Y employees with a very different work attitude (Solnet et al., 2012). But the literature on KM and KMS remains mute to the issues of adapting KM practices to the needs and wants of different generations.

Other factors that might influence the appropriateness of KM practices and KMS types include the size and age of the company, prior experience with KM, national culture etc. For instance, managers in small companies are considered the most valuable intellectual resource as

opposed to the collective knowledge evolving through shared practices in larger companies (Thorpe et al., 2005). In smaller companies knowledge sharing happens more informally and organically and is a part of everyday routines with no need for KMS support (Desouza and Awazu, 2006). And though the research acknowledges the differences between large and small organisations, the studies focused on smaller ones tend to be peripheral. Age is another important parameter and its influence was discussed in Section 3.1.3, but this aspect is neglected in KM and KMS related research. Prior experience with KM could also have an impact on the choices that a company makes, but case studies tend to focus on the results in a specific period of time. And finally, national culture is the parameter that unlike many others has been extensively researched in the literature, either explicitly (Ardichvili et al., 2006), or by acknowledging the observations that were made in the course of the project in a multinational organisation (Paik and Choi, 2005; Voelpel et al., 2005). Therefore there was no need to review this factor in more detail.

If we look at these factors, many of them are related to each other. For example, larger companies are likely to be older, and certain industries such as oil and gas are dominated by larger organisations, and if they are older, they are more likely to have prior experience with KM. At the same time, because of their age they are likely to have employees who have accumulated experience which is valuable for the companies, simply because they had time to do so. Whereas in the IT industry the lifespan of companies tends to be shorter, and so such problems as retaining accumulated experience is less likely to occur. It might also be the case that these industries are less attractive to the older generation, because they are more dynamic and less stable, so that knowledgeable workers with considerable experience are less likely to be found there. The countries in which companies operate might also relate to the other factors. For instance, the divisions of a large organisation that started operating in emerging markets fairly recently might behave like a younger company, and therefore KM practices and related KMS might be adopted and used differently not only because of the cultural differences, but also because of the immaturity of the division itself. These are only assumptions, questions that have no answer in the literature yet.

Coming back to literature deficiencies, most of the literature that covers KMS is presented in case studies, and analyses the experience of knowledge management initiatives in large international organisations, their successes and failures, with the greater focus on the former. The discussion above presented the variety of factors that can affect the choice of KMS, and therefore underlined generic models that could be suitable for any company. It has also suggested multiple ways in which these factors can be related to each other and even dependent on each other, but no attempt has been done so far to review these factors in a more holistic manner to synthesise accumulated experience.

From the above examples we can see that research pays little attention (1) to the less successful cases of KM implementation, (2) the particularities of conditions in which KM

projects are initiated, e.g. prior experience with KM and KMS, and (3) differences caused by the industry specifics and organisational parameters, such as organisational structure, although a separate stream of research acknowledges and investigates the differences in KM and KMS in small companies. In order to address the problem of seeing KM and KMS implementation as a one-off initiative, this research attempts to investigate the KM and supporting KMS as a learning process in which KM practices evolve and KMS needs change with time. With this approach we can also understand how prior experience with KM affects new KM initiatives using the example of several companies at different levels of engagement with KM. The third deficiency is addressed by focusing the research on companies from one sector and with similar organisational characteristics to achieve comparability of the cases through homogeneous context. With this approach it would be possible to find out how KM process should look like for one type of companies and to demonstrate how this question can be approached in other sectors with other types of companies.

The second major literature deficiency is related to the implementation process. The challenges related to the implementation of a KM project have already been discussed in the previous section. This section reviewed research related to the implementation process in the KM and KMS literature, which showed in particular that despite the enormous importance of this aspect to any KM project very little has been done to contribute to the fields of KM and KMS. Addressing this literature deficiency was left outside the scope of this research, but still some of the interviews harvested useful insights that are discussed in Section 6.2.

Among others, a number of researchers criticise KMS research for being too technology-oriented (Leonard and Sensiper, 1998; McDermott, 1999; Swan et al., 1999; Swan and Scarbrough, 2001) but trying to divide the research into techno-centric and socio-centric (Alvesson and Kärreman, 2001) might only take away attention from the core issues. In particular, managing explicit knowledge in the form of documents and reports is hardly possible without an appropriate technological solution, and even though it is not the ultimate goal of a KM initiative, it might be a real issue for many companies. Employees might not require KMS support for knowledge sharing, if they are physically located in one office, whereas if employees are dispersed and work remotely an appropriate KMS becomes an enabler of knowledge sharing. Therefore, social and technical aspects should be reviewed together rather than compared and contrasted with each other. By opening up the possibility that the role of KMS might be changing as KM practices evolve, this research attempts to build a bridge between two approaches and to suggest a more balanced view on the technology aspect of KM.

This section has demonstrated how disjointed and fragmented KMS related research is and outlines the ways to address some of these deficiencies. But the literature review was still not sufficient to draw distinct boundaries for the scope of this PhD. Therefore, in order to narrow down the scope, e.g. to identify the type of companies to be investigated, better understand

the context and find the ways to approach the problem area, I have conducted a series of exploratory interviews with practitioners involved in innovative activities. The revised scope was further refined with KM experts, and the results of these iterations are presented below followed by the discussion of the research question and context.

3.3. Knowledge Management Challenges in Practice

As was mentioned before, the empirical part of this study progressed in stages, starting from preliminary interviews with knowledge workers in technology intensive companies. The choice of companies was mainly defined by access to data and by my previous background, which helped me better understand the context that these companies operate in. Overall I conducted 8 interviews with 7 companies, of which 5 companies were design-intensive engineering companies from the energy sector and were mainly involved in the design or modification of complex machinery, one was a research centre for an aerospace industry and one was a producer of medical equipment. One of the companies was of a small size, 3 companies were medium size and 3 companies were large size. On the one hand, the number of interviews was limited by the access to data by that time, the issue that is discussed in more detail in Section 3.6.1 of this chapter. On the other hand, the last interviews gave an impression of achieving a saturation point, when the issues that practitioners were mentioning became repetitive and the range of ideas was diverse enough to move the research forward. All the interviews were conducted face to face or via Skype, and lasted 40-80 minutes. The recordings were mapped and coded directly.

The main objective of the interviews was to explore KM-related issues that knowledge workers are facing in practice, and to better understand the context in which these companies are operating. The main themes of the interviews were derived from the literature review. Regarding KM, Section 3.1.1 demonstrated the central role of knowledge sharing, therefore the questions were prompted around the issues of collaboration and communication, thus ensuring that the experience that practitioners share is relevant and they are asked the right questions. As was evident from the literature review, knowledge sharing connects other knowing processes and KM practices, subsequently, the discussion around knowledge sharing might lead to discovering other KM related issues, thus providing a more complete picture of the state of KM in each company. Since this research is focused on innovative companies and the support that KM could provide, the interviews examined R&D activities in the form of product development and project management processes in the companies interviewed, as they are an example of innovative activities and provided prompts specific enough for the interviewees to understand what to talk about. At the same time, comparing innovating activities examples of the PDP would allow one to judge whether the context in which different companies operated was homogeneous enough to conduct multiple case study analysis with similar companies in the future. These findings helped to shape the research

context, which is discussed in more detail in Section 3.6.1 of this chapter. Apart from that, I also wanted to gather information about the types of KMS that companies might be using and past experience with any initiatives that involved implementing KMS. Therefore, the main question themes were:

- The phases of PDP
- The phases of project management
- Project team management
- KM problems, e.g. related to the lack of communication or miscommunication
- Learning from projects
- Types of software that is used for project management or internal communication in the company
- Advantages and disadvantages of the software

However, outside these questions the interviews were relatively unstructured, and the interviewees were given a high degree of freedom to change the direction of the discussion. Since all the interviewees agreed to participate and have an informal discussion through a third party (a person that we both knew), they were open to talk about their problems and willing to discuss their everyday activities with me, as well as to share interesting stories from their past experience. Their stories were subsequently aggregated into emerging themes, preceded by comparison of innovating activities within the example of PDP.

3.3.1. Product Development Process and organisational structures

As was mentioned in the introduction to this section, one of the objectives aimed at comparing the companies and estimating the extent to which practices in companies of a similar profile would be different. The companies were asked to describe their PDP of a product and supporting project management practices. The term “product” was used in a generic sense and referred to anything from building a new plant to customising equipment. The interviews were conducted prior to the literature review about theoretical PDP frameworks developed, and this allowed a fresh and unbiased view on the processes and practices. A subsequent overview of the main PDP frameworks that helped to conduct the comparison is presented below.

The most widely adopted frameworks are those of Pugh (1991), Boothroyd et al. (1994), Peters et al. (1999), Ulrich & Eppinger (2000), and Figure 11 shows that the frameworks are not contradicting, but rather complementing each other, because each framework tends to give more emphasis to different stages of the PDP process. The frameworks of Boothroyd et al. (1994) and Peters et al. (1999) are built around engineering design methods and the possibility of product improvement from the engineering point of view. Of the other two the framework of Ulrich & Eppinger (2000) resembles Pugh’s (1991) model but is more detailed. Pugh was mostly focused on the engineering design aspects of PDP, whereas Ulrich &

Eppinger tried to incorporate all the activities in the company that can potentially influence product development. Overall we can see, that the main phases of the PDP that could be derived from these frameworks are: ideation or planning, concept design, detailed design, prototyping and testing, pre-production and production (Figure 11), and these phases can now be compared to the processes used in practice in certain types of companies.

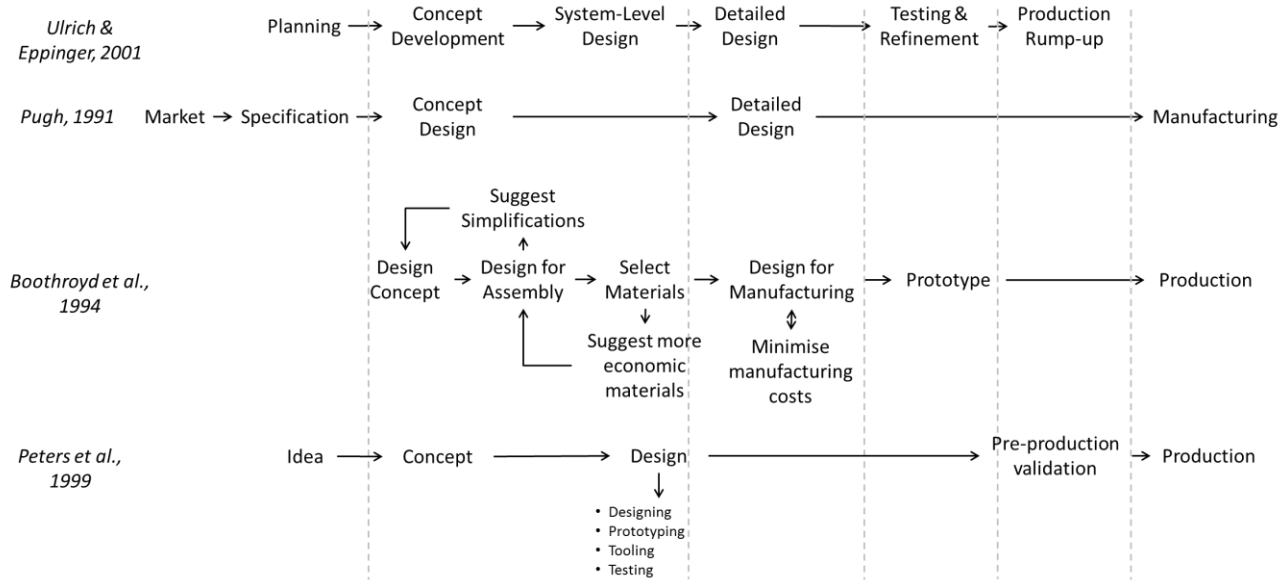


Figure 11. Product Development Process frameworks.

The processes that the interviewees described were mapped using the DFD method, which was presented in Section 2.5.1. It was only possible to build a very detailed diagram which involved all the sub-processes for each phase of the PDP for one company, but this example was shown to the interviewee during the second interview in order to verify the map, and the participant confirmed that the map was accurate. This could also indicate that my interpretation of the processes in other companies must have been correct as well. The processes maps are presented in Figure 12.

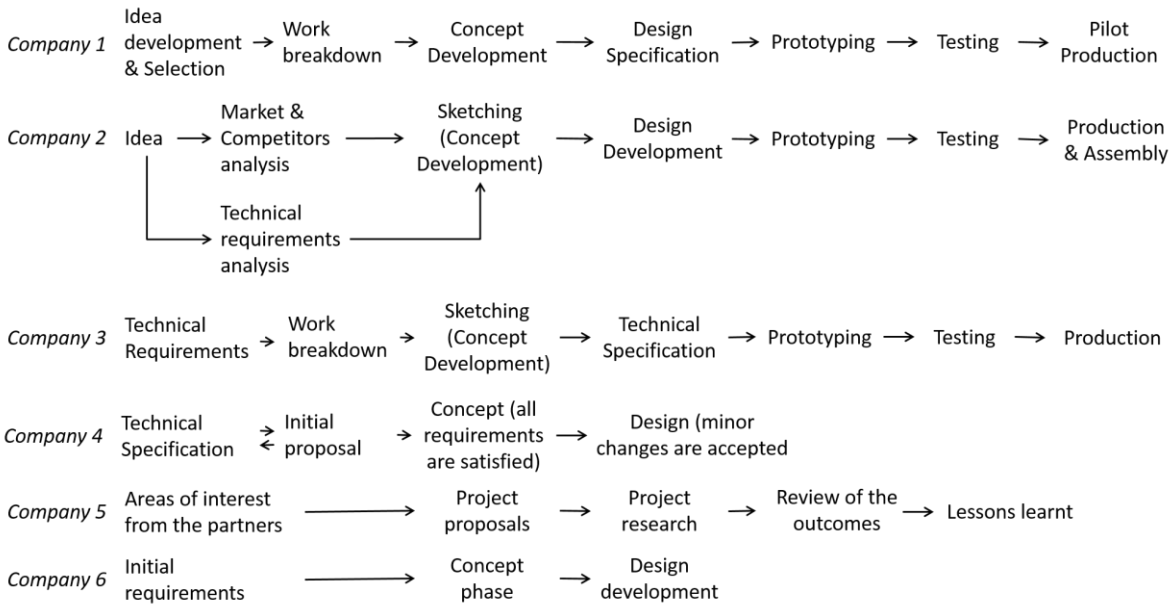


Figure 12. Product Development Process in practice.

Of the seven companies interviewed, six described the DPD at a level of detail sufficient for the comparison, while one company interpreted it as a project management process and highlighted the management milestones rather than the phases of product development (Company 5). The reason for that might be the fact that it is a research centre, it deals with the product design at a very early conceptual phase, working on new materials or new manufacturing methods before they become a final product, and so its process is rather different from the process of other companies. Of the other companies the first two were the initiators of a project, while the remaining three were working as subcontractors, and by comparing their processes we can see that they differ only at the beginning – the subcontractors receive technical requirements as an input from the initiators of the project after the idea has gone through the first phase of its development.

If the processes that were described during the interviews are compared to PDP frameworks in the literature, one can see that they overlap with all the frameworks and resemble that of Ulrich & Eppinger (2000) the most. The figure above also shows that the processes are quite similar to each other: they all start with the ideation phase or receive a set of requirements instead, then they develop a concept followed by detailed design. Of those companies that specified the process further all of them complete prototyping and testing and finish with the production phase, though one company also conducts a pilot production, which might be due to the type of the product they are making. Unlike all the other companies (except the research centre) that develop or customise unique products, this company develops products for a small serial production, and therefore the manufacturing process has to be tested as well.

The comparison of PDP demonstrated a great degree of similarity, therefore indicating that the companies of interest operate in a similar mode. But it was also possible to analyse the

organisational structure, in order to explore the context further. The organisational structure refers to the configuration of the different parts of the organisation and defines the rules of interaction between them. Though there are a number of classifications of the structures, the most widely adopted one is the structure in 5's by Henry Mintzberg (1980), which was mentioned in one of the dimensions of the implementation framework of Lapointe & Rivard (2007). It is based on such parameters as the level of standardisation of processes, unit grouping, level and direction of decision making centralisations, each of which can potentially indicate the type and level of KM support required.

Among the five structures, high-end technology companies are most likely to work as an adhocracy, because this structure supports a high complexity and a high level of dynamism of the environment (Mintzberg, 1980). However, companies with formal R&D groups tend to be structured as machine bureaucracies or divisionalised forms (Tidd et al., 2005), but these configurations are viable in less dynamic environments (Mintzberg, 1980). Similar patterns could be observed in the companies that were interviewed. Of the seven companies, six were structured as adhocracies and one had an R&D department in a divisionalised form with some elements of adhocracy in it. These findings helped to specify the sample of companies that were targeted for the principle investigation, and the types of companies that participated is discussed in more detail in Section 3.6.1 of this chapter.

In Section 3.1.3 it was discussed that the literature does not provide empirical evidence of the influence of the structure on the level of innovativeness of the company, but it can certainly influence the dynamics among the people inside the organisation, which might in turn affect KM practices that are more appropriate for a particular organisation. For example, it might be easier to attract diverse expertise into a project in an adhocracy setting than in a divisionalised form, and these issues are discussed in more detail in the next section.

3.3.2. Emergent themes

From the analysis above one can see that companies that are involved in the development of complex products tend to have a similar approach to PDP, which also enables the reuse of past experience derived from the supporting documentation of past projects, if systematic documentation is maintained. When the topic of reusing past experience and taking advantage of the appropriate documentation was raised with some of the companies interviewed, three of them confirmed that reusing past projects (up to 95% of a given project) was a common practice for them. Two companies had their projects stored and properly catalogued, while in one company referencing of past projects was done by the director of the company, and this practice was viable because of the size of the company.

In all the companies each product development project was delivered by a team, and team management was another topic that was raised during the discussion of PM practices. One of the two larger companies mentioned above shared their experience of tracking and reflecting

on the project management process in great detail with the support of specific PM software. For example, project team members could add comments that explain the reasoning behind each decision and attach emails that confirm agreements with clients. Good practice, combined with the widespread adoption of this practice, enabled a smooth transition if team members were to change. And these findings also indicate that knowledge workers of the chosen companies are most likely to be within the same category of knowledge workers. If we employ the framework of Davenport (2005a), they will be located between the enacted and collaborative workers, since they rely on collaboration, but on the other hand their work can be replicated and made explicit to a certain extent, making the codification of their knowledge and further reuse partially possible (Hansen et al., 1999).

The interviewees from other companies were more inclined to focus on problems, possibly because three of the four companies were somewhat familiar with the term KM. One of the problems that seemed quite frustrating for the interviewees was the lack of visibility of the work, and while for one of the companies it meant lost opportunities due to the lack of interaction between different departments that were approaching the ideation phase from different perspectives, and therefore there was lack of synergy in their effort. For another company the consequences were more severe – a conflict of interests and lost projects. For example, project managers could participate in different tenders, which were part of the same large project, but they did not know about each other's applications, and thus could not benefit from cooperating and offering a better and cheaper solution as a service pack.

Another problem was related to the engagement of specialists in PDP, but it was mainly observed in the company that had clearly defined departments, where participation in PDP was not part of the main responsibilities of some knowledge workers and was treated as an extra activity that only more enthusiastic employees would engage in. However, the companies that were operating in on adhocracy setting were most likely to formally involve required specialists, and the problems that they were facing were more likely to spread beyond the boundaries of a project. For instance, they would neglect or overlook the impact of the problems in their project on the work of their colleagues, because these problems did not affect their project directly, but they could have a wider impact.

The companies that experienced fewer KM related problems also emphasised the importance of lessons learnt, therefore benefiting from KM practices. Whereas one company, in which engineers and project managers treated lessons learnt as a formality, experienced a wide range of KM related problems. Though the former recognised the importance of lessons learnt, they approached this practice differently. One of the companies analysed each project from both technical and managerial aspects, and developed an action plan to address the problems that occurred and avoid repetition. Another company focused mainly on technical problems, which were then gathered centrally and addressed through the set of new industry norms. Another company aggregated lessons learnt during quarterly meetings, which proved

to be very effective, as lessons are usually learnt by the participants. The difference in approaches might be due to the scale of the projects and specifics of the company, but the importance that the companies place on these activities and the fact that they made a better impression as companies with better KM practices, confirm that lessons learnt are an important aspect of KM.

As a general observation, I could see that most of the practitioners had only a very vague idea of the meaning or purpose of KM. For them, KM was mostly associated with document management and less so with problems of knowledge sharing. Some of the companies had prior experience with KM projects, which were however unsuccessful. The small company spent two years creating a virtual working space platform, but the resulting solution did not bring any benefits, because their engineers were interacting with each other anyway. Another company attempted to implement a wiki to share updates and recent developments in the department, but no one adopted it, partially because the interface was not user-friendly, and partially due to lack of support from management. As a result, it lacked sufficient engagement to turn it into a powerful bottom-up initiative (Brown and Duguid, 2000), while it was also not considered an important initiative top-down (Grant, 2013). Another company tried to implement a document repository to create a cycle of knowledge, which had limited potential and did not transform the organisation, as was promised by Nonaka and Takeuchi (1995), but curiously, this company has already had a widely used CSN in place, which generated heated online discussions and ideas for new projects. However they however did not see this as a KMS.

One company implemented a maturity model for KM, which was consequently added to the scope of the project as was described in the introduction. Though the interviewee saw this model as a success, it was admitted that it had a limited potential due to the lack of budget to support its implementation in other divisions. KM started as a pilot project and never expanded, but pilot projects can demonstrate only very limited results, while the real impact grows exponentially as the scale increases (Liebowitz, 2001). This challenge was noted in Section 3.1.4 of this chapter, and this example illustrates and confirms it very vividly. However, this approach intrigued me, and this finding along with others had an implication on the progression of this research.

After having analysed these interviews I continued reviewing the literature and exploring some of the topics raised by the interviewees, in particular maturity models and the potential of using them for KM. This and other ideas were brought to KM experts for review when an opportunity occurred. As a result, these interviewees helped me refine the research design of the multiple case study, and brought to light a lot of interesting ideas that are described in the subsequent section, some of which are discussed in more detail together with the findings from the case study interviews.

3.4. (Dis)connection of Theory and Practice in KM and KMS

During the second year of my PhD I met with three experienced knowledge and innovation management practitioners through a KM LinkedIn group. It was not the original intention to include these interviews in the research design of this study, but talking to knowledgeable practitioners was an opportunity to validate ideas and receive their opinion about this framework. One of the practitioners was working as a KM manager in a large oil and gas company and was the initiator and developer of a KM program in that company. The second practitioner was working as an innovation management consultant, and had experience of implementing ideas management systems in a wide range of companies and industries. And the third practitioner was specialised in open innovation, and had experience of implementing ideas management as an open innovation initiative internally in a number of companies. Since my understanding of the KM field had advanced by that time, it was possible to have broader discussions and engage with topics that would have escaped my attention a year before. All the interviews were conducted face to face and lasted 90-120 minutes.

The interviews with them turned out to be much more interesting than it was originally anticipated. Firstly, these practitioners demonstrated that they understood perfectly well the difference between KM and innovation management, and the synergy between the two, and therefore they are referred to as experts in this study. Secondly, they mentioned various topics such as cultural differences, and could support their views on this matter with examples. Thirdly, they could link the field of knowledge and innovation management to a wider landscape of fields, such as noting the difference in corporate culture in different countries as the result of differences in regulations. And finally, some of their ideas had a profound effect on this research; in particular gamification and its relation to knowledge and innovation management became a new strong focus of this research. Since the interviews were unstructured, they were analysed by making sense of their judgement and examples. This section discusses the major themes that evolved during the interviews, followed by the aspects of KM that were either strongly supported, or in disagreement, or absent in the KM literature.

3.4.1. Practitioners view of Knowledge and Innovation Management

Despite the differences in the focus of the experts (KM or innovation), they have a good understanding of the boundaries of KM and the overlap with innovation. However, it seems that most of the companies that they are familiar with do not distinguish between the two. And quite often the practitioners do not favour the label of KM and try to disguise it under different names, such as continuous improvement, lean production or ideas management. And this observation resonates with the opinion of Prusak, who suggested that new researchers and practitioners in KM try to distance themselves from it and create new labels, such as social computing (Lambe, 2008).

Experts also understand the huge value of KM regardless of the industry. Their examples included a bank that earned $1.2 bln by working with new ideas only, or a new CSN that allowed one oil & gas company to save $3 bln in 4 years. These results were achieved by improving interactions between different divisions, so that they could quickly respond to urgent requests in the case of equipment failure, or provide feedback about a new product from a new supplier, which has already been tested elsewhere. And the cost of installing this system and training the employees was $3 million.

However, in their opinion, the approach to KM differs substantially between different industries, mainly because of the differences in generation profile and core work. In particular, industries like retail and telecom tend to have a larger proportion of employees from the Y generation, who need constant change and want their work to be interesting, while more technology-intensive industries like oil & gas employ a larger proportion of older generations, who have different working approaches and different priorities. With regards to the core work, retail and telecom mainly work with clients, whereas high-end technology companies work with technology, and so the latter tend to focus more on explicit knowledge.

Another aspect that was mentioned by all three experts was the role of different levels of hierarchy in the company. The experts acknowledged the important role of both top management and personnel, because without support from the top it will be hard for any bottom-up initiative to take off, and similarly any initiative from the top can fail when facing resistance to change and scepticism from the employees. However, they also acknowledged the importance of middle management. Firstly, because quite often the initiatives that come from the top are delegated to subordinates, who if not interested, will most probably not spend time and effort trying to perfect the initiative. Secondly, because middle managers have direct influence and control over employees, and if their employees are to spend time on non-job related activities, middle managers need to be educated about it. And thirdly, because they are likely to get involved in decision making processes, such as filtering good ideas and providing feedback, or praising employees for a valuable contribution in a new initiative, and they need to be educated about these aspects as well. The former is relevant not only to middle managers, but to all the experts that are involved in this process, if they are to provide feedback to the participants. Their feedback might encourage or, on the contrary, discourage employees from further participation.

Opinions in academic literature vary. On the one hand, researchers acknowledge the importance of top management support (Liebowitz, 2001; Paik and Choi, 2005), while on the other hand, a bottom-up approach can also drive KM forward (Brown and Duguid, 2000; Vaast, 2007), whereas middle management is seen as a key component in any system (Mintzberg, 2009). However, experts emphasize the importance of all three levels, while researchers tend to compare and contrast them, trying to find the key to success, rather than seeing them as parts of the whole.

Following the involvement of all levels of hierarchy in any initiative, all three experts praised ideas management as one aspect of knowledge management, and a very important one indeed. Apart from bringing an obvious benefit of collecting new ideas that a company can capitalise on, ideas management, and ideas competitions in particular, can have many positive side effects:

- Ideas competitions democratise ideas sharing and partially level the hierarchy, especially in large organisations, since ideas can be submitted directly and do not have to pass through sceptical middle managers.
- Ideas competitions improve knowledge sharing, if employees are invited to participate in the selection of ideas (e.g. rate the ideas of each other and comment on them).
- Similarly, work visibility is improved, because employees learn about each other's activities. As a consequence, improved transparency increases trust, which can have a positive impact on knowledge sharing (Davenport and Prusak, 1998).
- Ideas competitions help to study problems in the organisation, because ideas can be solutions to small problems that are symptoms of a larger problem.
- And finally, ideas competitions help to change the corporate culture towards being more innovative.

Ideas management is associated with innovation, but ideas might be of a different nature, not always classified as innovation according to the definition provided in the literature review. One of the experts suggested a different way of looking at ideas based on the result and the process. Depending on the result and process being known or unknown, ideas can be classified into four categories: improvements, adoption (e.g. best practices), adaption (e.g. benchmarking or reverse engineering) and innovation, and seeing ideas through this framework helps to think about different types of ideas that might follow, and therefore, different requirements that should be developed for them.

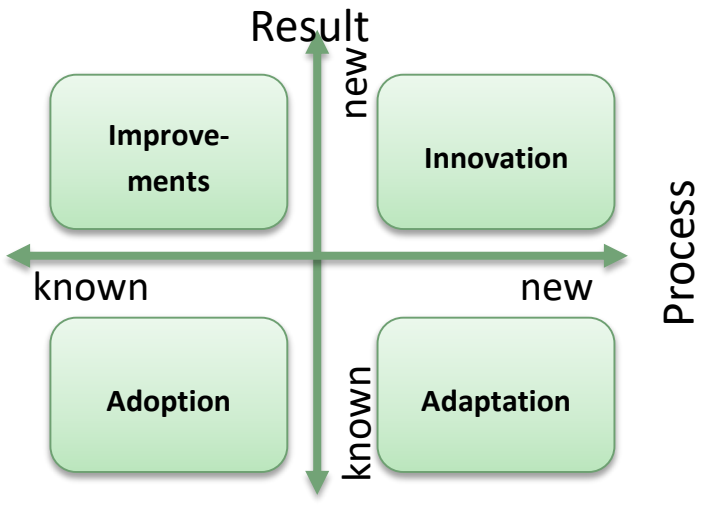


Figure 13. Classification of new ideas originally developed by one of the experts and adapted in this research.

Another aspect that all three experts discussed mainly in the light of innovation management is motivation, but their insights were somewhat contradicting. One of the experts found experimentally that in order to attract people to participate in open innovation, one needs to offer a monetary reward, and in order to encourage ideas of high quality, one needs to add a non-monetary reward (such as prestige or status).

Another expert was very critical of material rewards and advocated that experience rewards are much more effective in the longer run, since they cannot be accumulated. On the other hand, from the experience of this expert, bonuses proved to be effective as an acknowledgement of an overall contribution.

"…the job that he needs to do anyway, he can do it better…"

The third expert provided contradictory examples as well. On the one hand, when one nuclear factory compared the quality and quantity of ideas in two divisions, the nominal value of the vouchers (1000 vs. 5000 units) did not make any difference. On the other hand, the experience showed that knowledge workers were more motivated to participate in the call for open innovation, when they were offered a substantial reward, rather than a breakfast with a CEO or a small gift. However, this opinion contradicts with the experience of the second expert, who has seen contests generating a very negative and competitive dynamic when the prize was of particularly highly value (a car or a flat).

These findings showed that two of the three experts themselves do not have a clear understanding of the best motivation mechanism and had contradictory experiences. This indicates that motivation is a complex construct with many parameters influencing it, and therefore fitting it into one of the frameworks suggested by the researchers would not be possible.

Finally, the last aspect that was extensively discussed by all three experts is corporate and national culture, and their impact on KM. In particular, corporate culture was highlighted as the most important aspect for any initiative, and open and creative culture cannot be borrowed from a consulting company, but it can be influenced, e.g. through an idea competition, since it creates a cluster of innovators, who become local ambassadors of innovative thinking.

With regards to national culture, the opinions of the experts varied substantially. On the one hand, they disregarded national culture and backed up their opinion with the research of large consulting companies, such as IBM, that found that innovators are poorly regarded everywhere in the world (IBM, 2006). On the other hand, the experts provided examples in which the differences are quite notable. For instance, the system of acknowledging practitioners for contributing to the best practices might work perfectly well in the oil and gas industry in the US, whereas in Russia practitioners would try to play the system. Furthermore, the acceptable rate of successful ideas in Europe is 4%, while in China the rate is much higher,

because employees offer only workable ideas. Previous studies demonstrated that the same approach works very differently, e.g. in Accenture in America and China (Paik and Choi, 2005), or in Siemens in Germany and India (Voelpel et al., 2005), or on the contrary, seemingly different cultures demonstrate similar behaviour in Caterpillar in Russia and Brazil (Ardichvili et al., 2006).

These findings broadened the range of themes that could be explored during the interviews for the multiple case study, e.g. the effect of cultural differences on the interactions between colleagues in the international companies. Some of the insights are in disagreement with the literature, and are explored further during the discussion of the main results. Other themes became increasingly important, for example, ideas sharing as one aspect of knowledge sharing, and they directly contribute to helping in answering the first research question about the KM needs in innovative companies. One of the themes, gamification, was considered particularly important since it is not mentioned in the KM literature and only started being noticed in the innovation literature, but was brought up by all three experts. It was therefore decided to add it to the scope and explore its role in KM and innovation as is reflected in the third research question, and the remaining part of this section elaborates further on this aspect. Regarding the technology, interviewees mentioned a few interesting examples of using KMS for collaboration and less successful examples of using document repositories. These stories did not help to advance the second research question much further, therefore extra emphasis was put on these aspects when designing the interviews for the principle investigation.

To summarise, this phase of the research helped to progress answering the first research question forward by emphasising the importance of ideas sharing as one of the key KM practices in innovative companies. The interviews provided example of using various types of KMS, which were then prompted during the interviews with practitioners to help in answering the second research question. And finally, the interviewees opened up a new area of research – the use of gamification in KM, which became the third research question and is discussed in more detail in the following subsection.

3.4.2. Gamification as a next step

As was mentioned before, gamification was not in the original scope of this research. However, all three experts mentioned this approach or described some elements of it in their work, independently from each other. As a result, I could see that gamification could have a profound impact on KM and most probably will, and I became curious about the potential synergy between the two.

A company described by one of the experts was using a simple mechanics of rating or pledging for new ideas on the innovation platform and commenting on them, which encouraged the participation of not only those who had an idea, but also everyone else, since they could contribute to the campaign by sharing their opinions. As a result, the innovation campaign helped to improve visibility of the work: representatives of one department could share information about their activities and projects, if a similar idea has been suggested by someone else. A similar approach was implemented in another company – an oil refining factory, where this mechanics boosted enthusiasm among the employees.

Another company implemented a slightly more sophisticated system internally, and this innovation was mainly driven by the desire to create a more flexible motivation mechanism. The company implemented two types of points: innovation points and virtual currency, of which innovation points symbolised an expert status and were accumulated, and virtual currency could be redeemed in the online shop for different goods. This system aimed at influencing both intrinsic and extrinsic motivation, because as the company argued not only are people different, but also the same person can be motivated by different things at different points of time. The points were granted for different types of activities, such as sharing an interesting experience or a new idea, or helping to solve an issue raised by others, and adjusting the value of each activity indicated to the knowledge workers what activities were considered more important at a point in time.

These are simple and interesting examples, as they show that gamification can improve work visibility and encourage knowledge sharing, but they could be just the tip of the iceberg, and a much greater potential of gamification is yet to be unveiled.

3.5. Implications

This chapter introduced the reader to the field of KM and KMS, and provided an overview of the topics that were subsequently explored during the iterative cycles of the interviews with practitioners and experts. The literature review of the field of KM explored what is known and what is unknown in the field, and concentrated on three areas that could potentially help understand the approaches to selecting KMS: knowing processes, knowledge workers and the relationship between KM and innovation. In addition, the overview of the challenges in KM suggested the range of problems that are being discussed in the literature. The literature review of the field of KMS covered all the major aspects of it, and the overview of the literature deficiencies opened up a big range of topic that could be explored further. It was difficult to relate KMS types to the findings in the KM literature, and this created the need to step back and better understand KM needs and underlying context in the real world, while at the same time trying to relate them to KMS, and this search resulted in a number of preliminary interviews.

The exploratory interviews mainly targeted technology-intensive companies as companies that represent knowledge-intense environment, and aimed at understanding the problems in KM that practitioners face in real world, and the specifics of the work, e.g. business processes. As a result of these interviews, I was able to compare the PDP in different companies and to confirm that the approach to developing a new high-tech product is similar in different companies, and therefore could be used as a background context for studying KM practices in the multiple case study. A refined context of this research is discussed in more detail in the next section of this chapter. These interviews also helped identify themes that should be explored further in the main empirical part of this research, e.g. the problems that the practitioners were concerned with, such as visibility of work, the importance of lessons learnt and different approaches to them, and the influence of common working practices on knowledge sharing. A refined research question is discussed in Section 3.6.2 of this chapter. Apart from that, the interviews have opened a new area for exploring maturity models, which could become the basis for the KM model that I was to develop. As was described in Section 2.6, this model was at the centre of the survey that the companies were asked to fill in during the multiple case study.

The interviews with experts in knowledge and innovation management were much more diverse, since they were not bound by any specific issues or topics other than KM and innovation. Not surprisingly, the experts emphasised the importance of KM, but they supported it with more recent statistics from their experience. They have also suggested that KM and innovation are largely overlapping areas influencing each other. They touched on many topics such as motivation, the role of different hierarchical levels in the organisation, ideas management with its purpose, outcomes and influence of KM, and the role of national and corporate culture, but their opinions were contradicting with regards to some of these subject matters. Most of the contradictions were observed in relation to motivation, but these experiences only prove that motivation is a complex construct, which is difficult to fit in a neat and tidy framework. Section 6.2.4 elaborates on these aspects in more detail in relation to the results of the main interviews. None of the experts mentioned the maturity models for KM, but one of them described the natural progression of KM, implying that KM matures through time, which shows that identifying levels of maturity in one way or another should be possible. Apart from that, all three experts have mentioned gamification as an additional tool that could be successfully used in KM. This finding has moved me further in this direction and eventually led to an exploratory case study of using gamification in the corporate environment, and the effects that it might have on knowledge workers, which is presented in Section 7.2.

From the general observations of both rounds of interviews, some of the themes that are reflected in the literature have already been mentioned in the previous part of this section, such as the new labels that practitioners are trying to disguise KM behind, hierarchy in the organisation and top-down vs. bottom-up approach, or the influence of national culture on

KM initiatives. But we can also see that the literature remains ignorant of other interesting findings. The literature mostly discusses KM and innovation separately, or acknowledges that KM supports innovation (Swan and Scarbrough, 2001), but these interviews showed that these two are largely overlapping, mutually supporting and probably inseparable from each other. For instance, ideas contest is widely researched as an approach in open innovation, but it proved to have a positive impact on knowledge sharing, and the academic literature does not explore this practice as a part of KM. Ideas contests could potentially become a new approach for facilitating the creation and sharing of best practice or the creation of a library with solutions to potential problems. This example reinforces the decision to look at KM and innovating practices together as they seem to be inseparable from each other in innovative companies, and brings us closer to answering the first research question. Therefore, the synergy between KM and innovation needs to be explored further.

3.6. Formulating the research questions

The analysis of the preliminary interviews helped to specify the type of companies for further investigation in order to find a relevant sample of cases. It emerged that companies from the energy sector that are involved in the development or modification of complex products are likely to have a similar approach to product development and a similar organisational structure. These boundaries influenced the types of KM problems that they might have, and therefore the KM practices and KMS support that they might need.

The experts helped to confirm some of the assumptions. In particular, they mentioned the differences between the industries and the impact that these differences have on KM initiatives and priorities, and this finding supports the decision to tie the sample to the industry. As a result, the area of search for participants was limited to the energy sector, as explained in more detail further in this section, followed by the formulation of the research question.

3.6.1. Research context

When trying to understand the research context and approaching the selection of companies to sample in particular, scholars try to achieve a good representativeness of the sample. To do so, they select various approaches to sampling, such as probability sampling, purposive sampling, or mixed methods sampling (Teddlie, 2007). These methods are usually associated either with quantitative (probability sampling) or with qualitative (purposive sampling) research, but all of them aim to achieve the representativeness of the sample to ensure validity and enable generalisation of the results. This approach does not always help to answer the research questions due to the wrong assumption about the representativeness itself. When studying complex phenomena like KM or innovation, one usually deals with the complex meaning of a subjective nature (Tsoukas, 1989b), which is difficult to interpret and

impossible to quantify since an attempt to generalise the subjective meanings is inadequate (Argyris, 1979). Therefore, the researchers should look at the informative and relevant cases, rather than try to provide a statistical validity (Stierand and Dörfler, 2011), and this approach to choosing the cases was employed in this research.

There are three types of validity which are relevant to qualitative research: construct, internal and external validity, where construct validity ensures the truthfulness of the data and is usually associated with data collection, and the other two types are associated with data analysis. The internal validity is concerned with convincing logical reasoning, and external validity focuses on the problems of generalizability of the underlying construct (Gibbert et al., 2008). Since this part of the chapter outlines the data collection phase of the research, the discussion will be focused on the construct validity, which incorporates the choice of the companies themselves and the methods employed, and will be covered in the following sections.

The type of the companies, apart from being innovative, was partially shaped by the literature review and further refined during the first phase of the data collection. During the initial phase of the literature review one of the strategies employed was to analyse case studies of the experience of world leaders in KM according to The Most Admired Knowledge Enterprises (MAKE) Award, which was mentioned in the introduction. The award was considered credible because the KNOW network employs a rigorous method to identify the winners, and the importance of this award is acknowledged by KM gurus such as Laurence Prusak. The committee uses the Delphi method, for which experts are chosen from senior executives of Global Fortune 500 companies and leading experts in knowledge management, innovation and learning organisations. Invited experts nominate companies, then they select the 3 most prominent companies in their opinion, and finally the selected companies are evaluated by at least 5% of the experts against eight criteria: knowledge-driven culture, senior support, innovation capabilities, value of intellectual capital, knowledge sharing environment, learning organisation environment, customer/stakeholder KM, and transformation of knowledge into value.

It was interesting to note that most of the enterprises in the list were consulting companies (Ernst & Young, McKinsey & Co) or technology intensive companies, for example in the oil and gas industry (Schlumberger, ConocoPhillips) or electronics giants (Samsung, Siemens). Therefore, it is worth looking at the experience of other companies in these industries as well. Apart from that the KNOW Network uses innovation as one of the evaluation criteria, which indicates that for these companies innovation was important and inseparable from KM.

Though this award indicates the types of company where KM is appreciated more, and therefore the effort to improve KM will be valued more, the sample of the companies might be biased towards large companies with enormous budgets, which could be spent on KM. One would not find advertising or design agencies there, thought this does not mean that KM

is of less importance to them. They will never even enter the competition simply because of their size. But these remarks are just assumptions, and so it was worth comparing the experience of the winning companies with the experience of other companies operating in the same field. And since the initial contact with the companies was biased towards technology-intensive companies, companies of this type could be considered relevant cases, and my prior experience with these companies allowed me to better understand the context around their work.

But why the energy sector? Firstly, the need for better knowledge sharing is relevant to any company, but it could be best observed in innovative companies, because the innovation process lies at the core of their activities and is knowledge intensive. The energy sector could be a representative industry because it constantly faces technological challenges and ambitious goals ahead, and therefore it could be a suitable place to look for innovative companies and observe the knowledge sharing phenomenon.

Secondly, analysis of the initial interviews revealed differences in the organisational structure. Companies that are involved in the development of highly complex products tend to work in Engineer To Order (ETO) mode as opposed to Make To Order (MTO) or Assemble To Order (ATO), and in this mode much lower importance is given to supply chain processes (Childe et al., 1994), or these processes are equally important, but due to the complexity of the product their 'decoupling point' is shifted to the design stage, and so they are treated differently (Gosling and Naim, 2009). The interviews demonstrated that engineering companies tend to work in ETO mode due to the nature of their product being unique and tailored to the specific project and specific conditions. Other companies had traditional R&D departments and were more likely to operate in ATO mode.

As a consequence, the companies from the energy sector that were interviewed are most likely to work as an adhocracy, because this structure supports the high complexity of the products and a high level of dynamism of the environment (Mintzberg, 1980). However, in the companies with formal R&D groups these departments tend to be structured as professional bureaucracies and be embedded in the matrix structure in large organisations (Tidd et al., 2005). PDP in adhocracies is blended with project management, which had an impact on the type of questions that interviewees were asked during the principle investigation. And as an implication for the issue of sampling, it was more likely that there would be more homogeneous companies in the energy sector from the point of view of their operations setting. These companies had blurred borders between departments where constant involvement in interdepartmental projects was the norm. Therefore problems related to getting necessary specialists involved in the projects, that one of the companies during the preliminary interviews experienced, were less likely to occur. This structure creates different dynamics between knowledge workers and thus is likely to affect the KM practices that could be observed or were required.

Perhaps the findings in this research might be applicable to engineering companies outside the energy sector, but I decided to limit the sample to companies that are both design-specific and in the energy sector so as to reduce the amount of effort required to study the background context and prepare for the interviews.

Apart from the industry the companies were filtered by the number of employees. Of all the companies interviewed during the exploratory phase, one company employed 10 engineers, and all the other companies employed 100 people or more with a minimum of 25 engineers in a product development team. The experience of the small company was quite different from the others, and this finding correlated with the literature's stand on KM in SMEs. As was discussed in Section 3.2.6 of this chapter, the needs of the smaller companies might be different from that of the larger ones, so it was decided to adopt the European Commission classification of company sizes (2005) and to limit the sample to companies of medium and large size, 50-249 employees and over 250 employees respectively.

This part of the section outlined the profile of the companies for the main empirical part of the study. The related issue of the sample size is discussed in Section 5.1.1, prior to the overview of the multiple case study results, and the remaining part of the chapter formulates the research question that was driving this study further.

3.6.2. The research questions

The literature review of KM along with the exploratory interviews provided a range of KM needs that could be potentially related to KMS. But the analysis of the interviews also suggested that different companies have different levels of involvement in, and experience with, KM and therefore their needs might be different. This hypothesis was supported by one of the experts, and as a result the aim of this research transformed into trying to understand the evolution of KM in a company, complemented with gamification as a potential next step in this evolution. Therefore, the aim of this research can be formulated in three research questions:

1. *How do the KM needs of technology companies involved in innovative activities evolve with time in the context of PDP?*
2. *How can technology, especially with respect to KMS, be used effectively to support these needs?*
3. *What role might gamification play in the future of KM and innovation?*

The following four chapters represent four attempts to answer these research questions. *Chapter 4* presents a failed attempt to answer the first question by building a maturity model

for KM that could become the basis for the consequent analysis of the interviews. Through analysis of the survey it was not possible to find expected relations between PDP maturity parameters and KM / KMS parameters, so there was no ground for using the maturity model framework for KM any further. The negative results became the first contribution of this research, by questioning maturity models as an appropriate framework for KM and suggesting that the hierarchy of the parameters of the process maturity model needs to be investigated further.

Chapter 5 presents the second attempt to answer the first question through the analysis of interviews with the participants of the multiple case study, which resulted in the development of the organic roadmap of KM – a model that describes the KM needs of innovative companies in the energy sector and demonstrates how they evolve with time. This model is the second contribution of this research by suggesting the evolution of KM practices in an organisation which is derived from changes in needs, and suggesting that KM should be seen as a learning process rather than a one-time initiative, an opinion that has been expressed before (Davenport and Prusak, 1998), but is not widely reported among practitioners.

Chapter 6 presents the continuation of analysis of the interviews and answers the second question by describing the role of technology in the KM roadmap and characterising the types of KMS that are appropriate at different phases, and their purpose. These findings become the third contribution of this research, since the technology part of the model does not demonise or praise KMS, but rather indicates the instances where their use is appropriate and necessary, and characterises the types of KMS that were found useful in these case studies.

Chapter 7 answers the third question and demonstrates the impact that gamification might have on KM through the illustrative case study, and on innovation through the literature review and subsequent discussion. These findings are the fourth contribution of this research because they discover a new area of research by unveiling the hidden potential of gamification in KM, and suggest a range of directions that further research can undertake.

4. Building a Maturity Model for Knowledge Management

The previous chapter laid foundation for the multiple case study analysis, and the first part of it, namely the survey, is discussed in this chapter. The topic of maturity models (MM) emerged when it was recognised as a framework to help develop KM recommendations for a particular type of company. This framework was used by one of the companies interviewed in the early stage of the research, and it proved to be useful as a tool for a periodic KM "health check" in that company. However, it is important to note that this model was developed by a one employee specifically for this company. This turns out to be a significant drawback when such models are generalised, as will be seen from this review.

As is shown in this chapter, the review of this field has demonstrated that existing MM developed for KM have a number of significant drawbacks, and therefore cannot be used in this study. Subsequently, the survey that was conducted as the first part of the multiple case study was an attempt to partially answer the first research question regarding the KM related needs in innovative companies in the energy sector, and changes in needs with time, and build a structure for the interview analysis. However, the results of the survey analysis, presented in this chapter, did not support the initial assumptions, forcing me to look for a different approach to the interview analysis. This resulted in employing concept mapping as a way of structuring the interviews themselves, which was described in Section 2.5.4.

This chapter unfolds as follows. To have a better understanding of this field, it starts with a literature review by tracing back the origins of the framework, presenting examples of successful MM applications and analysing existing MM in KM. Then the chapter provides more details about the methods that were used for the analysis and that were described in Section 2.7. And finally it presents the results of the survey analysis and discusses the implications of the results.

4.1. Overview of Maturity Models

The first MM was developed by Crosby (1980) to help quality managers assess operations in question against the quality matrix and start an appropriate investigation if the evaluation outcomes were not satisfactory. It was called a Quality Management Maturity Grid and was developed primarily as a recommendation for quality managers with little or no experience to give them some guidance and help them learn. The model consisted of five maturity levels and six parameters on each level which were evaluated against these rates; the total score indicated the overall maturity level, and the parameters with the lowest score showed areas for improvement.

A decade later the MM framework caught the attention and was widely adopted in software development, where it was primarily used as an approach for continuous improvement (Paulk et al., 1993) or as an assessment tool (Fraser et al., 2002). In 1987 the Carnegie Mellon

Software Engineering Institute (SEI) developed a Capability MM (CMM) (Humphrey, 1987) which evolved into CMM Integration (CMMI) Version 1.1. The model was so successful in this industry that it became an industry standard in 1993 (Davenport, 2005b; SEI, 2002), competing with ISO, but later SEI and ISO collaborated and created a common standard known as ISO 15504. However, the CMMI standard remains an independent and widely accepted assessment tool in the software development industry. With the dissemination and adoption of this model the software development process was improved significantly and later standardised, which helped to boost the development of software companies in China and India and raised the level of quality within the industry worldwide (Davenport, 2005b).

Apart from providing obvious benefits that are discussed later, this model became successful partially due to the support of the U.S. government, the independence of the model developer from commercial organisations, and availability of free detailed supporting documentation that clarifies the interpretation of the model and its application (Davenport, 2005b). As a result, these recommendations were expanded from the area of software development exclusively to the broader areas of process and project management, engineering and support, which are now included in the SEI documentation (SEI, 2002).

Inspired by this success, other industries attempted to adapt and replicate this framework and develop models of their own. For instance, in 1996 two consulting firms – PRTM (Pittiglio Rabin Todd & McGrath), now part of PricewaterhouseCoopers, and AMR (Advanced Marketing Research), now part of Gartner – developed a Supply Chain Operations Reference, a comparison model to evaluate supply chain processes starting from five top-level processes and unrolling down to the fourth level sub-processes (Stewart, 1997). Replicating the success in previous areas, this model proved to be successful as a means of evaluation. For example, Alcatel increased the rate of on-time delivery by 40%, and Mitsubishi Motors saved $100 million by reducing the number of vehicles in port. And later this model was even incorporated by supply chain software vendors, such as SAP (Davenport, 2005b).

Other areas of MM application include business analytics (Davenport, 2006), product development (Hynds et al., 2014), and business processes (de Bruin et al., 2005), and KM. KM in particular spurred numerous MM, but none of them became widely accepted. And before looking at them it is necessary to review the framework in more detail.

4.1.1. Defining a Maturity Model Framework

A Maturity Model is usually seen as a tool to assess the degree of maturity of a given area, e.g. a process, against defined levels of maturity (de Bruin et al., 2005). One of the reasons why this framework became so popular is because it could show a clear evolutionary progress from the initial to the desired state for the company, where the ultimate goal is to achieve the maturity or 'the state of being complete, perfect or ready' (Simpson and Weiner, 1989) in a particular area, for example, product development (Mettler, 2009).

The purpose of the model varies, and can be descriptive (describing the state of maturity without establishing the causation between the actions and the maturity progression), prescriptive (suggesting actions for improvement down the maturity path) or comparative (benchmarking the maturity against the industry) (de Bruin et al., 2005). But what all the models have in common is the number of levels of maturity and the characteristics of each level, which were originally described by Crosby (1980) and have not changed since then.

The model defines five levels of maturity and suggests the intermediary steps to follow, which help to proceed to the next level (Figure 14). Each level of maturity defines an evolutionary stage on the path to maturity, which cannot be bypassed, if the company is on the previous level (Paulk, 1993).

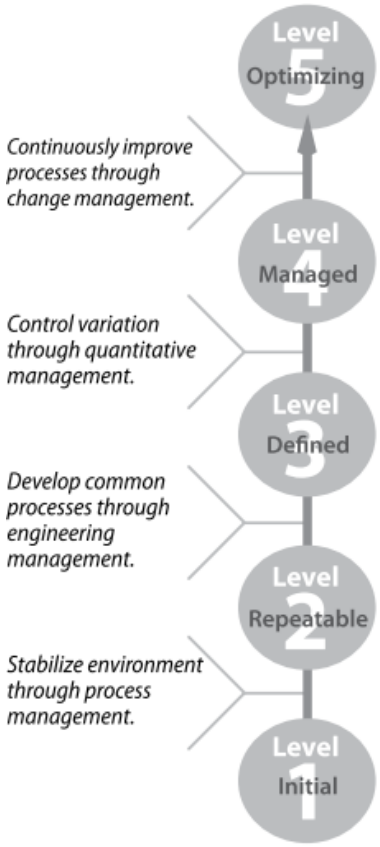


Figure 14. SEI's Capability Maturity Model. Source: (Davenport, 2005b, p. 104).

Companies on *level 1* have poorly defined processes; they work in an unstable environment and quite often cannot fulfil commitments, which results in abandoning procedures and performing uncontrolled improvisation. On this level the success of the project depends entirely on the leadership skills of the project manager.

Companies on *level 2* have better defined processes that are repeatable and can be measured with basic performance indicators, such as cost. The success of the projects depends mainly of the prior experience of the developers with similar projects.

Companies on *level 3* have their processes standardised with well-defined allocation of responsibilities and regular quality checks. Training programmes for staff are usually implemented to ensure the development of the set of skills required to perform certain tasks.

Companies on *level 4* measure performance in more rigorous ways to ensure excellence of the product and processes. The performance varies less and is rather predictable, which allows them to identify and analyse special cases quickly.

And finally, when companies reach *level 5*, they work in an environment which encourages continuous improvement, performs lessons learnt practices regularly and allows the conducting of controlled experiments. Work is driven by focusing on preventing problems rather than solving them (Davenport, 2005b; Paulk, 1993; SEI, 2002).

Just like the model described above, most of the MMs focus on process maturity, but there are other models that categorise object maturity or capability maturity. Weinberg (1992) tried to link these different types of MM by attempting to determine the dependencies between these types and their maturity levels in the software development (Figure 15). The relationship between the three types shows that they mature together at the first level, but then the object and the process can continue only after people capabilities reach their maturity level, and finally the processes can reach their final maturity level only after the objects have matured.

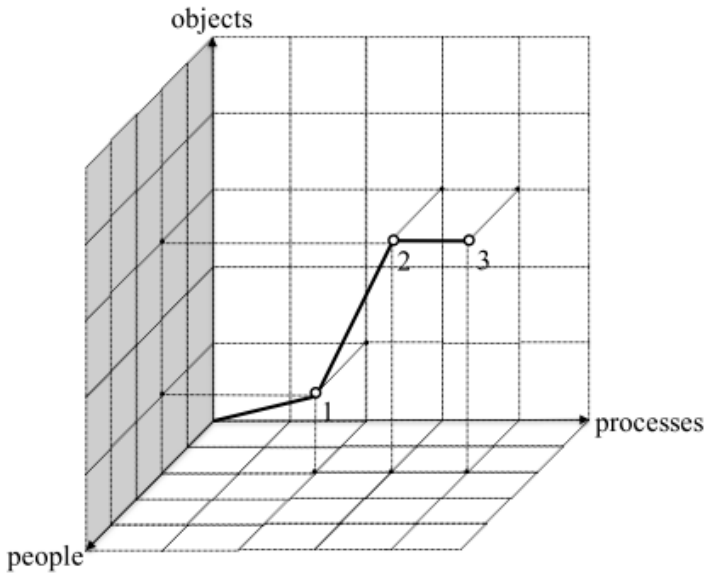


Figure 15. The progression of levels of maturity. Source: (Weinberg, 1992).

Developers of MM in other areas adopted the given 5-level structure without questioning the relevance of the characteristics of each level to a given area. The review of KM MM below illustrates that existing models adopt the structure for the framework and populate it with characteristics that resemble the characteristics of Crosby. These characteristics are relevant in their opinion, but this opinion is hardly supported with any evidence, nor is it empirically

tested. On the other hand, the success of CMMI gives validity to this framework, and through the relationship between different types of MM that Weinberg found, it could be possible to develop a KM MM which is founded on a solid basis rather than plain speculations.

4.1.2. Maturity Models in Knowledge Management

Most of the KM models that were found in the literature (Table 5) are based on the five levels of CMMI standard for software development (APQC, 2003; Disraeli, 2006; Harigopal et al., 2001; Ruiming, 2013; Shang and Lin, 2010). Many of them are descriptive and mainly focused on characterising each level of maturity from the KM perspective, and therefore they aim at helping to locate the companies on their KM journey (Harigopal et al., 2001; Klimko, 2001; Shang and Lin, 2009). Several models also suggest a direction in which a company should be moving to progress to the next level of maturity (APQC, 2003; Feng, 2006; Ruiming, 2013).

Table 5. Knowledge Management MM examples.

MM name	Reference
Knowledge Management Maturity Model	(Klimko, 2001)
Knowledge Management Capability Maturity Model	(Ekionea et al., 2011)
Knowledge Management Capability Assessment	(de Bruin et al., 2005)
Knowledge Management Maturity Model based on Industry Life Cycle	(Ruiming, 2013)
Knowledge Navigator Model	(Hsieh et al., 2009)
Knowledge Management Maturity Model	(Feng, 2006)
Model of Intellectual Capital Management Capability	(Shang and Lin, 2010)
Cognizant Enterprise Maturity Model	(Harigopal et al., 2001)
Knowledge Management Maturity Model	(Arling and Chun, 2011)
Siemens Knowledge Management Maturity Model	(Ehms and Langen, 2002)
Infosys Knowledge Management Maturity Model	(Disraeli, 2006)
The Knowledge Journey	(KPMG, 2000)
Road Map to Knowledge Management Results	(APQC, 2003)

The models listed above were developed either by researchers (Hsieh et al., 2009; Klimko, 2001) or practitioners, such as consulting companies (APQC, 2003; KPMG, 2000) or large companies that developed the models for their own needs, e.g. Infosys (Disraeli, 2006) or Siemens (Ehms and Langen, 2002). The development process of the practitioners' models is not disclosed for confidentiality reasons. But the methods in use and underlying assumptions of the models developed by researchers are not described either, for no apparent reason.

The models are mostly based on prior attempts to develop one (Harigopal et al., 2001; Ruiming, 2013; Shang and Lin, 2009), and this approach has a number of issues.

Firstly, there is no justification that the models that were developed for a specific case (Ehms and Langen, 2002; Sapir et al., 2016) could be applied elsewhere, even if they were considered very useful in a particular company. Secondly, the generic models (Hsieh et al., 2009; Klimko, 2001) were not tested in different conditions, so there are no grounds to consider them suitable for different types of companies in different industries, even if the model incorporates several models with several different perspectives (Feng, 2006). On both of these occasions the external validity of the model is assumed without testing or argument. Furthermore, if a new model is based on models that were not empirically tested (Arling and Chun, 2011; Ekionea et al., 2011), it doesn't make it not more legitimate than others, and, if anything, its internal validity should be questioned. Moreover, the choice of the models is not justified either: the models are neither filtered by particular parameters, nor represent an exhaustive list of the available models at that point in time. Thirdly, the authors that decided to build a model either by merging the older ones or by creating one of their own without referring to others (Feng, 2006), do not justify the need for a new model, e.g. by pointing out the flaws in previous attempts.

Apart from the methodological considerations the contents of the models raise concerns as well. The commercial organisations, such as KPMG (2000), Siemens (2002), Infosys (2006), and APQC (2003), suggest models with low level of detail with regards to the interpretation and adoption of their models. Having said that, I do not want to undermine the competence of such accomplished companies as KPMG and APQC, but the models that they published are designed for commercial use, and it is the expertise of the consultants who help to adopt them that makes them work. This observation explains why the models are very generic and difficult for companies to apply without the involvement of professional consultants.

In some cases, researchers choose the concept of capabilities as a starting point. For instance, Ekionea et al. (2011) use the concept of organisational capabilities, which they equate to KM capabilities, while Shang & Lin (2010) use the concept of Dynamic Capabilities (DC) to build a maturity model of intellectual capital management capabilities. On the one hand, the idea of using the concept of capabilities sounds sensible because it is incorporated in the CMMI framework as well, but on the other hand, the concept of capabilities is not very well defined with reference to KM; e.g. it is unclear whether KM capabilities should be seen as a subset of organisational capabilities, or as a kind of meta-capabilities located above the organisational capabilities, as enablers of them. Similarly, it is not clear why the authors chose a particular perspective of dynamic capabilities given that there are several competing views. The fact that the models were developed primarily by theorising about how CMMI characteristics were transferred into the KM field raises the question of transferability of the characteristics of the maturity levels. For instance, if level 2 of the process maturity of the CMMI model is

characterised as 'repeatable', there is no evidence or argument to suggest that the equivalent KM maturity level should also be characterised as 'repeatable'.

The analysis of the content of the models is heavily linked to the development process, assumptions and methods that were used by the researchers in order to develop their models, and the overview of existing KM maturity models showed that existing models lack credibility to be adopted to improve KM practices in an organisation. However, these models could be used for developing a starting point, by attempting to aggregate the characteristics from different models that describe each KM maturity level, and then examining these aggregated characteristics in order to test whether they indeed correspond to equivalent levels of process maturity, and if not, then try to identify where they belong. A list of characteristics by level is shown below:

Maturity level 1

- KM success is a stroke of luck (Ehms and Langen, 2002; KPMG, 2000)
- Knowledge is shared, captured and stored in own ways (Hsieh et al., 2009)
- Basic IT capabilities (de Bruin et al., 2005)
- Knowledge sharing is not discouraged and knowledge is valued (de Bruin et al., 2005)
- KM equals information management (Klimko, 2001)

Maturity level 2

- Individual KM pioneers (Ehms and Langen, 2002) in functional departments (APQC, 2003)
- Pilot KM projects (Hsieh et al., 2009)
- Start building technological environment for KM (Hsieh et al., 2009)
- Knowledge sharing is encouraged (de Bruin et al., 2005)
- Defining, capturing and storing knowledge is more frequent (Hsieh et al., 2009), but not reliant on technology (de Bruin et al., 2005)

Maturity level 3

- Formal implementation of KM initiative (APQC, 2003)
- Lessons learnt (APQC, 2003)
- Knowledge leveraging systematically (Disraeli, 2006; KPMG, 2000)
- Organisation promotes KM initiatives (de Bruin et al., 2005; Hsieh et al., 2009)
- KMS is implemented (de Bruin et al., 2005; Hsieh et al., 2009)
- Knowing processes are managed (Hsieh et al., 2009)

Maturity level 4

- KM activities funded by the organisation (APQC, 2003)
- KM activities are integrated in day-to-day processes

- Quantitative and qualitative measures of KM performance (de Bruin et al., 2005; Hsieh et al., 2009; Klimko, 2001)
- KMS is implemented (Hsieh et al., 2009) and easy to use (de Bruin et al., 2005)
- KM strategy is developed (de Bruin et al., 2005)
- It is possible to locate knowledge (de Bruin et al., 2005)
- A company conducts trainings (de Bruin et al., 2005)
- Knowing processes are institutionalised (Klimko, 2001)

Maturity level 5

- Full deployment of the KM initiative (APQC, 2003)
- Adapt flexibly to meet new requirements (Ehms and Langen, 2002)
- Reliable KMS (Hsieh et al., 2009), that are widely adopted, monitored and updated (de Bruin et al., 2005)
- Construct network environment (Hsieh et al., 2009)
- The system improves itself (Klimko, 2001)

The survey aims to create a structure for the subsequent analysis of the interviews as a second part of the main investigation that will answer the first and the second research questions: what are KM needs of innovative companies and whether KM needs evolve with time, and how technology supports these needs. The parameters above are used in the survey as dependent variables, but the levels that they were assigned into in previous studies are used only to compare the final results with the previous studies, when / if the model was built. By identifying the level of process maturity in each company with the help of CMMI parameters it should be possible to reveal which of these KM practices are used in that particular company, and therefore which KM practices are associated with each maturity level. The details of the survey design and analysis are discussed further in this chapter. And the last part of this literature review takes a closer look at the benefits and limitations of this framework that proved to be useful during the discussion of the negative results.

4.1.3. Benefits and Limitations of Maturity Models Approach

The MM framework became so popular in many other areas, because the models are quite simple (with five levels of maturity) and flexible at the same time (Davenport, 2005b). The depth of analysis as well as the amount of parameters that are analysed is limited by the level of imagination and expertise of the model developer, but trying to make them too complex might result in them being rigid at the same time. MM are applied by many companies to assist decision makers in assessing their objectives, and influencing the development of improvement activities in a more comprehensive and unbiased way in order to avoid a conflict of interests (Mettler, 2009). And potentially they can be useful for KM in particular because they could present a bigger picture of KM in the organisational context and help companies identify their current position on this “KM map” and the barriers / requirements to proceed

to the next level (Hsieh et al., 2009). Apart from that MM can serve as an "implementation journey" with the list of steps the companies need to follow to achieve desired results (Hsieh et al., 2009; Klimko, 2001).

But on the other hand the "construction material" of MM raises concerns. MM are usually based on the best practice and opinions of experts shared during the interviews with the developers In other words, they are based on perception with its biases and experiences rather than a robust theory (Biberoglu and Haddad, 2002), which is not necessarily bad if a potential user is aware of these biases. But the structured and formalised nature of the model creates an illusion of well-grounded decisions and offers little room for questioning the recommendations and their applicability and fit in a new situation. Apart from that, many of the models provide an ambiguous link between current problems and the actions that need to be taken to solve them and to reach the desired state (Mettler, 2009). This ambiguity leaves a lot of space for interpretation to the users of the model, who subconsciously project their own biases onto the solution. If they are experienced, the interpretation might be useful, but if not, the model gives them false confidence in the solution that they suggest.

Other limitations are derived from the perception of the developers. The seeming simplicity of the model creates an illusion among researchers and practitioners that they understand the model perfectly, and therefore they can replicate it in a different field. But as was shown in the review of the existing KM MM, quite often they do not, instead incorporating selected concepts without explaining the reasons and without exploring the connections between the concepts.

The last limitation implies that MM cannot be used blindly for the purpose of this research and their appropriateness needs to be tested first. And the survey was designed as a way to examine the link between the process and KM maturity, which is presented below.

4.2. Methodological approach

Section 2.6 introduced the approach to the survey design and the methods that were used for survey analysis, their areas of application and reasons for choosing them without elaborating on them in great detail. This part of the chapter describes the survey design in detail and demonstrates how the analysis was conducted.

4.2.1. Survey Design

The survey was designed as the first step in answering the first and the second research questions, and the structure that can be complemented with rich in detail findings form the interviews. As was mentioned before, the survey consists of two parts. For the first part the CMMI model was used as a known component in the equation which assumes the existence of the relationship between process and people MM, the latter being KM. The CMMI model

consists of four categories of parameters: process management, project management, engineering and support. Of these categories only the first two were included in the questionnaire, since the others were either too technical or not-applicable to the context of the participants of this study. The full list of parameters of the first two categories includes 127 parameters, but after carefully revising them with the contact persons from the companies participating in the multiple case study, it was possible to reduce the list to 52 items, because some parameters were partially redundant or not clear enough for the practitioners. The list of participating companies is provided at the beginning of the next section. The parameters were then grouped into three categories corresponding to PDP, project management and process improvement, and the questions (see Appendix 1) were designed around these groupings.

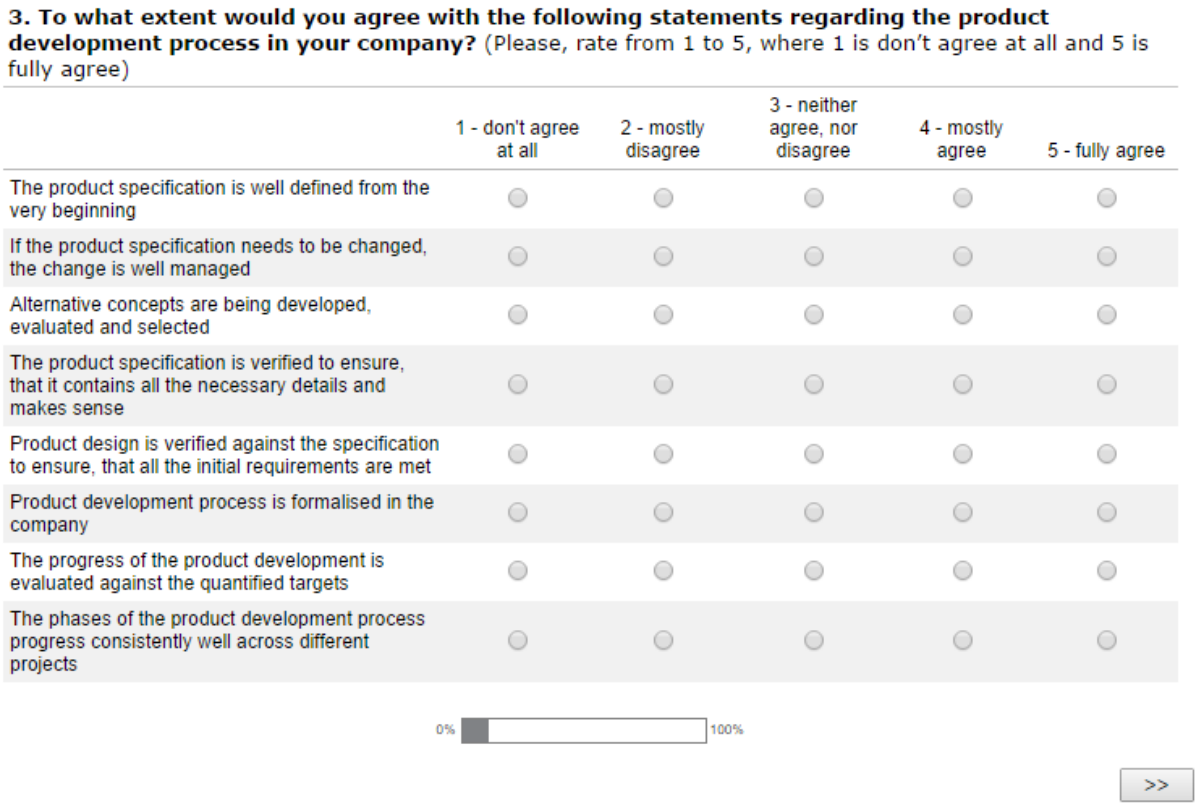
The maturity levels 1-3 are best described in this model, and all the parameters that were excluded were taken from these levels. Even after the reduction of the parameters these levels were overly-represented, but it was decided not to create new parameters to balance levels 4-5, since they were not in the original model.

The second part of the survey consisted of the parameters that characterise KM practices and the use of KMS, and they were taken from existing models of KM that were described in the previous section, and the KMS software tools that were identified in Section 3.2.2. However, the parameters were treated equally regardless of the level of maturity they were assigned to by the authors of the models that they were taken from. These parameters (being dependent variables) were either evaluated based on the 5-point Likert scale or a yes/no answer, and the number of values was limited to 5 based on the recommendation of the analysis obtained from machine learning of having up to 7 values (Dörfler, 2003).

With regards to the other two types of variables, the controlled variables are designed to control the subjective matter of the answers and are mostly relevant when the respondents are asked about their attitude to a subject matter. However, this was not the case in this survey, and therefore this type of variable was not included. The uncontrolled variables are designed to eliminate the source of variation, and in this survey the differences could be expected at a company level and potentially at the hierarchical position level. Therefore, the respondents were asked to specify their company and position in the company.

All the variables were grouped by themes to structure the survey for the respondents (e.g. product development related questions, or KM practices in use), and each theme was assigned to one question. The full list of questions is provided in Appendix 1, and they include the open-ended questions that would suggest how the processes are organised in the company in order to provide extra insights before the follow up interviews. The full list or parameters is provided in Appendix 2.

Question 1 was included to "warm up" the respondent, questions 2 and 8 provided answers to the open questions about the processes, questions 3-7 and 9-10 included the dependent variables, questions 11-18 included experimental variables and questions 19-20 included uncontrolled variables. The questionnaire was set up online in Qualtrics[6] (Figure 16) and distributed among the participants via the link.



3. To what extent would you agree with the following statements regarding the product development process in your company? (Please, rate from 1 to 5, where 1 is don't agree at all and 5 is fully agree)

	1 - don't agree at all	2 - mostly disagree	3 - neither agree, nor disagree	4 - mostly agree	5 - fully agree
The product specification is well defined from the very beginning					
If the product specification needs to be changed, the change is well managed					
Alternative concepts are being developed, evaluated and selected					
The product specification is verified to ensure, that it contains all the necessary details and makes sense					
Product design is verified against the specification to ensure, that all the initial requirements are met					
Product development process is formalised in the company					
The progress of the product development is evaluated against the quantified targets					
The phases of the product development process progress consistently well across different projects					

0% 100%

>>

Figure 16. An example of a survey question in Qualtrics.

After the questionnaire was designed, a pilot test was conducted with 4 representatives of the participating companies in order to test the clarity of the wording, the flow and length of the survey. The changes were made based on the feedback that they provided, and after the survey was adjusted, it was launched in all the companies participating in the multiple case study. The results were analysed before the interviews, and the following section discusses the methods that were used in more detail.

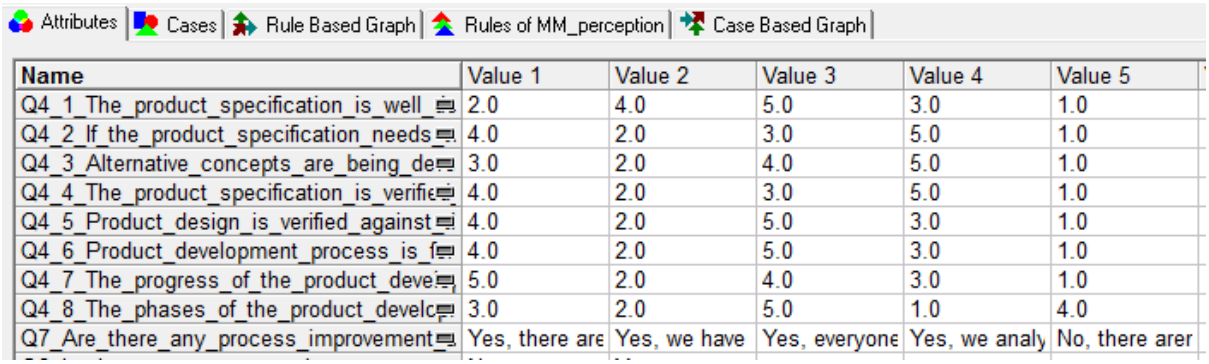
4.2.2. Survey Analysis

Before presenting the results of the analysis, it is necessary to explain the methods that were used in more detail. Section 2.7 provided the reasons for choosing specific methods for the survey analysis and gave a brief overview of the methods. This section aims to continue the overview by discussing the details of how the methods were used.

[6] https://www.qualtrics.com

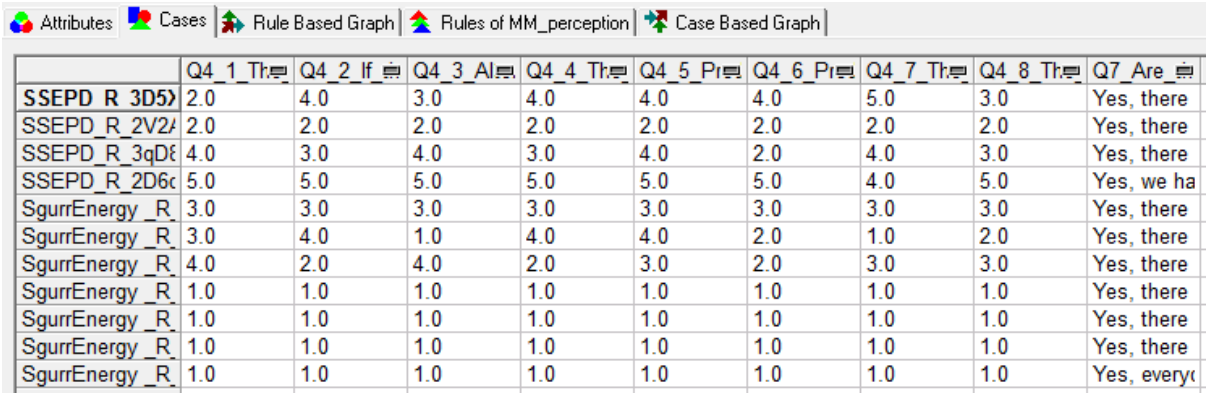
Machine learning

The machine learning analysis was conducted in the knowledge-based expert system shell Doctus[7] which allows the building of decision support expert systems based on a sufficient amount of decisions in past cases, which are described through the set of attributes (characteristics of each decision), or rules which are elicited from the decision makers. In this study the respondents were treated as cases and each parameter was treated as an attribute (Figure 17) that describes the cases, with values being the responses or the rates given by the respondents (Figure 18).


Attributes | Cases | Rule Based Graph | Rules of MM_perception | Case Based Graph

Name	Value 1	Value 2	Value 3	Value 4	Value 5
Q4_1_The_product_specification_is_well_	2.0	4.0	5.0	3.0	1.0
Q4_2_If_the_product_specification_needs	4.0	2.0	3.0	5.0	1.0
Q4_3_Alternative_concepts_are_being_de	3.0	2.0	4.0	5.0	1.0
Q4_4_The_product_specification_is_verifie	4.0	2.0	3.0	5.0	1.0
Q4_5_Product_design_is_verified_against	4.0	2.0	5.0	3.0	1.0
Q4_6_Product_development_process_is_f	4.0	2.0	5.0	3.0	1.0
Q4_7_The_progress_of_the_product_deve	5.0	2.0	4.0	3.0	1.0
Q4_8_The_phases_of_the_product_develc	3.0	2.0	5.0	1.0	4.0
Q7_Are_there_any_process_improvement	Yes, there are	Yes, we have	Yes, everyone	Yes, we analy	No, there arer

Figure 17. An example of attributes in Doctus; values correspond to the possible values of each attribute.


Attributes | Cases | Rule Based Graph | Rules of MM_perception | Case Based Graph

	Q4_1_Th	Q4_2_If	Q4_3_Al	Q4_4_Th	Q4_5_Pr	Q4_6_Pr	Q4_7_Th	Q4_8_Th	Q7_Are
SSEPD_R_3D5)	2.0	4.0	3.0	4.0	4.0	4.0	5.0	3.0	Yes, there
SSEPD_R_2V2/	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	Yes, there
SSEPD_R_3qD8	4.0	3.0	4.0	3.0	4.0	2.0	4.0	3.0	Yes, there
SSEPD_R_2D6(	5.0	5.0	5.0	5.0	5.0	5.0	4.0	5.0	Yes, we ha
SgurrEnergy _R_	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	Yes, there
SgurrEnergy _R_	3.0	4.0	1.0	4.0	4.0	2.0	1.0	2.0	Yes, there
SgurrEnergy _R_	4.0	2.0	4.0	2.0	3.0	2.0	3.0	3.0	Yes, there
SgurrEnergy _R_	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	Yes, there
SgurrEnergy _R_	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	Yes, there
SgurrEnergy _R_	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	Yes, there
SgurrEnergy _R_	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	Yes, every

Figure 18. An example of cases in Doctus; attributes correspond to the survey questions and the values to the answers.

Then the machine learning algorithm was used to infer the 'if… then' rules; the results were displayed in a case-based (or inductive) graph, an example of which is presented in Figure 19 and Figure 23. Such a graph is a decision tree in which the 'if… then' rules can be read from the root of the tree towards the leaves. The values of the outcomes are located on the leaves. Attributes that appear in the graph are 'informative', meaning that they produce the most significant entropy gain (Figure 20). This produces a graph with a minimal number of attributes that are sufficient to classify all the cases. In other words, these are the attributes we can use to most easily sort our cases into the categories defined by the outcome values (Baracskai et al., 2001).

[7] http://www.doctuskbs.com/

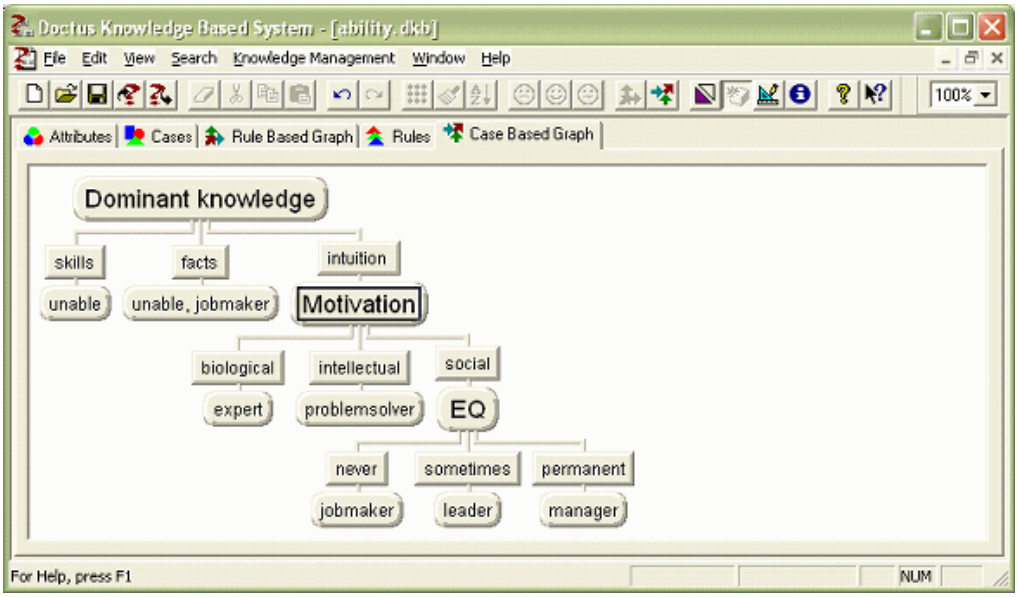
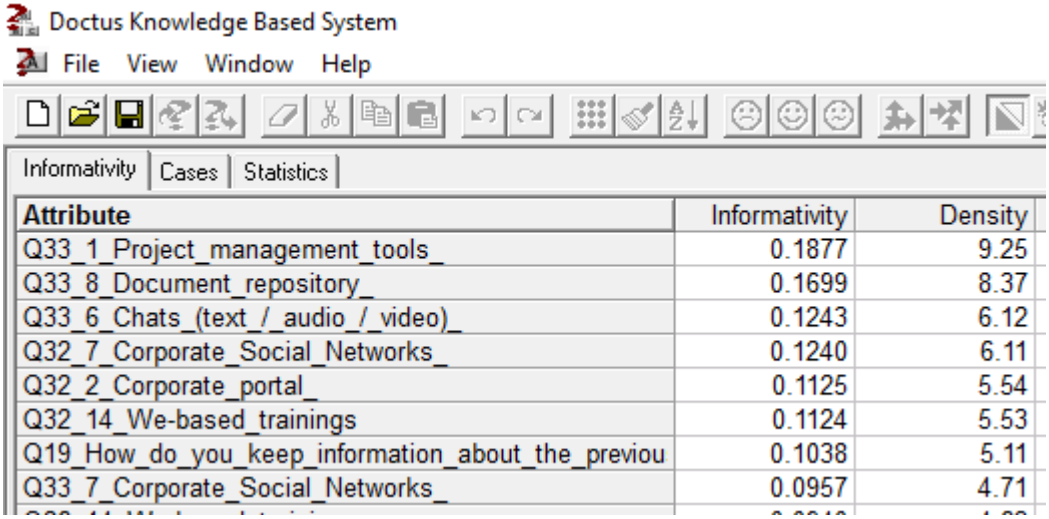


Figure 19. An example of a decision tree. Source: (Dörfler, 2003).



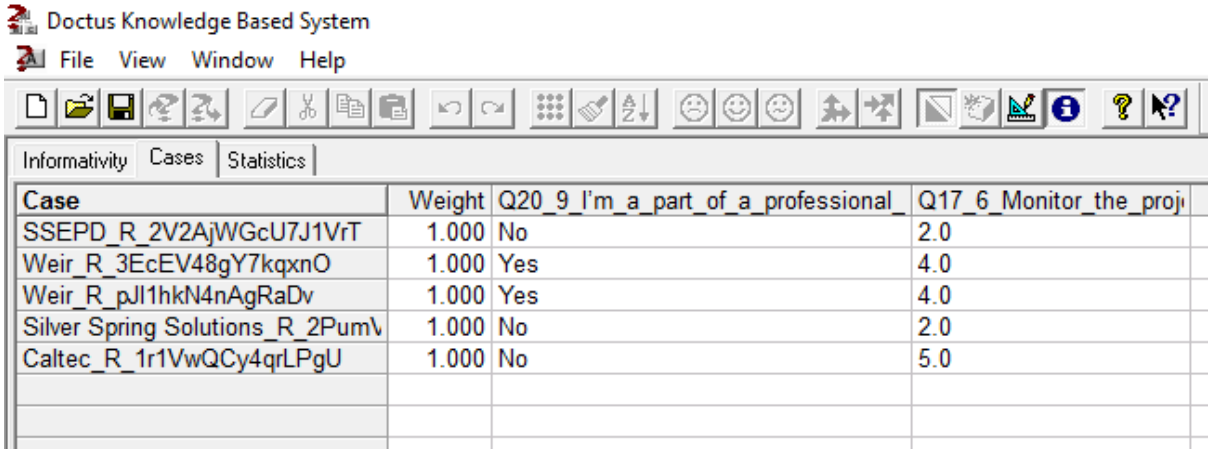
Attribute	Informativity	Density
Q33_1_Project_management_tools_	0.1877	9.25
Q33_8_Document_repository_	0.1699	8.37
Q33_6_Chats_(text_/_audio_/_video)_	0.1243	6.12
Q32_7_Corporate_Social_Networks_	0.1240	6.11
Q32_2_Corporate_portal_	0.1125	5.54
Q32_14_We-based_trainings	0.1124	5.53
Q19_How_do_you_keep_information_about_the_previou	0.1038	5.11
Q33_7_Corporate_Social_Networks_	0.0957	4.71

Figure 20. Informativity and density of attributes in branching in Doctus software.

Sometimes the branch might contain cases with the same values of all the attributes, but with different outcomes, and in this case “clean” branching is not possible. If the decision tree is based on the knowledge of the expert, then an extra input is required since an attribute that could explain this instance is required. Then the analysis of the decision tree needs to be repeated, since a new attribute might have a significant impact on the structure of the tree (Baracskai et al., 2001).

Apart from the informativity, the parameters are chosen based on their density (Figure 20) and case statistics (Figure 21), which becomes increasingly relevant for the leaves closer to the end of the tree. The density corresponds to informativity weighted on the number of case statistics, or in other words the number of cases included. These two parameters indicate the

same aspect, and it is a matter of preference which one should be put forward. In this research it was more convenient to look at the number of cases. The attributes might have a high level of informativity, but if they can explain only a small number of cases, then it either indicates unique cases or is not informative enough to be considered. And experimentally it is recommended to only consider attributes with 4 cases or more to be important.



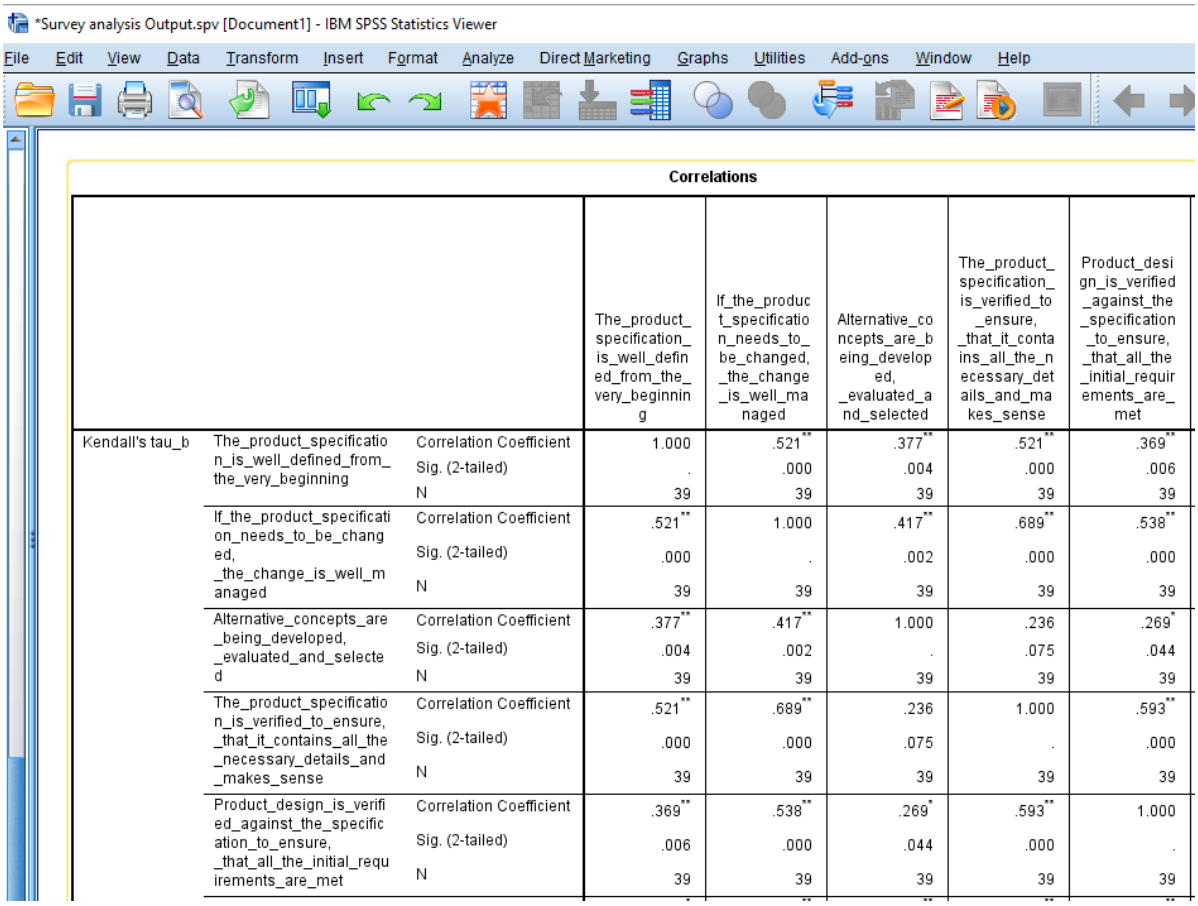
Case	Weight	Q20_9_I'm_a_part_of_a_professional_	Q17_6_Monitor_the_proj
SSEPD_R_2V2AjWGcU7J1VrT	1.000	No	2.0
Weir_R_3EcEV48gY7kqxnO	1.000	Yes	4.0
Weir_R_pJl1hkN4nAgRaDv	1.000	Yes	4.0
Silver Spring Solutions_R_2PumV	1.000	No	2.0
Caltec_R_1r1VwQCy4qrLPgU	1.000	No	5.0

Figure 21. Case statistics in Doctus software.

This part of the section explained the principle of using machine learning for analysing the questionnaire. The next section provides the details of the correlation analysis that was used as a complementary tool to analysis obtained from machine learning.

Correlation analysis

As was mentioned in Section 2.7.2, correlation analysis can show the degree of linear relationship between two variables through the correlation coefficient, which indicates the degree of this correlation. However, the correlation can be insignificant, and the significance of the correlation is tested with a two-tailed significance test, which indicates the probability of having a result outside the given range, and the recommended accepted levels are usually 0.05 or 0.01. In Figure 22 the significant correlation indexes are marked with "*", and the significance index is provided in the next section before the discussion of the results. The correlation analysis and the significance test were conducted in SPSS.


*Survey analysis Output.spv [Document1] - IBM SPSS Statistics Viewer

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Correlations

			The_product_specification_is_well_defined_from_the_very_beginning	If_the_product_specification_needs_to_be_changed,_the_change_is_well_managed	Alternative_concepts_are_being_developed,_evaluated_and_selected	The_product_specification_is_verified_to_ensure,_that_it_contains_all_the_necessary_details_and_makes_sense	Product_design_is_verified_against_the_specification_to_ensure,_that_all_the_initial_requirements_are_met
Kendall's tau_b	The_product_specification_is_well_defined_from_the_very_beginning	Correlation Coefficient	1.000	.521**	.377**	.521**	.369**
		Sig. (2-tailed)	.	.000	.004	.000	.006
		N	39	39	39	39	39
	If_the_product_specification_needs_to_be_changed,_the_change_is_well_managed	Correlation Coefficient	.521**	1.000	.417**	.689**	.538**
		Sig. (2-tailed)	.000	.	.002	.000	.000
		N	39	39	39	39	39
	Alternative_concepts_are_being_developed,_evaluated_and_selected	Correlation Coefficient	.377**	.417**	1.000	.236	.269*
		Sig. (2-tailed)	.004	.002	.	.075	.044
		N	39	39	39	39	39
	The_product_specification_is_verified_to_ensure,_that_it_contains_all_the_necessary_details_and_makes_sense	Correlation Coefficient	.521**	.689**	.236	1.000	.593**
		Sig. (2-tailed)	.000	.000	.075	.	.000
		N	39	39	39	39	39
	Product_design_is_verified_against_the_specification_to_ensure,_that_all_the_initial_requirements_are_met	Correlation Coefficient	.369**	.538**	.269*	.593**	1.000
		Sig. (2-tailed)	.006	.000	.044	.000	.
		N	39	39	39	39	39

Figure 22. Correlation matrix in SPSS.

4.3. Maturity Models as an appropriate approach to Knowledge Management?

The survey was conducted in the companies as the first phase of the main empirical investigation of this research. The second phase is described in Chapters 5 and 6. 45 participants from 8 companies started answering the questionnaire, of which 39 completed it (Table 6). The number of responses was sufficient to explore the relationship between the parameters through a machine learning algorithm, and was also considered high enough to complement it with the correlation analysis. Of 117 questions, 105 were close-ended questions and therefore could be used in this analysis. However, 5 questions referred to the answer "other" on various questions, and therefore could not add any value to the analysis because they could not be interpreted, and 3 questions were answered the same way by all the respondents. Therefore, the analysis was based on the remaining 97 questions.

Table 6. List of survey respondents.

Company name	Company type	Size	N of responses
SSE Power Distribution	Distribution Network Provider	500	4
SgurrEnergy	Engineering Consultancy	500	7
SP Energy Networks	Distribution Network Provider	400	2

Weir Group	Engineering Consultancy	14 000	10
Lukoil	Oil refinery	110 000	1
ABB	Engineering Consultancy	140 000	2
Caltec	Engineering Design	18	5
Silver Spring Networks	Engineering Design	600	8

The questionnaire consisted of 5 themes: Product Development Process, Process Improvement, Project Management, KM practices and KMS, and each of the themes was split further into categories for the convenience of the analysis. All the parameters (the statements in the questions) are listed in the Table 15 in Appendix 3.

In order to perform the correlation analysis, the data was tested on reliability and normality. Cronbach's Alpha was used to perform the reliability test. There is no agreement on the acceptable value of reliability, but the most widely accepted one is 0.7 (Nunnally et al., 1967). The results of this test for the given dataset are above this level, and thus the data are considered reliable (Table 7).

Table 7. Reliability test.

Case Processing Summary

		N	%
Cases	Valid	39	100.0
	Excluded[a]	0	.0
	Total	39	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.775	.608	97

The normality test was performed using Kolmogorov-Smirnov and Shapiro-Wilk significance values, with the required values being above the significance level of 0.05. However, the results for all the parameters were below 0.05, therefore the data were not normally distributed and the correlation analysis had to be performed using Kendall's tau-b or Spearman coefficients. Table 8 below shows the results for the first 9 parameters, and the rest of the table can be found in Appendix 4.

Table 8. Normality test.

Tests of Normality[b,c,d]

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
The_product_specification_is_well_defined_from_the_very_beginning	.181	39	.002	.915	39	.006
If_the_product_specification_needs_to_be_changed,_the_change_is_well_managed	.224	39	.000	.873	39	.000
Alternative_concepts_are_being_developed,_evaluated_and_selected	.201	39	.000	.895	39	.002
The_product_specification_is_verified_to_ensure,_that_it_contains_all_the_necessary_details_and_makes_sense	.235	39	.000	.891	39	.001
Product_design_is_verified_against_the_specification_to_ensure,_that_all_the_initial_requirements_are_met	.279	39	.000	.860	39	.000
Product_development_process_is_formalised_in_the_company	.231	39	.000	.892	39	.001
The_progress_of_the_product_development_is_evaluated_against_the_quantified_targets	.201	39	.000	.899	39	.002
The_phases_of_the_product_development_process_progress_consistently_well_across_different_projects	.248	39	.000	.895	39	.002
Are_there_any_process_improvement_activities_taking_place_in_your_company?	.380	39	.000	.725	39	.000

The remainder of this section presents the findings of the machine learning and correlation analysis of the survey, and discusses whether the chosen model was an appropriate tool to be used in KM.

4.3.1. Connection between KM parameters and process maturity parameters

In order to examine the connection between the MM parameters and KM parameters, the analysis obtained from machine learning in Doctus was combined with correlation analysis in SPSS. As was explained in Section 2.7, the two types of analysis could be complementary to each other: correlation analysis shows the significance of correlation between any given pair of parameters, whereas analysis obtained from machine learning can evaluate the influence of the group of parameters on a given parameter vs. independent pairs. In other words, correlation analysis identifies influential parameters independently of each other, while analysis obtained from machine learning can identify groups of parameters that become influential, when taken together. For example, Figure 23 shows a decision tree built in Doctus

for question Q17_6 (monitoring the project against the plan). All the other MM parameters were excluded from the branching so that the decision tree could show only KM related parameters that potentially influence a chosen outcome. The resulting decision tree should be interpreted as follows: if a type of KMS features with a rating from 1 to 5, it indicates that the system is used regularly and the rating shows how convenient the system is; if the system is rated 0, then it is not used regularly or at all. The figure below demonstrates that the outcome of parameter Q17_6 is defined by the regular use of project management tools, or document repository, or chats, all of which represent means of electronic communication and information exchange. None of these parameters showed a significant level of correlation with parameter Q17_6, but when taken together, they were the most informative ones for the outcome of this parameter.

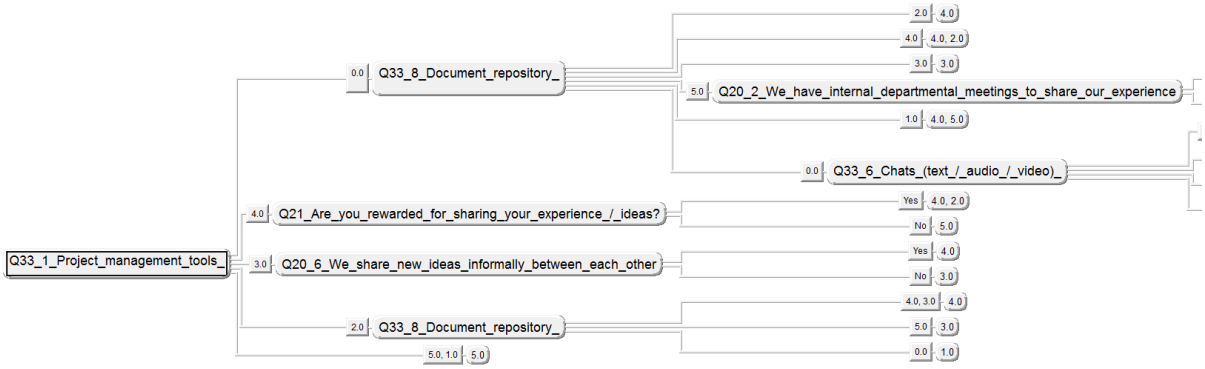

Figure 23. Doctus decision-tree for question Q17_6.

Apart from the levels of informativity and density, that are used to identify whether parameters are important or only explain a small number of cases, as was explained in the previous section, one should also look at the connection between the outcome and each informative parameter. For instance, in the example above, improved Q21 (rewarding for sharing experience) does not necessarily lead to a better outcome, and this result could be related to the literature review about motivation in Section 3.2.5, as well as the interviews with the experts in Section 3.4, which demonstrated that rewards (which are usually associated with extrinsic motivation) do not necessarily lead to better results. This parameter will be marked as unclear in the analysis.

To complete the analysis, machine learning was run for each of the MM parameters, and informative parameters were written down for every MM parameter. Then this analysis was complemented with the parameters that had a significant level of correlation for a given parameter – the outcome (Appendix 4). Then the MM parameters were grouped according to their maturity level and the groupings were analysed for any distinct patterns.

MM level 1 consisted of 10 parameters, and for 9 of them regular use of document repositories and project management tools were the most informative parameters. Regular use of chats was also connected with 9 parameters, but for 5 of them more convenient chats

did not necessarily lead to a better outcome. Among the traditional communication and information exchange tools, corporate portals were the least informative (4 out of 10, of which 2 were unclear). Among the lessons learnt practices, which also include sharing best practices and mistakes, sharing best practices was the most influential parameter among them (6 out of 10). Being part of a professional community (5 out of 10, 2 of which were also supported by significant correlation in SPSS) and addressing a problem to a professional community (4 out of 10) were similarly important. Profile libraries were informative for 3 parameters, all of which were related to the theme of Product Improvement. More contemporary communication tools (Web 2.0) featured predominantly in SPSS: forums (3), wikis (1), blogs (1) and CSN (1 in Doctus). Correlation analysis showed that ideas sharing parameters are significant at MM level 1 (ideas sharing systems – 2, ideas contest – 1, ideas library – 3, and sharing ideas informally – 2), which might not be as informative as other parameters, but are better connected with MM level 1 than other levels.

MM level 2 consisted of 12 parameters, and similar to the previous model regular use of a document repository, project management tool and chats were the most informative, though the influence of chats was unclear in 5 cases as well, while corporate portals were slightly more informative on this level (6 out of 12). Lessons learnt practices were mainly identified in SPSS and became significantly more important: sharing best practices (8 out of 12), and mistakes and lessons learnt (7 out of 12). Web 2.0 tools and professional communities were highlighted as significant in both types of analysis, but for fewer parameters (4 out of 10).

MM levels 3, 4 and 5 have significantly less parameters that characterise them (4, 4 and 3 respectively), and therefore observing patterns and deciding whether the parameters are significantly informative is more difficult. Still, some patterns could be observed as well. On level 3 regular use of a document repository (4 out of 4) and project management tools (3 out of 4) was again the most informative, as well as having a corporate portal (3 out of 4), but not chats. Profile libraries were also significantly more important (3 out of 4, of which they are used regularly in 2 parameters). Lessons learnt practices and Web 2.0 tools were relatively less important.

MM level 4 was explained by the same informative parameters as levels 1 and 2 – document repository, project management tools and chats (4 out of 4). In addition to that, sharing best practice parameter was also informative (4 out of 4). The importance of Web 2.0 increased in relation to level 3 as well: forums (3), wikis (1), blogs (1), CSN (1).

At level 5, the importance of project management tools decreased compared with other levels, but not of document repositories and chats (1 vs. 3 out of 3). Web 2.0 tools also showed almost no connections. Investing in knowledge sharing events as well as addressing problems to professional communities became important (2 out of 3), though one of the parameters had a negative correlation with the latter.

Advanced search system had a low level of informativity on the first three levels, but on levels 4 and 5 it was correlated negatively with other parameters, which could also mean that a prediction that cognitive computing becomes a major new trend in KM (O'Dell and Trees, 2016) is probably exaggerated. Rewarding for sharing experience appeared once on three levels, and in two of the cases its connection was negative or unclear.

From the results above we can see that a document repository is important on every level, project management tools are important on levels 1-4 and chats are informative on most of the levels, though their influence is not always clear. As for other parameters, it is difficult to observe any patterns in relation to maturity levels and their progression. For instance, Web 2.0 tools are informative on levels 1 and 4, profile libraries and corporate portals on levels 2 and 3, professional communities on levels 1 and 2, while addressing problems to professional communities on level 5, sharing best practices on levels 1, 2 and 4, but investing in knowledge sharing events on level 5, and it seems that sharing best practice is relatively more important than mistakes.

Analysis of the connection between the MM levels and KM parameters did not show expected results, but a pattern became more distinct, when the parameters were regrouped by themes. For example, on two levels profile libraries were informative for Process Improvement parameters exclusively, so I continued the analysis and rearranged the parameters according to the themes in an attempt to test this observation. A document repository and project management tools showed high level of informativity on all levels, and therefore they will not be mentioned in the analysis below, unless they prove the opposite.

The PDP theme consisted of 8 parameters and, unsurprisingly, parameters related to ideas sharing were relatively influential. From the KM parameters that are related to learning, only sharing best practice was important (6 out of 8). What was less expected was the correlation between forums and PDP (7 out of 8), supported by the other communication tool – chats (7 out of 8).

The Process Improvement theme was composed of 8 parameters, and surprisingly lessons learnt KM parameters were not as highly represented in this theme as one would expect. Among the informative ones were profile libraries (5 out of 8), addressing problems to the professional communities (4 out of 8), being part of a professional community (3 out of 8), and investing in knowledge sharing (3 out of 8).

The Project Management theme incorporated a large number of parameters, and in order to make the analysis more convenient, its categories were analysed separately before being aggregated. When combined, the analysis showed that corporate portals were relatively important (7 out of 14). Sharing best practice, mistakes and conducting lessons learnt were also relatively informative, though sharing mistakes was more important for engaging with experts and stakeholders (4 out of 4), while for other categories sharing best practices was

more informative (6 out of 10). Chats were positively informative for engaging with experts and stakeholders only, and not for any other group of parameters. Surprisingly, of the few parameters that positively correlated with advance search system in all themes, most were related to the project planning category (4 out of 5). Similarly, the ideas library was correlated with mostly project planning parameters as well (3 out of 5).

To conclude, reorganising the parameters according to the themes allowed identification of interesting and sometimes counterintuitive patterns, like the importance of forums and sharing best practices for PDP, profile libraries for process improvement and advanced search systems for project planning, and these patterns could be informative for the analysis of the interviews. Inability to find patterns between MM levels and KM parameters suggested that the MM framework cannot be used for KM, and probably the very connection between the parameters of MM itself should be examined. The following section attempts to shed light on these concerns.

4.3.2. Connection between process maturity parameters

In order to examine the connection between various parameters of the maturity model, I referred mainly to analysis obtained from machine learning in Doctus, in which all the parameters were included into branching. This method was considered more appropriate for the following reasons: the analysis in Doctus showed that the level of informativity is not bi-directional for every pair of parameters, unlike the correlation coefficient. For instance, Q4_8 (PDP performance) is the most informative parameter for question Q4_3 (concepts), but not vice versa. Therefore, if a maturity model is seen as a progression, then it would be expected that each maturity level would be mainly informed by parameters that are all of the same level or lower. Similar to the previous analysis, each parameter was taken as a decision criterion and the most informative parameters were registered with the density of at least 5 cases. Correlation analysis could be still used as a supportive information source.

When the parameters were analysed and grouped according to their maturity level, the parameters of the higher maturity level were as likely to be informative for the parameters of a given maturity level as the parameters of the same or lower maturity level (Appendix 5). This finding indicates that the way in which the parameters are arranged and form maturity levels is not supported with the connections that were identified through machine learning.

This finding is also supported by descriptive statistics of these parameters (Table 9): the mean value of the parameters of the higher maturity levels can be higher as well as lower as that of the lower MM level parameters. For instance, the parameter Q4_5 corresponds to MM3 and is the highest in the block of question 4. Similarly, the parameter Q16_2 has a relatively high mean, especially when compared with MM3 (Q17_10) and MM2 (17_9) in the blocks of questions 16 and 17. However, the questions relating to process improvement showed relatively lower results and this theme is associated with MM5. This block of questions also

shows the inconsistency in the model that was developed by SEI (2002): though this theme is referred to the fifth level of maturity, some of the parameters are described as belonging to levels 1 and 2.

Table 9. Descriptive statistics of MM parameters.

Parameters	MM level	N	Mini-mum	Maxi-mum	Mean	Std. Deviation
Q4_1 The product specification is well defined from the very beginning	MM1	39	1	5	2.87	1.174
Q4_2 If the product specification needs to be changed, the change is well managed	MM1	39	1	5	3.05	1.025
Q4_3 Alternative concepts are being developed, evaluated and selected	MM1	39	1	5	3.03	1.347
Q4_4 The product specification is verified to ensure, that it contains all the necessary details and makes sense	MM2	39	1	5	3.31	1.173
Q4_5 Product design is verified against the specification to ensure, that all the initial requirements are met	MM3	39	1	5	3.49	1.211
Q4_6 Product development process is formalised in the company	MM3	39	1	5	3.00	1.214
Q4_7 The progress of the product development is evaluated against the quantified targets	MM4	39	1	5	2.97	1.135
Q4_8 The phases of the product development process progress consistently well across different projects	MM4	39	1	5	2.67	1.060
Q7 Are there any process improvement activities taking place in your company?	MM5	39	1	5	2.77	1.202
Q8 Is there a system at place to promote process improvement?	MM5	39	0	2	1.51	.556
Q10 Does the corporate culture promote process improvement?	MM5	39	0	2	1.38	.544
Q12_1 Determine process improvement opportunities	MM1	39	0	5	2.69	1.173
Q12_2 Conduct lessons learnt sessions	MM1	39	0	5	2.54	1.211
Q12_3 Collect and analysed process improvement proposals	MM1	39	0	5	2.31	1.127
Q12_4 Pilot the best proposals	MM1	39	0	5	2.56	1.231
Q12_5 Develop action plan for further deployment of the best proposals	MM2	39	0	5	2.54	1.120
Q12_6 Measure process improvement effects	MM2	39	0	5	2.41	1.229
Q16_1 Project management process is formalised in the company	MM3	39	1	5	3.38	1.115
Q16_2 Each project has well defined objectives and quantified targets	MM4	39	1	5	3.85	.933
Q17_1 Define the scope of the project	MM1	39	1	5	3.97	1.135
Q17_2 Estimate the project costs	MM1	39	2	5	4.10	.995
Q17_3 Develop a project plan	MM2	39	1	5	3.92	.984
Q17_4 Establish the budget and schedule	MM2	39	2	5	4.03	.932
Q17_5 Plan and allocate resources required for the project	MM2	39	2	5	3.90	.968
Q17_6 Monitor the project against the plan on a regular basis	MM2	39	1	5	3.90	1.071
Q17_7 Identify, evaluate and prioritise project risks	MM2	39	1	5	3.54	1.144
Q17_8 Develop a mitigation plan for the identified risks	MM3	39	1	5	3.59	1.093
Q17_9 Conduct lessons learned sessions at the end of the project	MM2	39	1	5	2.82	1.097

Q17_10 Analyse the results of lessons learned sessions and implement key takeaways	MM3	39	1	4	2.59	.966
Q17_11 Identify needed knowledge and skills for the project	MM2	39	1	5	3.64	1.038
Q17_12 Assign responsibilities to the project members who have relevant knowledge and skills	MM2	39	2	5	3.85	.812
Q17_13 Collaborate with all the parties that have interest in the project, to ensure that their interests are met	MM2	39	2	5	3.62	1.042
Q17_14 Involve external experts, who have relevant knowledge, but don't have direct interest in this project	MM2	39	1	5	2.95	1.169

If the themes are reviewed separately, one can see the parameters are much better connected within the theme than between the themes. Figure 24 shows the clusters of correlations of the themes: Product Development Process, Process Improvement and Project Management Process, with Process Improvement having a relatively higher correlation with the other two themes. The larger version of this figure is included in the appendices. Maturity parameters correlate with each other significantly more than with KM parameters, which is expected, because they describe various aspects of a business process. But from the observation noted above they could be rearranged in a number of different ways and form another model, which will be different from a MM.

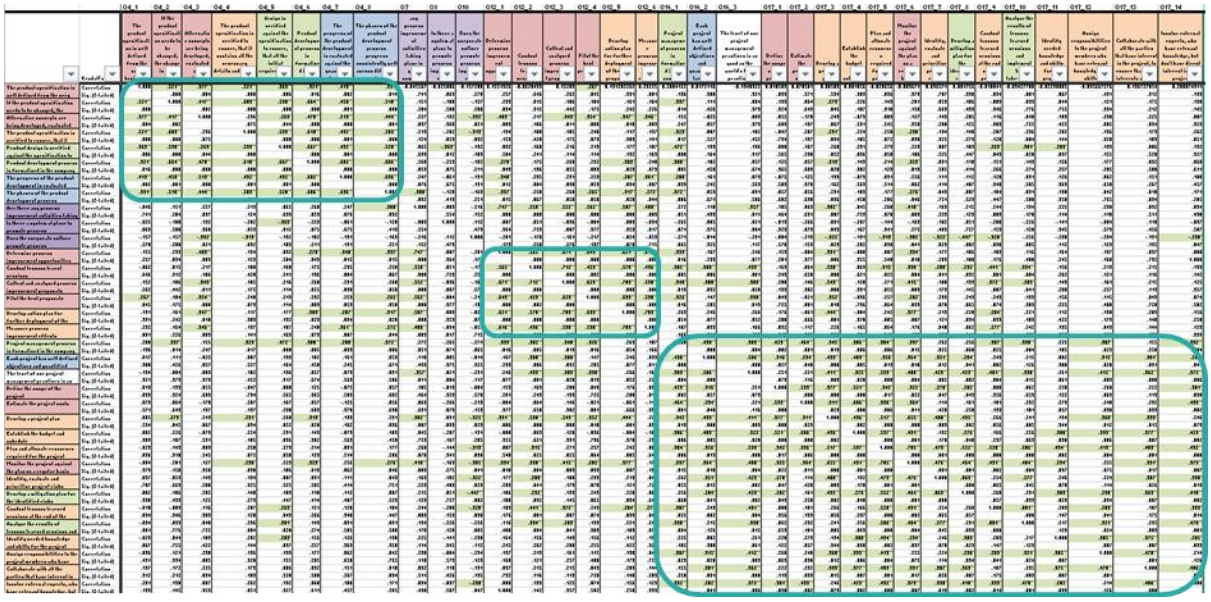

Figure 24. Correlation table for process maturity parameters.

To investigate the connections between the parameters within one theme, machine learning analysis was run again, but with the theme of project management excluded from branching for PDP and vice versa (Appendix 6). The new list of informative parameters for each parameter was similar to the previous one, and this was an expected outcome, since for each of the parameters only one or two (maximum three) parameters were from the other theme. This finding also supports the observation of clusters in the correlation matrices. But similar

to the previous analysis the parameters from higher MM levels were informative to the parameters of lower MM levels, which supports the conclusion that even though the parameters are connected with each other, they do not necessarily form a hierarchical structure in the MM the way we know it, and could be arranged in a number of other ways, forming different models.

4.4. Implications

The analysis of the survey showed that KM parameters do not appear as informative parameters in almost any of the process maturity parameters, and considerably fewer of them have a significant correlation coefficient. This suggests that it was not possible to extrapolate KM MM from the process maturity in this research. The literature review of MM and their application to KM showed the lack of a robust approach to the development of the models among the KM researchers, and this analysis suggests that it might be not possible to develop such a model if it is derived from the process MM and follows its logic. Although I worked with a small sample, the robustness of the results suggests that there is a serious underlying problem – no doubt a promising future research avenue. However, further research in this direction on a larger sample would be useful to confirm or reject these tentative findings.

Apart from that, the analysis obtained through machine learning, as well as the analysis of the descriptive statistics in the previous section, demonstrated that various process maturity parameters do not follow the pattern that was set in a well-established MM; therefore, it is less likely to serve as a robust basis for a model in another area of application. These findings also suggest that academics and practitioners might over-rely on MM, and though MM can be successfully applied in a specific area, one should be more cautious when trying to generalise them. And we need to look back to the origins of the MM in order to understand why.

As was mentioned at the beginning of the literature review, the first MM (Quality Management Maturity Grid) appeared as an application for quality management – a helpful tool for new quality managers with little or no experience for a periodic health check of their processes that could give them a hint on what could be improved (Crosby, 1980). It is important to emphasise that it was a tool for inexperienced managers only in a very specific area of application. But later it was adopted as an industry standard in the software development industry, and though it proved to be successful, it provided little justification for applying it elsewhere. The popularity of MM, encouraged by the success of the software industry, grew so significantly that it started being applied everywhere without any reservations, but their adaption in other areas lacked sufficient validation and analysis, as well as a robust development approach, which was demonstrated so vividly in the literature review of MM for KM.

MM have possibly become so popular due to their relatively simple structure – a small and well-defined number of levels – and they could be helpful as an extra tool for a periodic health check in a very specific area (the way it was originally intended to be used in quality management), but not as a full-scale model for the development of a KM strategy. The attempts to make them as generic and widely applicable as possible are bound to fail, because the generalisation normally leads to loss of context and details that count the most.

These negative findings lead to two main contributions: (1) that MM based on CMMI is not an appropriate tool for structuring a KM initiative and suggesting KM improvements, and (2) that the hierarchy of process maturity parameters as well as the very applicability of the model itself need to be re-examined when used outside the software development industry.

As an implication of these findings to this research, since MM could not be used as a backbone structure in the multiple case study, the interviews were structured with the help of concept mapping analysis based on the emerging themes, which is presented in Section 5.2. Some peculiar patterns were identified after rearranging MM parameters by themes (e.g. an unusually high correlation between forums and PDP), and were examined more closely during analysis of the interviews. Some of the parameters, such as a document repository and project management tools, proved to be of significant importance, and as is shown in Section 6.1, instead of being neglected and criticised in the academic literature, they should rather be examined in more detail in order to better understand what they should be really used for, what limitations they have, and what makes them useful and allows successful adoption.

4.5. Limitations

This was an unexpected outcome, and more research needs to be done to verify these findings. The findings were made possible because new methods were employed in this research and had the data tell a new story. However, one needs to keep in mind that they are based on a relatively small sample, and a large study needs to be conducted in order to further verify the results. It is also important to note that this chapter criticises a very particular type of MM in KM – those that are based on the CMMI model and incorporate five predefined levels of process maturity that were developed for and became popular in the area of software development.

Because of the small sample these findings can only indicate directions for further research. In particular, one could make a larger study with companies from different sectors in order to test whether CMMI maturity levels are indeed not applicable in KM. For instance, we might find that in the software development industry different KM practices are more strongly correlated with the process maturity levels. One could also investigate whether the parameters from the CMMI model itself are applicable in other sectors in the area of product development. For instance, in the technology companies that were in the focus of this investigation it seems that product development process does not follow the same levels of

maturity, and a study with a larger sample could prove or disprove this. We might find that the levels of maturity resemble that of CMMI model, but the parameters that constitute each level, need to be changed. However, the results of the survey analysis need to be taken into account in this study, meaning that it is required to find a different approach to structuring the interviews.

5. Understanding the Journey of Knowledge Management in a Company

The previous chapter attempted to create a structure in a form of a MM that could be used in the analysis of the interviews from the multiple case study. However, the results of the survey analysis did not provide sufficient evidence for such model to be built. Thus I dismiss a very specific type of MM which was transferred to KM without any justification, which however does not dismiss the concept of MM all together. These findings made me search for another method to structure interviews; thus this chapter presents the second attempt to answer the first research question. In addition to exploring the variety of KM practices, I had to find a different way of looking at the interviews as part of the multiple case study and understanding and building the journey of KM, which led to employing a new method – concept mapping. The previous chapters have built the basis for this analysis: Section 2.2 has explained the choices that were made with regards to the methodological approach, and Chapter 3 has explored the background both in the literature and in practice, which helped define the research question in Section 3.6.2. This chapter presents the findings that were planted and harvested in this rich soil. It answers the first research question by identifying KM needs of innovative companies and describing how they evolve with time, and prepares basis for answering the second question regarding the supporting technology – a model of KM, which is complemented with KMS layer in Section 6.1.

The chapter starts by discussing the technicalities of the methodological approach that was employed for the multiple case study design and analysis based on the interviews. This is an extension of Section 2.5, where the methodological choices were discussed on a more generic level. Then it continues by presenting the findings of the analysis of the interviews that resulted in a KM model – the main contribution of this research. And finally this chapter discusses the role of these findings for the existing literature, explores curiosities that emerged during the interviews, such as the role of corporate and national culture in KM, and discusses the implication of these findings on the overall research.

5.1. Methodological approach

As was described in Section 2.2.2, the main part of the empirical investigation adopted a multiple case study design and a mixed method approach to the analysis, which consisted of two parts – surveys (the quantitative component) and interviews (the qualitative component). Section 3.6.1 described the research context of the investigation. One aspect of it that is relevant to this part in particular, is the issues of sampling size, and therefore this section starts by discussing sampling in more detail. Then it discusses the design of the semi-structured interviews and demonstrates how the methods of concept mapping and Gioia's second order themes were applied in order to conduct the analysis.

5.1.1. Sampling

The number of interviews required to build a robust theoretical contribution in qualitative research is a topic that is much less discussed than the sample size of a data set for statistical analysis (Robinson, 2014). The sample size of the in-depth interviews is expected to be smaller, and is justified by the labour-intensive nature of this type of research (Crouch and McKenzie, 2006). For qualitative, and especially concept-generating studies, a relatively small sample size might be an advantage (Dreher, 1994), but at the same time, one needs to have a meaningful sample size (Crouch and McKenzie, 2006), which in turn raises the question of imposing a positivistic frame on qualitative research in order to fit it into a world dominated by the laws of statistics (Pratt, 2008).

The literature suggests different ways of determining sample size that would be satisfactory for a particular research project, such as identifying a point of saturation in the interviews (Morse, 1994) or informal redundancy (Lincoln and Guba, 1985). Some scholars tried to calculate empirically the average number of interviews that result in saturation by analysing qualitative studies. Other scholars tried to identify empirically the norm with which saturation is achieved by analysing empirical papers, and they have calculated a range of 30-50 (Morse, 1994), or 15-60 (Saunders and Townsend, 2016), 20-30 for grounded theory and 15-20 for a single case study (Marshall et al., 2013), less than 20 for a small scale exploratory study (Crouch and McKenzie, 2006), and 3-5 per case in a case study strategy (Creswell, 2013).

However, this approach was criticised, because the very question of demanding a minimum number of interviews from qualitative research, where everything depends on the specifics of the study, is wrong (Pratt, 2009), as not achieving saturation does not mean invalidity of the findings. It might mean that the phenomenon is partially explored, and further research might build on these findings (O'Reilly and Parker, 2012). On the other hand, it means that the size is defined after the data collection is complete (Safman and Sobal, 2004), which is not possible unless researchers have unlimited access to the source of data, which most of researchers do not. At the same time, in cases when companies are being recruited for a specific study, the conditions for participation, such as the number of interviews, need to be specified in advance. Therefore, the indicative number of interviews helps to estimate the amount of companies and the commitment required from them.

In a recent study that was conducted specifically for organisation and workplace research Saunders and Townsend (2016) suggest 30-50 interviews, which overlaps with other interview ranges that were suggested by researchers before, and therefore this sample range was taken as the target. In a multiple-case study it is recommended to have 3-5 interviews per case, but from past experience 3 interviews might not be sufficient to draw a bigger picture of the practices in a company, especially in a large organisation. Therefore, 5 interviews seemed a more realistic requirement, which amounted to 6-10 companies that are ready to commit to have at least 5 interviews each, in order to complete the research.

Since the interviews for the main empirical part of this research were the basis for the main analysis, it was essential to generate an estimate of a sample size. The interviews during other phases of the research were of an exploratory nature and were also bound by access constraints to resources, and so estimates for them were not provided and sample size was defined by the strategy of "getting as many interviews as I can". On the other hand, achieving a larger sample might be necessary in concept-generating studies, whereas in the exploratory studies a relatively small sample might be an advantage (Crouch and McKenzie, 2006).

Defining the parameters of the desired companies that were described in Section 3.6.1 helped to improve the focus of the research, but recruiting companies was challenging and time-consuming. This aspect of the research is undeservingly overlooked in the literature, and therefore it is discussed below.

Access issues

Sampling issues can be of various natures. The two that I encountered in this research were related to sample bias and the difficulties associated with getting access to companies. With regards to the first issue, my research does not identify the point at which companies come to realise the importance of KM, because the companies that agreed to participate in the research are already at this stage, and those that are not, or that are approaching this stage, are likely to either not see the value for themselves, or not want to look "underperforming" among their peers, and are thus likely to decline interview requests. And this suggestion was confirmed by at least two companies that refused to participate. It is also likely that companies that have achieved significant results in improving their KM practices will not agree to participate in this study, because the perceived benefit from the results might be smaller than the resources invested (the time of their employees). And this suggestion was confirmed with at least two companies that were recommended by others or described in the literature as achieving significant improvements in KM, who refused to participate.

The second issue is tightly coupled with the first and is related to the difficulty of getting access to companies. The problems of getting access to companies are rarely discussed in the academic literature. Papers are usually carefully sanitised, and success stories and positive outcomes are overly represented. But this aspect of the research takes a lot of time and resources as well as shaping the research itself and the impact that it makes. For example, knowledge-intense companies, and large international consultancies in particular, tend to be highly concerned with confidentiality issues, and therefore interviews are conducted to the extent at which they are comfortable engaging with researchers, and any type of ethnographic research (such as shadowing) is highly problematic (Karjalainen et al., 2015). Additionally, the very nature of field work is changing: organisational ethnography has traditionally been expected to take place inside the organisation, whereas now professionals spend an increasing amount of time in the field, which complicates field work for researchers even further (Karjalainen et al., 2015). Companies become more fluid and flexible, and thus

the boundaries of an organisation change and blur (Pritchard, 2011). Apart from that, the most successful companies tend to be even more protective of any disclosure of their internal operations and are not willing to discuss them with anyone, and so other companies do not get a chance to learn from the industry leaders through this type of research (Starvish, 2012). This argument might explain why the company that was recognised by several other companies as highly successful in KM never responded to my attempts to get in touch with them.

Recruiting the companies was a similarly painful experience. During the recruitment period I contacted 59 companies and 5 regulatory bodies and networking organisations in the energy sector, inviting the former to participate in this research and asking the latter to recommend potential candidates. The organisations were chosen based on their main areas of activity that are described on their websites, the number of employees, and recommendations and references from previously contacted companies, regulatory bodies or people that were knowledgeable in the energy sector in my network. Of the organisations contacted, 3 assisted in making an introduction to companies, and one of the connections resulted in success. Of all the companies contacted only 16 replied, of which 8 initially agreed to participate and 6 reached the second phase of the research and agreed to have 5-6 interviews in each company, resulting in 32 interviews. The shortest time to respond was 1 day, the longest was 80 days, with the average being 28 and the median 33 days. The first contact was initiated on 20 August 2015, the last company agreed to participate on 04 February 2016, and the last reminder was sent on 3 March 2016, which proves that recruiting a company is a very lengthy and time-consuming part of the research, which is however rarely noticed or acknowledged.

5.1.2. Design of interviews

Section 2.4 has described that the main empirical investigation has employed a semi-structured design for the interviews, which allows a certain degree of freedom, but also assumes a high level structure with pre-defined themes that are supposed to be explored during the interview.

During the main investigation the interviews were focused less on processes, since they were outlined by respondents in the survey. Instead, I was more interested in the knowledge flow in the company, and types of KMS that were in use and any issues related to KMS. Apart from gathering ideas and opinions I intended to create a holistic picture of the state of KM in each company in order to be able to compare and contrast them, and to identify the patterns of natural progression of KM, if they occur. The themes were supplied by both the literature review and preliminary investigation. They include various aspects of knowledge sharing as the core knowing process, aspects that were perceived important by the practitioners and experts interviewed before, such as lessons learnt, the purpose of KMS and types of KMS in use at the company. The list of the themes is provided below:

- Document management practices
- Project management practices: team management, stakeholders' engagement, learning, software
- Experience sharing
- Experience reusing
- Lessons learnt
- Finding experts in the companies
- Ways to identify and track experts
- Employees networks
- Communities of practice
- Collaboration with partners
- Collaboration with remote offices
- New ideas sharing
- Ideas management
- Process improvement initiatives
- Types of KMS in use
- The origins of KMS
- Advantages and disadvantages of KMS

The themes were sometimes explored with the help of open generic questions, at other times they were prompted with the help of an example from other companies. Quite often interviewees shared their experiences through stories, and these parts of the interviews helped to harvest the most fruitful results. All the interviews were conducted face-to-face or via Skype/phone, they were audio-recorded and transcribed to allow further analysis.

5.1.3. Analysis of interviews

Concept mapping

The outcome of this method was meant to be used instead of the survey findings and to help structure the interviews was concept mapping, or the map of concepts that were discussed in the interviews and their relations with each other. The nodes of the map represent concepts or entities that interviewees used to describe practices in the company and their experiences (Figure 25). The nodes can be grouped in different categories, such as KM-related (teal) or KMS-related (purple), and such visual representation helps to conduct the analysis.

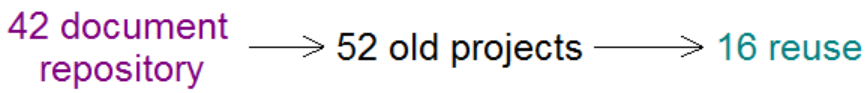

Figure 25. Example of concepts and relationship.

The relationships might be of a multiple nature: they can show the phases of the process, e.g. a project team is selected and engages in project management, resulting in project documents, or they can indicate the consequences of the entities taking place, e.g. the inconsistency of work that has led to the implementation of standard procedures.

The analysis could be conducted on a piece of paper, but in this research it was completed using a specialised software called Decision Explorer[8]. Apart from helping to visually rearrange the map and indicate the central concepts, it also helps find reinforcing loops that emerge on the map. These loops reveal non-linear possibly reinforcing situations (Eden et al., 1992), which would not have been identified otherwise. For instance, the loop below (Figure 26) suggests that project managers rely on their extensive experience and therefore resist adopting a standard approach to project management, which in turn creates inconsistency in working practices among colleagues. Therefore the company can afford to hire only project managers with a wealth of experience in order to function properly. This loop can be a vicious or a virtuous cycle. If it is in balance at the moment, with all experienced project managers, it can perform exceptionally well. But this balance is fragile, and therefore could be a source of a potential problem; for instance, hiring less experiences project managers, or those who have preference to more formal procedures, there could be disagreements, poor collaborations, etc.

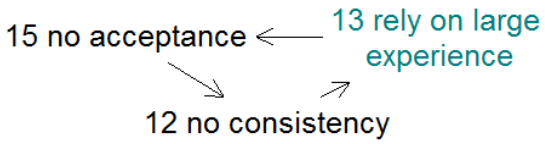

Figure 26. Example of a loop.

Furthermore, Decision Explorer can perform *central analysis*, which calculates an overall impact of each concept on the map and therefore helps identify the key concepts (Figure 27). Sometimes this analysis can reveal surprisingly influential concepts, which do not look visually particularly highly connected, but in reality have an indirect impact on a large number of nodes.

[8] http://www.banxia.com/dexplore/

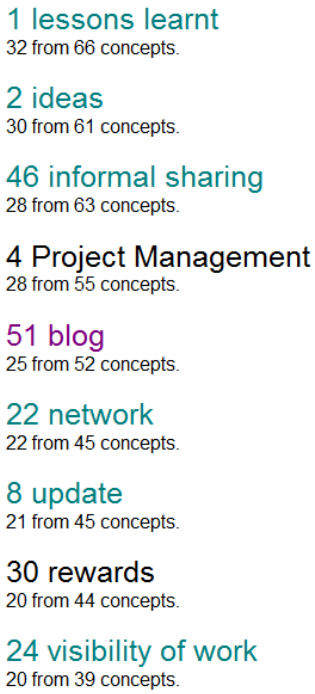

Figure 27. Example of centrality analysis.

Gioia's second order themes

Gioia's method (Gioia, 2004) of second order themes was used to analyse rich and diverse empirical material and populate the structure that emerged from the concept mapping analysis with these insights. A three-level codification strategy lies at the heart of this method: during the first round groups of ideas from the interviews and observations are combined together, during the second round clusters of these groups are combined in the second order themes, and finally the themes are united in the aggregated dimensions (Langley and Abdallah, 2011). As was mentioned before, this method cannot be fully used due to the inability to collect data of the required level of richness, but the codification approach can be applied to the analysis of the raw data and case studies, as it helps to analyse the diversity of opinions about a specific subject matter and to identify emerging themes. The codification phase of the analysis was done using NVivo software (Figure 28).

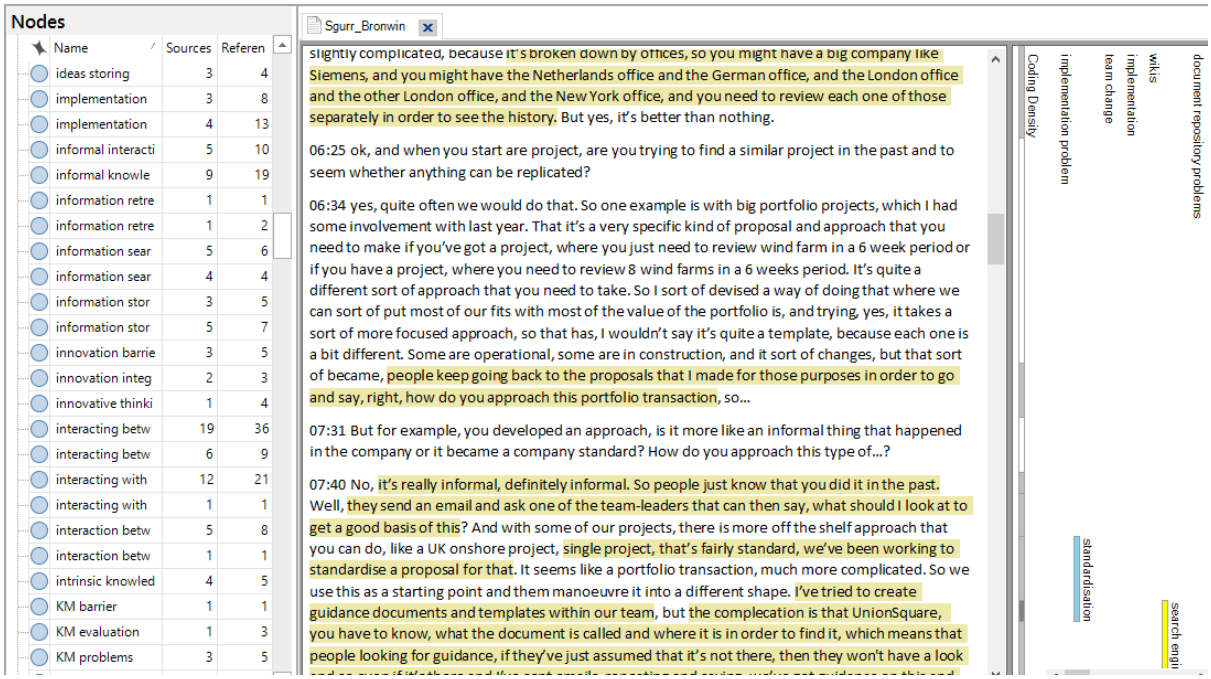

Figure 28. Coding in NVivo.

5.2. The Organic Roadmap of Knowledge Management

Of the eight companies surveyed six agreed to proceed with the interviews. The interviewees were intended to be selected from those who had filled in the survey, but it was not possible to verify this, since the survey was anonymous. The contact person in each company helped select a mix of employees with varying levels of experience both within and outside the company, at different levels hierarchically and representing at least two geographic locations of the company, and who are involved in the project management of product development.

Overall 32 interviews were conducted, each lasting from 30 to 70 minutes and covering the range of themes highlighted in Section 5.1.2. The list of all the interviewees is presented in Table 10.

Table 10. The list of interviewees.

Name	Company	Location	Position
Colin	Caltec	HQ	Experienced PM
Najam	Caltec	HQ	Experienced PM
Paul	Caltec	HQ	Medium Experience
Rhodri	Caltec	HQ	Medium Experience
Bronwin	SgurrEnergy	HQ	Experienced PM
Iain	SgurrEnergy	HQ	New Hire
Jean-Christoph	SgurrEnergy	Remote	Medium Experience
Richard	SgurrEnergy	HQ	KM team
Sarah	SgurrEnergy	HQ	Medium Experience
Curt	SilverSpringNetworks	Remote	Medium Experience
Larry	SilverSpringNetworks	Remote	Experienced PM

Mimi	SilverSpringNetworks	HQ	Medium Experience
Simon	SilverSpringNetworks	Remote	Medium Experience
Victoria	SilverSpringNetworks	Remote	New Hire
Gilbert	SilverSpringNetworks	Remote	Medium Experience
Colin	SP	HQ	New Hire
David	SP	HQ	Medium Experience
Gordon	SP	HQ	Experienced PM
James	SP	HQ	Experienced PM
Neil	SP	HQ	Medium Experience
Fraser	SSE	HQ	KM team
Peter	SSE	HQ	New Hire
Richard	SSE	Remote	KM team
Simon	SSE	Remote	Experienced PM
Sorcha	SSE	HQ	KM team
Tawanda	SSE	Remote	Experienced PM
Alan	Weir	HQ	New Hire
Anthony	Weir	HQ	Experienced PM
Christian	Weir	HQ	Medium Experience
Ian	Weir	HQ	Experienced PM
Michael	Weir	HQ	New Hire
Zi	Weir	Remote	New Hire

Each interview was transcribed afterwards. Though transcribing the interview fully is labour-intense and time-consuming, and some researchers suggest that it is unnecessary (Weiss, 1995), the process of transcribing triggers the analysis (Gillham, 2005), and so is preferable. However, in order to optimise the effort, the repetitions and linguistic fillers were dropped from the transcript.

In the first phase of the analysis the interviews were mapped as a concept map of the current state of each company in Decision Explorer. The resulting maps were analysed visually (seemingly central vs. peripheral concepts), by calculating the centrality for each concept and analysing the most central concepts (in terms of having the most impact on all the other concepts), and by identifying the reinforcing loops in the maps. This analysis was supplemented with my initial impression about the state of KM in each company and provided evidence of the patterns of KM evolution that were initially observed.

The transcripts of the interviews were then coded in NVivo following Gioia's 2 stage process described in the previous section. The preliminary list of codes was not developed, but instead the codes were emerging from the data. After the initial coding the list of codes was revised, while some of the codes were revisited because of ambiguity and duplication. As a result, 217 nodes were reduced to 193. The resulting nodes were then aggregated to 18 parent nodes according to emerging themes. During the second phase of the analysis the codes for each

node were analysed one by one within each parent node and the observations and patterns supplemented an emerging model of KM evolution in the companies of the selected type. The resulting model is described later in this section after the concept mapping analysis.

The initial findings were sent to all 6 companies in the form of a consulting report, of which four companies requested a presentation and the other two provided feedback via email. Writing a report helped analyse the data by articulating them, and the feedback helped validate the model and adjust it accordingly. The adjusted findings were presented at the board meeting of the Durham Energy Institute of Durham University, and the industry representatives that attended this meeting could relate to the problems described and provide examples of solutions, and this feedback supported the validity of the findings.

The rest of this section explains the model and the way it was developed, and then each phase of the model is explained in more detail with emphasis on the interrelations between the phases. During the analysis the companies are referred to as Company 1 to Company 6 in different order to that shown previously to ensure the anonymity of the participants.

5.2.1. The model of KM

After having completed the coding of the interviews, I tried to interpret the stories that the interviewees from each company shared and the issues that they kept referring to. The companies seemed to have different levels of involvement with KM and experiences even if they did not always call it KM. **Companies 1** and **2** had engaged in little knowledge sharing, and justified it by mostly not having time for it. Document management was poorly organised and some of the interviewees recognised this as the major issue. Though one of the companies had a formal KM team, it served mostly a commercial purpose – to demonstrate the novelty of projects in order to justify the funds, and learning from past experience largely depended on the consciousness of project managers. **Companies 3** and **4** had document repositories that were working reasonably well, and both of them had assigned a person to be responsible for KM and were mostly concerned with improving knowledge sharing between engineers and project managers, and particularly lessons learnt and their impact on future work. And finally, **companies 5** and **6** were not concerned with the document management problems anymore, because they had well-established practices. It was possible to see quite a lot of examples of knowledge sharing, though it was not always successful, and both companies were greatly concerned with managing new ideas, having people that were responsible for ideas management.

It was decided to build a concept map for every company, to see whether the observations and observed practices were particularly influential. The following analysis is based on observing the most connected KM (teal colour) and KMS (purple colour) concepts and comparing them with the results of the centrality analysis with the 12 most central concepts

for each company (Figure 40), complemented with the analysis of the loops that emerged from the maps.

In company 1 the map (Figure 34) shows the three most connected KM concepts: *informal sharing, little communication* and *ideas* However, the centrality analysis showed that only *little communication* influences practices significantly, and being a negative statement, it signalises KM-related problems in the company. *Informal sharing* is the 12th most connected concept, and the connectivity index of *ideas* is much lower. The shape and the location of *ideas* as a concept and other KM and KMS concepts show that they are situated in the periphery, and are poorly connected with the rest of the activities. In particular, employees have an opinion about KM, but it is not translated into practice. KMS also exist (document repository, forum and portal), but they are also poorly integrated with the work.

Similarly, the reinforcing loops that emerged from the map (Figure 29), showed that such important practices as *learning from and reusing past experience* occur and are shared informally. Another central concept that emerged from the analysis is *self-defined communities*, which shows the impact that they have on the activities, but it was clear from the interviews that these communities are not recognised by the company, and sometimes are discouraged.

> *"I keep telling the rest of the business, keep knocking their head against the brick walls: you've got to improve this if you want to get benefit from that. We are constantly trying to maintain this community because I see it fundamentally as the basis for improving the business innovation."*

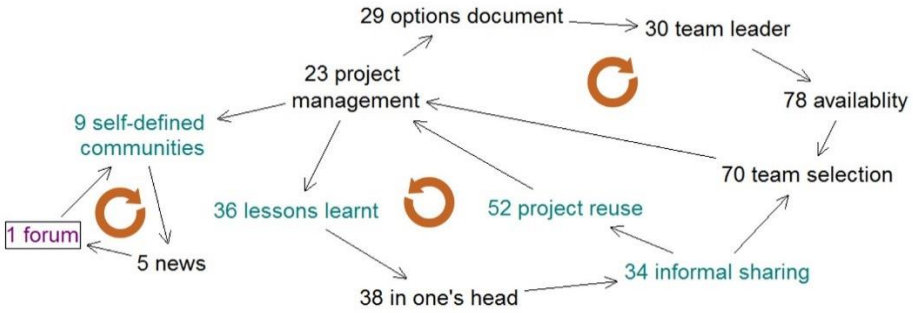

Figure 29. Reinforcing loops of Company 1.

On the second map (Figure 35) we can see six well-connected concepts: *ideas, lessons learnt, project dissemination, showcase projects, document repository,* and *forum*. It is important to note that this company has a KM team, but the focus of KM is highly commercial, which is also shown on the map – *lessons learnt* are important, but aim at disseminating results and demonstrating achievements to an outside audience. This demonstration oriented approach is also reflected in the top central concept, where *reuse of the experience* is largely based on having the right people, who will know what to do. Though *resistance to change* has a significant influence at the moment, the company tries to improve internal KM, e.g. they

realise the importance of *document repository* for document management and the impact that it might have when implemented.

The controversial findings were reflected in the reinforcing loops (Figure 30) as well, where negative statements are being amplified, e.g. no *visibility of work* and poor *check for redundant projects*, *difficulty to find details* and *right people knowing things*, and *resistance to change* and *sanitising the reports*.

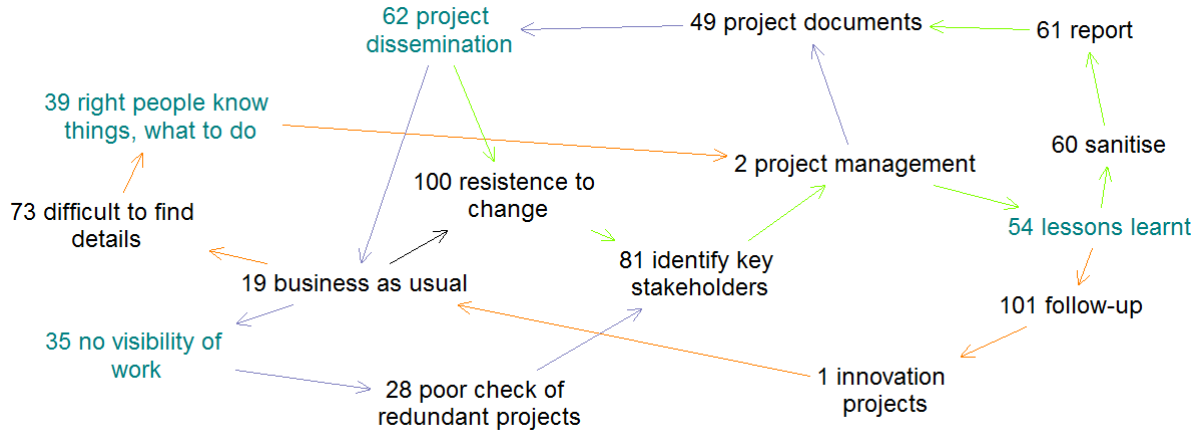

Figure 30. Reinforcing loops of Company 2.

Company 3 has a KM team as well, but their activities are directed inwards, which is shown by the connectivity and integration of *KM* as a concept. From the map (Figure 36) we can see that other KM concepts are also well-connected, including *informal communication, reuse of past projects, document repositories, wikis,* and *bad search*. Four of them are highlighted in the centrality analysis, which indicates that the company has a reasonably well functioning *document repository* and takes advantage of it by *reusing past experience*, actively relying on *informal sharing*. *Bad search* and *wikis* were not highlighted in the centrality analysis, possibly because the issue of *bad search* is solved by introducing *wikis* and because *wikis* are a new tool, and therefore have not had an impact on KM activities yet.

The reinforcing loops (Figure 31) showed that knowledge reuse is supported by *document repository*, the company maintains the *redundancy check* and the employees help each other both locally and internationally.

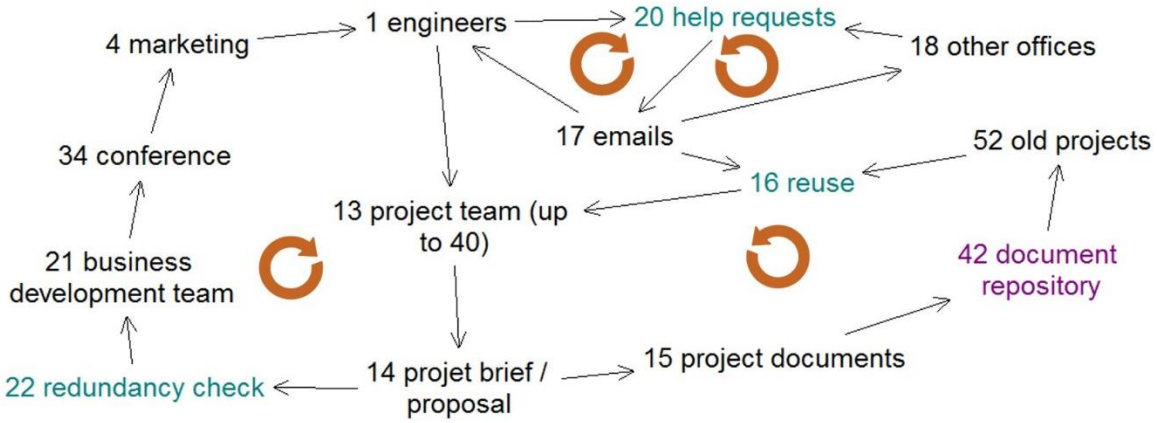

Figure 31. Reinforcing loops of Company 3.

Company 4 moved one step further, and the map (Figure 37) revealed the following connecting concepts: *lessons learnt, informal communities, ideas*, which are mostly obtained through *competitions*, and *wikis*. Most of the concepts are also reflected in the centrality analysis, apart from ideas and competition. Furthermore, the centrality analysis showed the impact that *annual summits* have by shaping the KM and being a form of knowledge sharing of their own. In addition, it highlighted *updates* and *request for help*, which demonstrate that the company is trying to maintain constant information and knowledge sharing about corporate activities: *"...we are trying to stay on top of things."*.

The analysis of the loops did not bring such interesting insights in this case, but one loop is worth noting (Figure 32). It shows that project managers rely on their considerable experience, and therefore do not embrace attempts to make their work more coherent with each other, which in turn affects consistency.

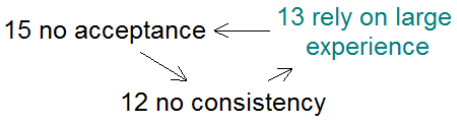

Figure 32. Reinforcing loop of Company 4.

In Company 5 (Figure 38) the concept of *ideas* becomes more connected along with *knowledge sharing, visibility of work, lessons learnt* and *networks*. The technology aspects are not discussed much apart from *LinkedIn*, which becomes a useful multi-purpose tool. The centrality analysis showed partially overlapping results. Apart from the *lessons learnt* and *ideas* which were the most central for this company, the analysis also revealed other impactful concepts such as *informal sharing*, *providing updates*, *visibility of work,* and *knowledge reuse*. Curiously, *blogs* also had a significant impact, which was however not obvious from the interviews, since they were mentioned only a few times.

The reinforcing loop analysis (Figure 33) showed that *knowledge reuse* and *lessons learnt* are quite important components, and the work in general is widely broadcast thus contributing

to these KM activities, whereas the *blog* is one of the channels being used to broadcast ideas. It also showed the key role of *networks*, which help to identify experts and *reuse knowledge*. Is addition, it revealed that the company has developed a more formal approach to managing ideas that also incorporates the results of *lessons learnt*, and the interviews confirmed that the company is expanding this approach further.

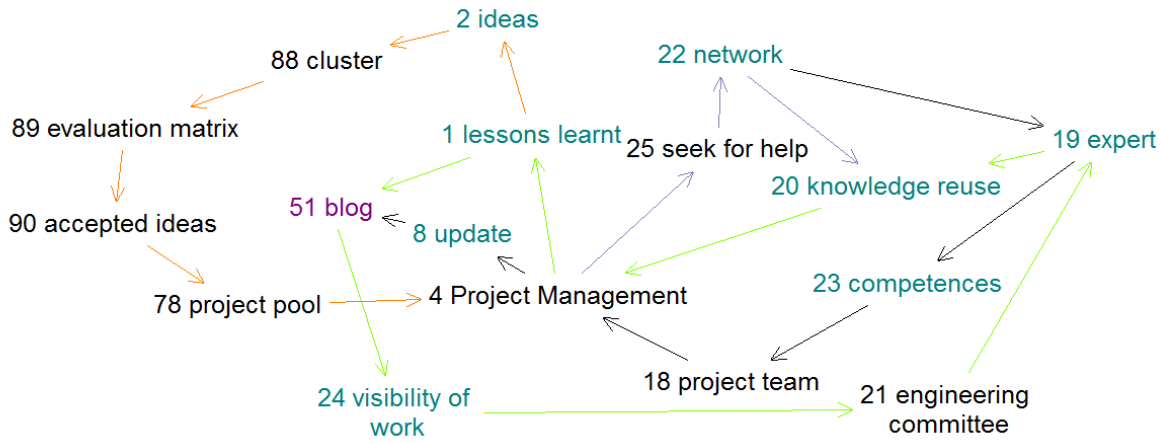

Figure 33. Reinforcing loops of Company 5.

Company 6 is slightly different from other companies: being part of a large company, it still functions as a separate enterprise with the constraint of having to ask for permission for almost any business decision. However, it is interesting for this research because it is strongly driven by innovative culture, and its size allows us to see KM practices that remain important. The map (Figure 39) shows two most connected KM concepts: *ideas* and *document repository*, with *ideas* being the second most central concept according to the centrality analysis. The map also shows the dependence on the parent company, which is symmetrically reflected in the centrality analysis. The loops that emerged from the map did not provide any other insights.

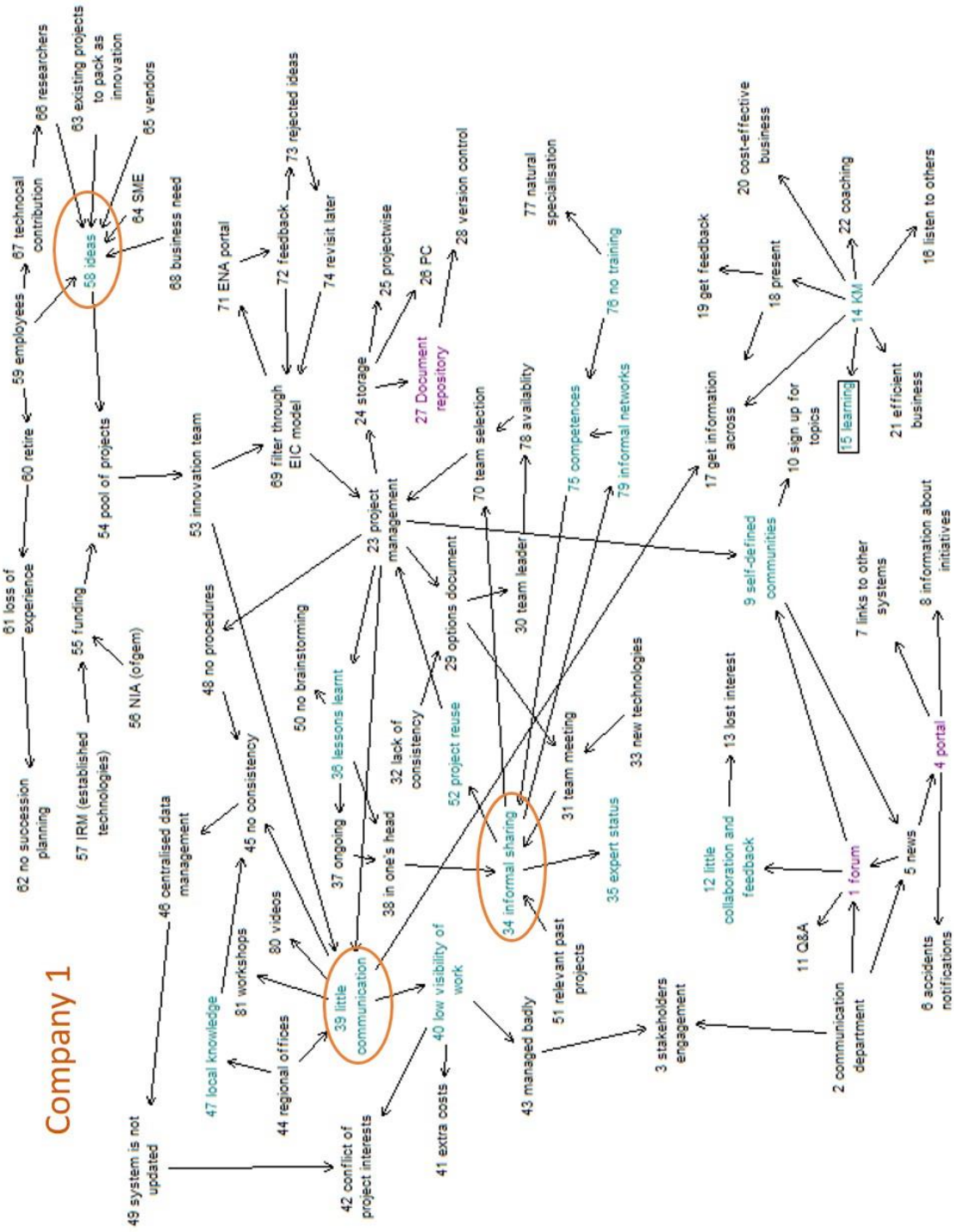

Figure 34. Concept map of Company 1.

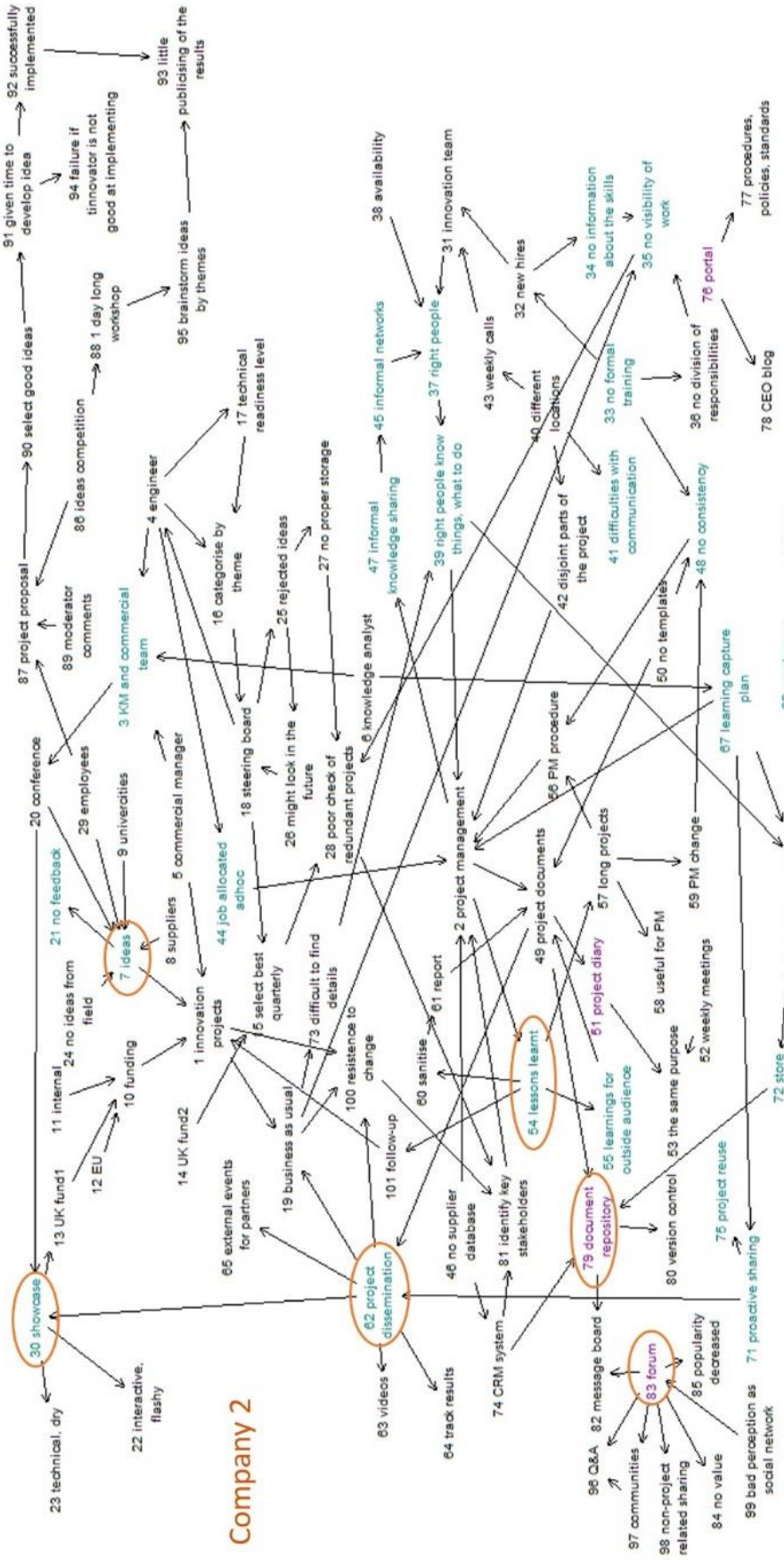

Figure 35. Concept map of Company 2.

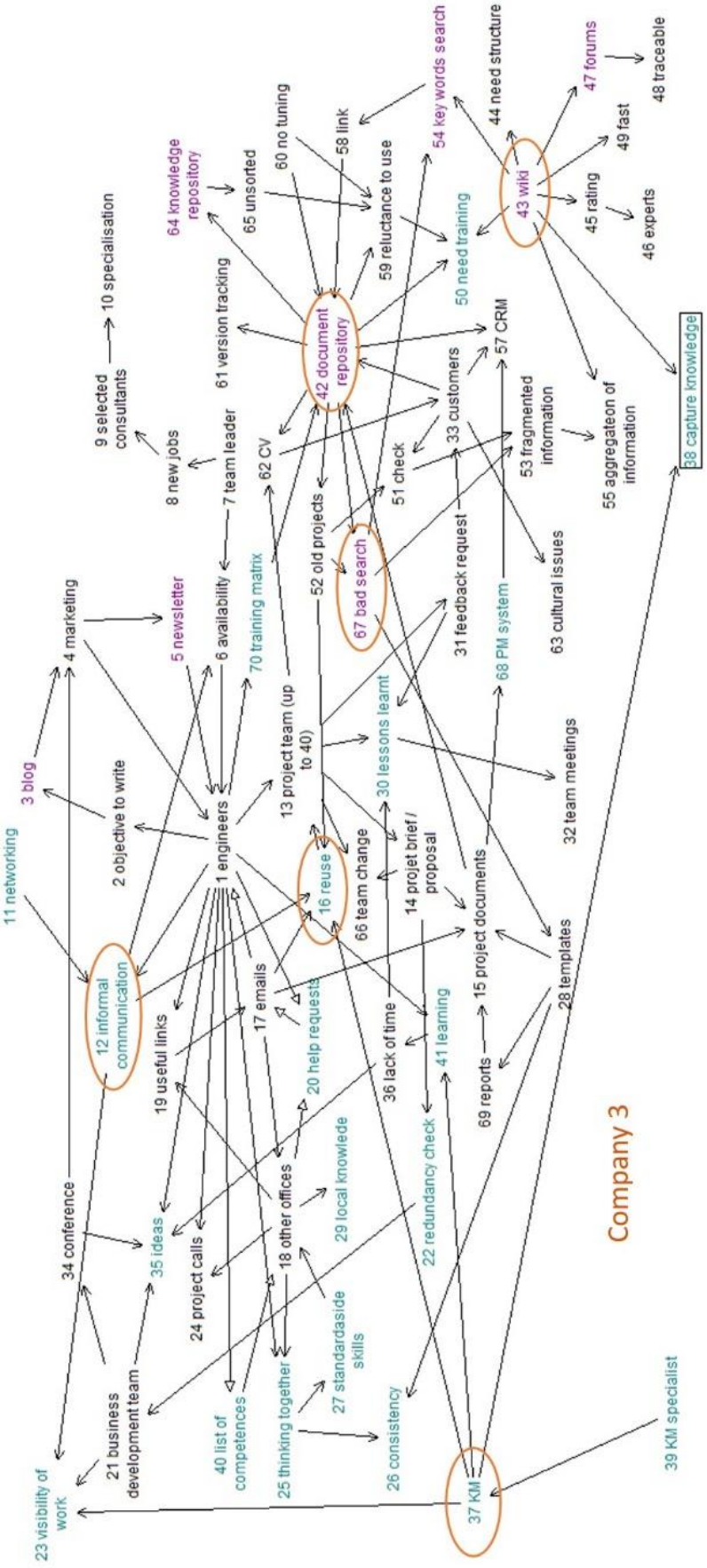

Figure 36. Concept map of Company 3.

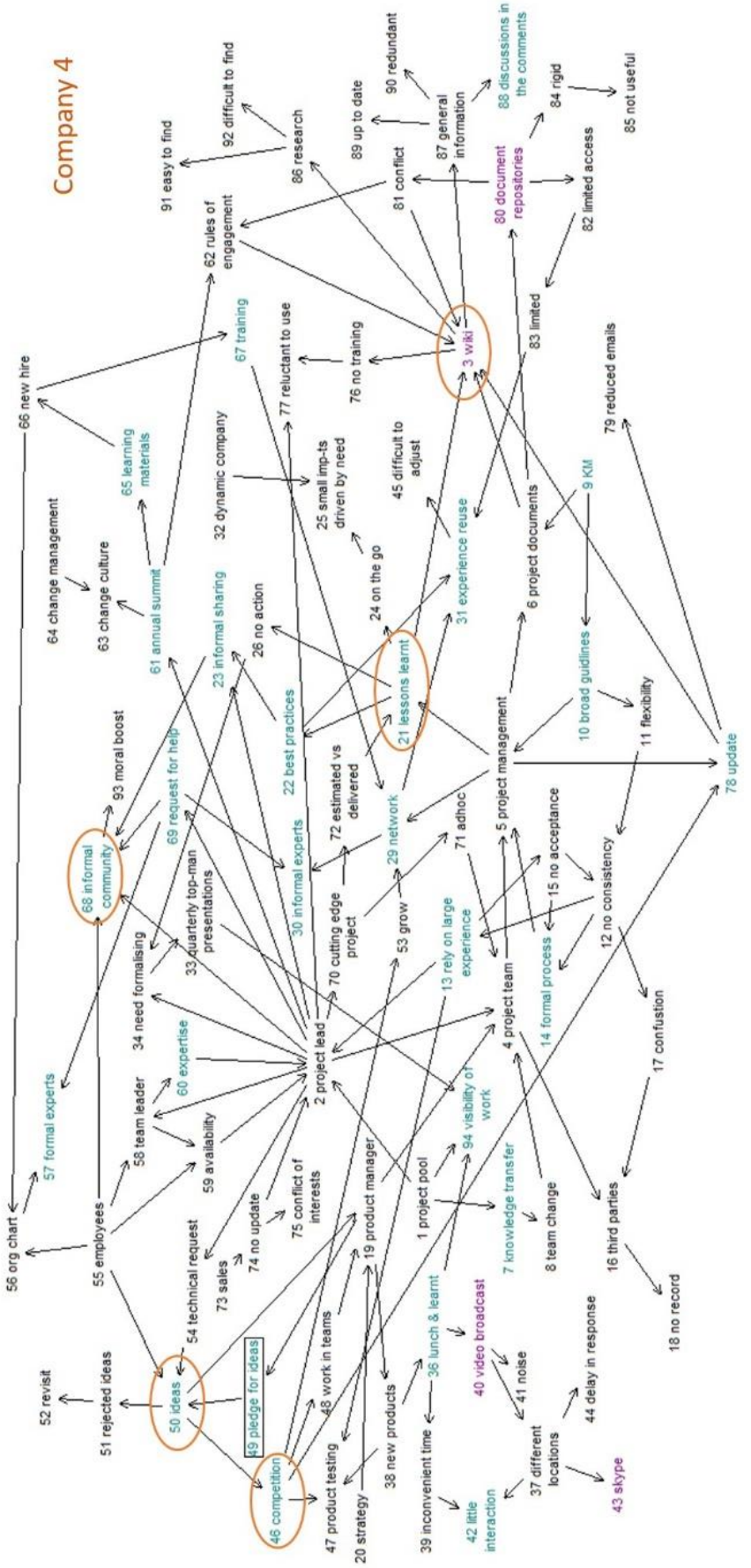

Figure 37. Concept map of Company 4.

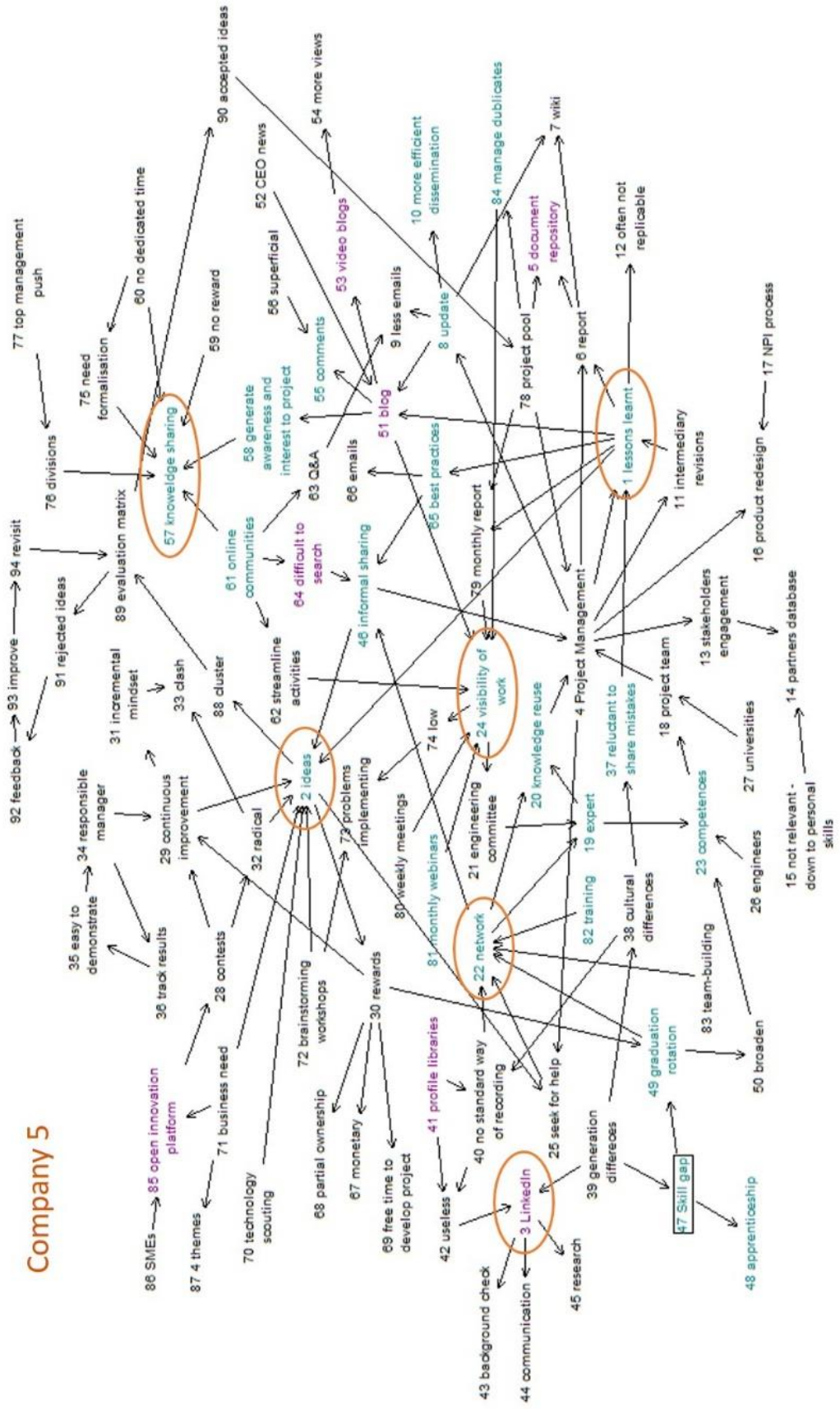

Figure 38. Concept map of Company 5.

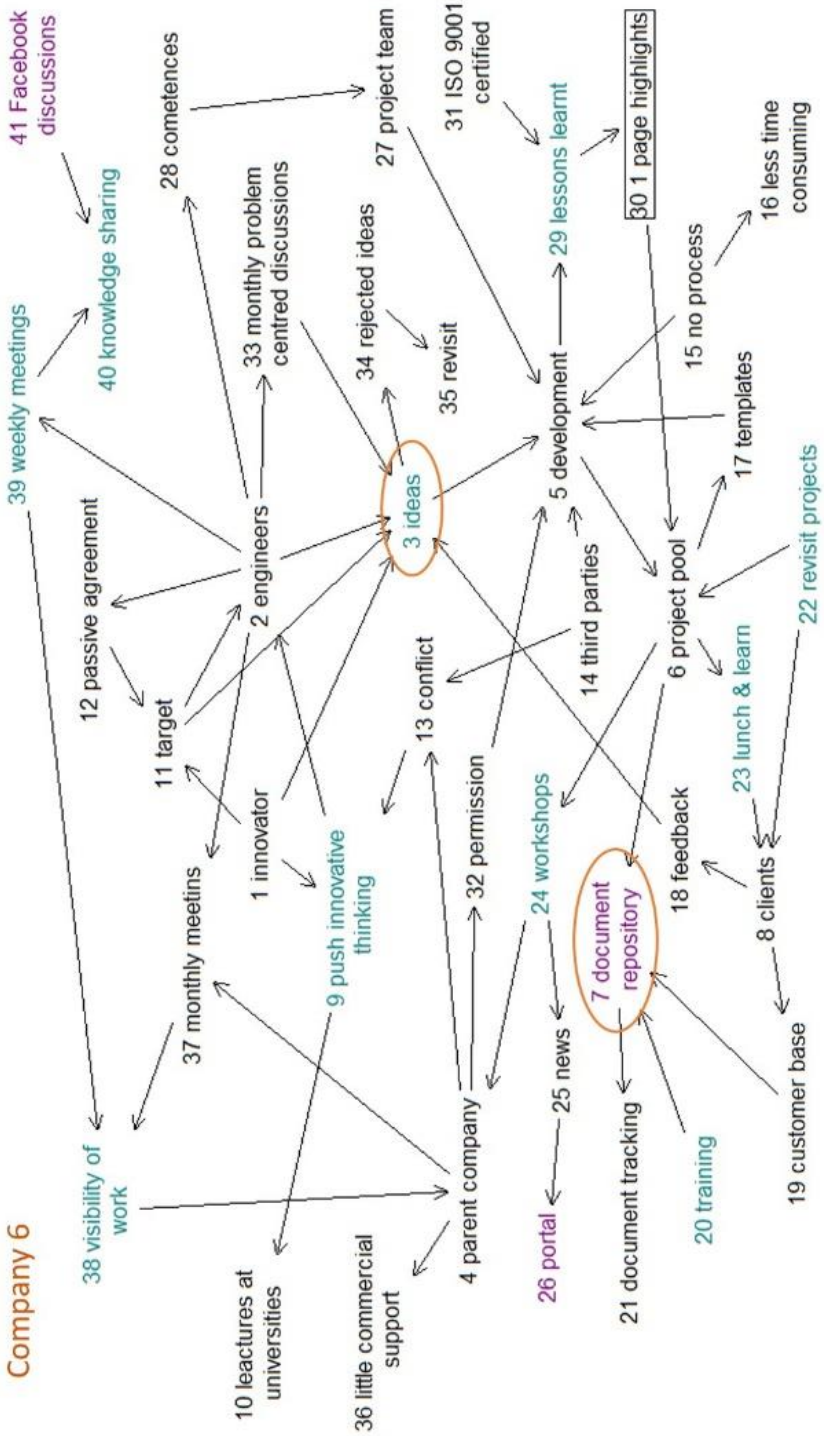

Figure 39. Concept map of Company 6.

If the companies are arranged according to the progression of KM based on my judgement and the insights above, as seen in Figure 40, we can observe three interesting patterns. Learning from past experience grows in importance, with the exception of company 3.This can possibly be explained by them being honest about poor performance in the final part of project closure and not considering their personal insights as lessons learnt, unlike the other companies. Lessons learnt were also not highlighted in the centrality analysis of company 6, though the company considered them to be an essential part of their project management, and even had their process ISO 9001 certified. But probably the dependence on the parent company outweighed the impact of this practice. The second pattern is the emergence of ideas as an important concept as KM progresses. And finally, the influence of document the repository grows in importance, being at the peak in company 3, and then is shifted to the periphery and replaced by social media tools.

This analysis supported the initial observations of the organic evolution of KM in three phases, and complemented it with additional insights. In other words, KM naturally undergoes the phases of *managing explicit knowledge, knowledge sharing* and *creating new knowledge*. In the first phase the companies learn to manage the knowledge that can be and is articulated, such as project reports and summaries, and improve the consistency of work through the use of standards, procedures and templates. In the second phase the companies learn to share knowledge that is difficult or impossible to articulate. Informal sharing can be found in almost any company regardless of their engagement with KM, but it was possible to observe other forms of knowledge sharing, such as sharing within communities and lessons learnt, and they should be recognised and supported as such. However, many companies fall into the trap of extending the logic of managing explicit knowledge to knowledge sharing, without understanding the complex nature of knowledge. And finally, in the third phase the companies learn to facilitate the creation of new knowledge, an essential part of which is ideas management. Most of the companies have tried to engage in ideas management; however, only in companies 5 and 6 did it have a significant impact, which suggests that the companies should naturally progress through the initial phases before the following one can have an impact on their activities.

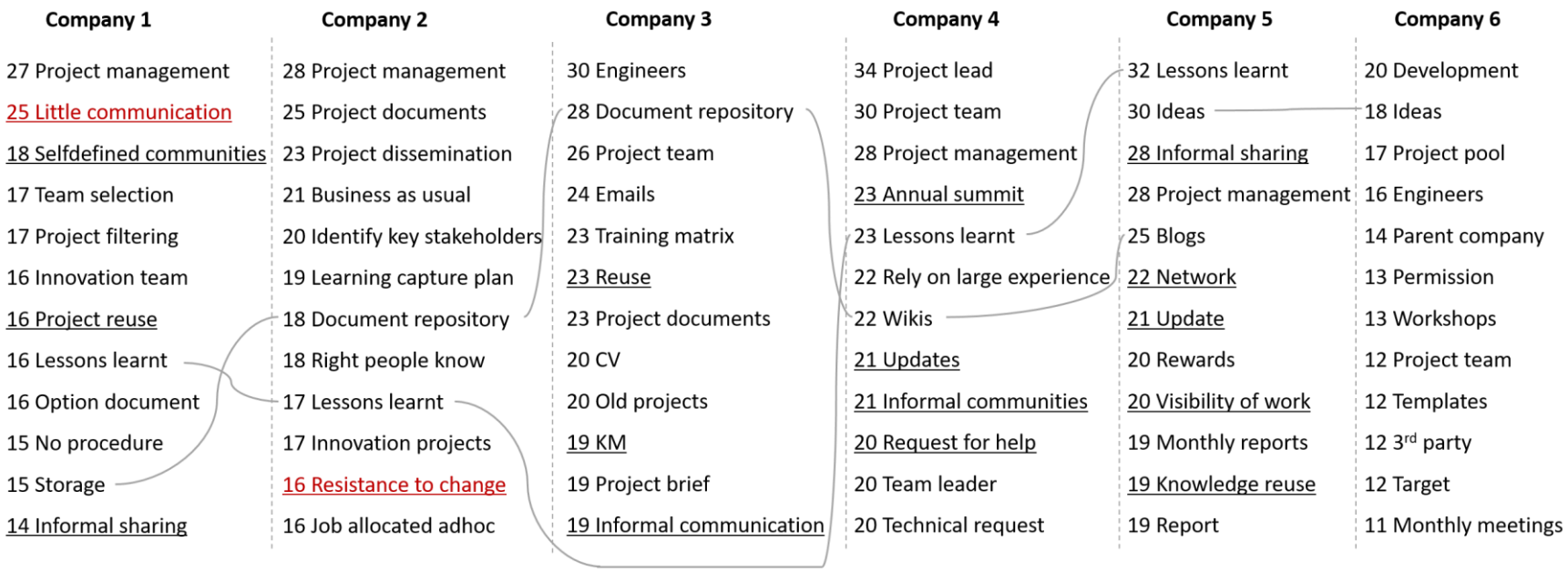

Figure 40. Central concepts.

These phases overlap with and influence each other, e.g. if creating new knowledge is facilitated through ideas competition, as the experience of one of the experts showed, it can improve visibility of work and knowledge sharing, when conducted in a certain way. On the other hand, in a company where knowledge sharing is not appreciated and encouraged, employees are less likely to share new ideas. Similarly, knowledge sharing helps develop common approaches to work, which can improve the consistency of work and of explicit knowledge created as a by-product of it, which in turn eases the reuse of explicit knowledge. On the other hand, with poor document management practices, knowledge workers are less likely to have time to share knowledge, or this is limited to helping each other locate relevant documents.

The impact of the technology component varies across the phases. During the first phase effective management of explicit knowledge starts with developing common practices for managing data and information, such as employing common standards and templates. This can be achieved only with the help of a document repository, where consistent explicit knowledge can be stored, located, shared and reused. From the companies interviewed we can see that company 3 has integrated the use of document repository at its core and is at the beginning of the second phase now. Starting from the second phase technology is more likely to become a mediator for physically separated employees, but it can only function within a system of knowledge sharing processes and practices, that it cannot itself facilitate. In the second phase, among all the KMS types that were reviewed in Section 3.2.3 wikis stand out as a tool for improving the imperfections of a document repository and enabling collaboration. It is shown in Section 6.1.5 of the next chapter that wikis can be an interface of document repositories, or they can even replace them. Finally, in the third phase gamification could become a potential technology layer, lowering barriers to creative thinking, but the gamification aspect is discussed in more detail in Section 5.5 at the end of this chapter. The resulting model is presented in Figure 41.

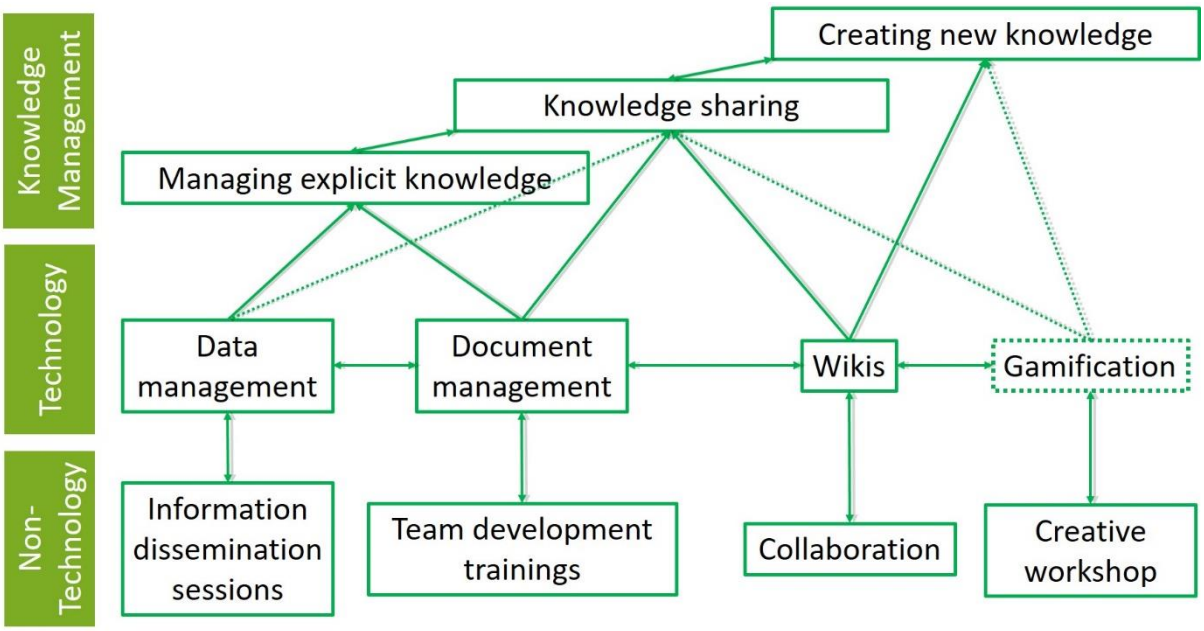

Figure 41. Organic Roadmap of KM.

It can be argued that this is a MM of KM as well, and in essence it is, but this model is grounded in data, in the observations of what KM practices are like in different companies, not conditioned by the predefined levels of maturity adopted from a different area. Similarly, the first maturity model that developed by Crosby (1980), was grounded data, in his experience, and that might be one of the reasons why it became successful and was acknowledged useful. For that reason I intentionally do not call it a MM in order not to confuse the foundations of this mode with a widely accepted CMMI framework.

This model was presented to the companies that participated in this research, and they found it relevant. The following part of this section expands on each of the levels of KM. The third level – non-technology – suggests the equivalent to the KMS function on a roadmap and is implicitly included in this chapter.

5.2.2. Managing explicit knowledge

Managing explicit knowledge is usually associated with capturing and codifying existing knowledge, and a supporting technology system – document repository – is considered an important if not central part to it. The technology aspect of this topic is covered in Section 6.1 of the next chapter. This section examines knowledge capturing and mapping, which are regarded as essential to KM in the literature (Hansen et al., 1999; O'Dell and Grayson, 1998) as opposed to the practices that were discovered in the interviews.

With respect to knowledge capturing, the major issue raised by companies in more established parts of the energy sector was knowledge loss and succession planning, referring to employees that have decades of experience in a company and approach their retirement age. Similar problems have also been noted in the literature (Grant, 2013). The companies

tried to capture the knowledge of "wizards" through exit interviews or through recording their experience in the form of manuals, but these attempts had very limited results. This is not surprising. Knowledge of intellectually-intense workers (like that of the engineers in the energy sector) is highly contextual and tacit to a large extent, and so capturing 40-50 years of this rich experience in a manual is hardly possible. Such knowledge can be transferred only through spending time with the knower (McIver et al., 2013), for example, through apprenticeship programmes. One of the companies realised the complexity of the problem and that it does not have a short term solution, and started a two-year rotation programme for new hires, during which they change their position 3-4 times in different departments, division and countries. During this induction, they get a chance to spend time with highly experienced engineers, many of whom are close to retirement, and learn from their experience which they would not have gained otherwise, because unlike university graduates that enter the company nowadays, many of the experienced engineers started their career on the shop-floor. This program is a short version of the apprenticeship program, in addition to a standard apprenticeship for factory technicians.

Nevertheless, parts of this knowledge can be captured and formalised, such as the outcomes of projects and best practices, or some aspects of lessons learnt that are recorded in project reports, and this topic is further elaborated upon in Section 6.1 of the next chapter. With regards to formalisation, it was interesting to observe a contradictory attitude to rules and regulations. On one hand, the interviewees reported that they would like to see the organic growth of KM, but on the other hand, they suggested that a certain level of formalisation is needed in order for people to take KM activities more seriously, and this is especially true at the beginning, when the change is being introduced and routinized.

> *"There is no clear process for managing information that goes on each platform, that's what's really lacking."*

> *"If they scheduled it like every 2 months on Thursday we are gonna have something, and it's mandatory for you to attend, then we could probably do something about it."*

> *"I've offered a part of this to my colleagues, but I'm pretty sure that it was not taken on board, not because they ignore me, but because there is no formal way of doing that."*

Below are some examples of formalisation that interviewees provided as already successfully taking place, or as rules required to make new practices function:

- Targets for a number of new ideas proposed by each employee.
- Formal closure of reports (including mandatory lessons learnt sessions and debriefing of clients).
- Contributing to the knowledge pool as a formal objective during appraisal (e.g. a blog).

- Making knowledge sharing sessions mandatory (e.g. lunch & learn session, which are discussed in more detail in the next sub-session).
- Formally assigning a person to be responsible for the action plan as a result of lessons learnt.

A number of interviewees suggested that initiatives that are not directly related to their job and are not formalised tend to be ignored, while they also mentioned that if some activities were mandatory, the interviewees would probably participate in them. This finding does not suggest that KM practices should be over-regulated, but the power of formalisation should not be underestimated either. The right balance is necessary.

The other aspect that was mentioned multiple times, and can be related to formalisation, is standardisation in the form of templates and checklists, and standard approaches to performing certain tasks (e.g. a gate process). For more KM-experienced companies it was standard practice, which was also helping to improve the consistency of work:

> *"…trying to make sure that all our reports and deliverables look similar, and that's where templates come in, but also that they are written in a similar style, and we have a style guide just to make sure that everyone writes in a similar way…"*

In other companies this topic had an emotional response, especially among less experienced engineers:

> *"I've spoken with my colleague before about potentially trying to make a golden sample, where you know exactly what the standard should be, a really good example of how to complete one."*

The need for formalisation is only natural, as employees tend to focus on what they are evaluated for, things that are a part of their everyday job (Bassi, 1997; Davenport and Prusak, 1998), and formalising, recognising and setting targets justifies the effort put in completing non-job-related activities, or in changing routines. An example would be keeping a tidy and detailed record of project progress in a dedicated system, instead of keeping messy documents on the local drive, and not conducting lessons learnt, just because they will not affect the outcomes of this project.

Even though formalisation was opposed to organic development, it can be introduced organically by "legitimising" the KM activities and inviting employees to participate in them. For instance, activities can be tracked using the mechanics of gamification (e.g. through collecting points for contributing).

> *"It's much easier to encourage people to do something because they've been ranked on it every day and it's part of their actual job – to make sure that things have been run efficiently."*

The phenomenon of gamification is discussed in more detail in Chapter 7, but it is important to note that we can only gamify an activity that is formalised to a certain extent. Collecting points can only be meaningful, if employees are recognised for their score or can do something with the points. Points might also cause competition among employees, which does not always have a positive effect on corporate culture. The dynamics of competition vs. collaboration and the ways to balance them are discussed in the appendices related to gamification.

With regards to explicit knowledge KM literature also emphasises the importance of knowledge mapping, which is achieved to a large extent through recording the experience of the employees (Davenport and Prusak, 1998; O'Dell and Grayson, 1998). However, during the course of the interviews there was no evidence of the need for experience mapping, primarily because people naturally tend to look for relevant experts informally and seek recommendations within their network. One could think that people do not realise the usefulness of this tool, because they have no experience of using it, and some interviewees have even suggested that it could be useful in a bigger company. One of the interviewed companies was tracking experience automatically through a document repository, since engineers had to claim hours for each project only if they are listed against it, but knowledge workers did not find any use for this carefully gathered information. There were several explanations for that: the list of all projects does not differentiate between projects, or indicate which were the most important ones for an individual; and secondly, it gives only a vague idea of what people are actually good at. But even if the projects are transformed into competences, interviewees identified several problems associated with that:

- Experts in some countries (such as the UK) tend to be modest about their competences and might not want to list what they are good at.
- This information is useful only if updated regularly, but this is unlikely to be maintained.
- Even if this information is updated, it might not mean anything, as one can judge if the person is an expert only after having interacted with them.
- Sometimes differences between departments and areas of expertise are not obvious and can only be clarified by talking to people.

However, having a list of subject matter experts as the first point of contact proved to be useful for remote offices. In some companies heads of departments or teams were expected to be subject matter experts, while in other companies such lists were the result of an agreement between top managers on who the experts are. The use of gamification mechanics, such as tracking points based on the activities on a knowledge sharing platform, might also help.

The practice of mapping knowledge and locating experts was only developed to help the knowledge seeker find the knower, as a prelude to knowledge sharing. The following section

discusses this practice in more detail, and in particular it shows that instead of trying to map experts the company needs to create conditions for its employees to grow informal networks and interact with each other.

5.2.3. Knowledge sharing

In the literature review it has already been discussed that knowledge sharing does not have a commonly accepted definition and is more likely to be an umbrella term for various practices. Through the course of the interviews I observed various forms and formats of knowledge sharing in the companies, and discussed with the interviewees necessary conditions for and barriers to knowledge sharing. All of the interviewees get naturally involved in informal knowledge sharing with their colleagues, and when asked about the purpose of KM, they do not necessarily relate the two, and talk about knowledge capture and dissemination instead. But as we saw in the literature review in Section 3.1.1, knowledge sharing is central to KM.

Not surprisingly the interviews showed that most of the knowledge sharing happens in the office during team-meetings or informally during casual conversations. Other more formal events included organising formal presentations and demonstrations of new products, conferences and workshops, of which a particularly interesting event that proved to be successful is called "Lunch & Learn" and is discussed below.

Lunch & Learn

The Lunch & Learn format was used by several companies and was successfully applied to educate people about new products or services, or new initiatives in a company. The format varied from organisers providing some snacks and sandwiches to inviting people to come along with their lunch and listen to a presentation. As one of the interviewees commented:

> *"...it's a way to bribe people to come and listen to you for some free food."*

Lunch & Learn sessions were particularly successful in companies 4 and 6. However, this format, like any other face-to-face activity, tends to naturally exclude remote offices. Some companies tried to overcome this barrier by setting up a video conference call for everyone to join, but participating remotely was still difficult. The most common reasons were being in different time zones and background noise, which disturbs the flow of the presentation for them. This observation emphasises two points: the importance of a common physical space and the need to put extra effort into engaging remote employees in various activities.

The importance of common physical space, and more importantly, the area where people can mix with each other (metaphoric coffee-machine areas), has been emphasised by a number of authors (Davenport and Prusak, 1998). For instance, Shell reflected that while 85% of their KM budget was spent on building the database, only 15% of the value is gained from its use,

and the other 85% comes from the interpersonal discussions (Grant, 2013). And when I was presenting these findings, one of the representatives at the board meeting of Durham Energy Institute shared a story about a factory that had to rebuild a common room, because when it had previously been shut down due to cost savings, informal knowledge sharing was paralysed.

Remote knowledge sharing

When asked about the remote work, many interviewees did not see geographical separation as a problem and reported being able to work with their colleagues from other offices almost as effectively, relying on emails, video calls and chat. But examples and stories from the answers to other questions proved the opposite. For instance, when people in one company were invited to participate in an ideas competition, only the employees based at the head office were involved, since it was easier for them to form teams and work on a project. Those interviewees who saw distance as a potential problem were addressing it proactively by forming communities with colleagues in order *"to stay in the loop"*. Among other ways to overcome distance was an interesting example of forming project teams made up of specialists from different offices, since it forced them to maintain regular communication about on-project related matters and improved integration of the employees. It also led to discussion of more general topics, such as policies, standards, and working practices.

> *"...we kind of like to push each other a little bit and provoke each other saying: are you sure that it should be considered that way."*

This is an example of an extra effort that a company makes to overcome a geographic separation. However, other interviews showed that it could also disjoint a long project (longer than a year) since remote members tend to work on their part of the project in isolation.

> *"I am worried, that when we get to the end, we'll end up with a report and my report."*

Without a doubt, face-to-face knowledge sharing cannot be substituted with a KMS, but it can be complemented with electronic forms of knowledge sharing and dissemination in order to build a bridge between different offices. The most widespread forms include newsletters, group emails (e.g. for all project managers), formal summaries of all reports in a given period of time, or white papers which reach a wide audience. Other forms that were observed less frequently include using Web 2.0 tools, such as blogs and wikis. These tools are discussed in more detail in Section 6.1, but it is important to note the characteristics that are relevant to knowledge sharing in this section.

Wikis, blogs and forums were deemed particularly useful in knowledge sharing because they allow knowledge workers to pull information and knowledge, as opposed to having it pushed onto them. They can do so by signing up for the pages they are interested in and receiving updates when they occur. These tools were increasingly in use in companies 3, 4 and 5 and

were employed for maintaining updates about a project or product or a new initiative (e.g. an ideas contest), to post news, or to share interesting material with the members of a new group (e.g. new hires or project managers). These tools were praised for giving others control over what they follow and when, and when they want to stop following them, or for having all the information gathered in one place, and therefore drastically reducing the amount of emails.

Web 2.0 tools introduced the notion of knowledge pull in a virtual space. Traditionally it is associated with active knowledge seeking and subsequent sharing between the knower and the seeker. Section 3.1.2 described different knowledge worker roles that can be found in the company and discussed the role of the connector in helping to establish the connection between the knower and knowledge seeker. What makes connectors stand out is a larger network of people that they are connected with.

Networks

The informal way of knowledge seeking and sharing depends largely on the **networks** of each individual. The previous section showed that even if the expertise of employees is well documented, employees tend not to use these kind of maps. Repeated questions about the need for a formalised expertise map or recorded activities in order to improve visibility of work did not find any emotional response. But employees tend to look for help and advice among their immediate surroundings, or in other words, network. Therefore, the companies have clearer focus on creating opportunities for growing networks, especially for new hires.

Some of the companies interviewed organise sports activities and competitions, training programs for new hires and rotation programs. In other companies the network growth happens in the project teams formed from different offices or through company-wide initiatives, such as ideas contest.

> *"I'll organise weekly meetings with them, and that way to talk to them long enough, that you start building the relationship."*

Networks help achieve two aims: they create overlapping maps of experts in the minds of knowledge workers, and improve visibility of work. Interestingly, the latter was rarely discussed by the interviewees as an important aspect of KM, and mostly in relation to the problems that are caused by the lack of work visibility. Some of the interviewees anticipated these problems and formed communities in order to regularly share activities they are engaged in with each other and be aware of the things happening around them.

Communities

The term 'communities' is often used interchangeably with networks, but these terms are different and serve different purposes. A network could be compared to LinkedIn connections – a group of people that you have something in common with, and the interests of whom

might intersect with your interests at a point in time. **Communities**, on the other hand, could be compared to the group of electrical engineers that are working on developing new standards for solar energy. In the community people are united by common goals or interests outside their main job responsibilities, with the main objective being to develop common practices and approaches, discuss and solve contradictions, and learn together. Some companies, such as Schlumberger and Fluor, built their KM strategy around communities of practice – a sub-group of communities, which are facilitated by community leaders, who define the main goals and objectives and keep the communities active (Grant, 2013; O'Dell and Huber, 2011). In these companies being nominated for a position of a community leader is considered very prestigious, as well as being well compensated.

In the companies interviewed it was possible to identify communities formed around a certain profession or area of interest. In company 5 they were formally recognised, the company 4 relied on unofficial communities quite significantly, as the centrality analysis showed, whereas in the first three companies it was possible to identify grass-root communities, which were maintained on pure enthusiasm.

> *"I keep telling the rest of the business, keep knocking their head against the brick walls: you've got to improve this if you want to get benefit from that."*

The interviewees from the first three companies were aware of some of the corporate communities, but the most common reason for not following or committing to them was lack of time. The lack of time to spend on activities that are not a part of their primary job in general, not only communities, was the most frequently cited reason for not sharing and not getting involved in KM activities, and it was more frequently mentioned in the first three companies. This observation correlates with the findings in the literature review (Alavi and Leidner, 2001; Sveiby, 2007), and suggests that once explicit knowledge management is improved, employees might find time and start appreciating the benefits of knowledge sharing more. The other side of this problem was the apathy of peers or the lack of response to their contributions, which discouraged sharers from contributing to the knowledge sharing platforms and could also be linked to lack of time.

The communities were mostly formed either around a profession (e.g. project management), or around an emerging area of expertise, which was not well regulated yet, or could potentially become an important strategic competence for the company. The communities were sharing their findings, working on developing common standards and approaches to work, and helping each other to learn, but communities were not the place where new breakthrough ideas could emerge. Though communities were identified in all the companies, none of them reached the potential of communities of practice that would engage in thinking together and increasing common expertise (Pyrko et al., 2017). Their activities varied from spontaneous discussions about working practices to informal sharing of updates, mutual

moral support, streamlining group activities and sharing knowledge in the form of reports and presentations, being an extension of formal meetings.

Most of the times communities require IT support in the company setting, and from the experience of the companies the communities were using group emails, which would sometimes generate heated discussions, forums and wikis, where the main information, news and updates are posted. Though interviewees understand that the use of wikis or forums is preferable, since the information remains there for further use, smaller communities tend to use group email as the simplest solution.

Communities require a certain level of formalisation, rules of engagement that might be created by the members of the community and following which indicates the commitment of the members to the community. This might be the reason why not many communities were observed in the companies interviewed and their productivity was limited. As similar situation was observed with another knowledge sharing practice that requires a certain level of formalisation and structuring – lessons learnt.

Lessons learnt

Lessons learnt represent a deeper level of knowledge sharing, including self-reflection and reflection on the work that can lead to re-contextualisation of existing knowledge and even creation of new knowledge. This might be the reason why of all the companies interviewed only one (company 6) was satisfied with the performance of this practice in their company and was even ISO 9001 certified, though my impression was that company 5 was too modest about their practices. All the other companies acknowledged its importance, especially companies 3 and 4, and tried to utilise it in one way or another, but could share very limited results. For some project managers it was a good self-reflection practice, which enriched their own experience, but which they did not share with others, for others it was a topic for discussion as part of a project closure, but the results of this group reflection were not taken forward.

Analysing part experience can involve a variety of things from the things that were done well to the things that could be improved. However, lessons learnt were mostly associated with analysing the mistakes, during the interviews, and less so with examples of excellence at work, or best practices. Of the companies interviewed two maintained case study databases with **best practices**, but they were mainly created to show-case the projects to clients, and where the emphasis is put on the external aspects of the project rather than the information that could be potentially useful to other project managers. One of the interviewees shared his experience of working in a previous company, where a database with best practices was used as a learning tool at the initial stage of any project, and saved him a lot of time.

With regards to mistakes, interviewees agreed that learning from past mistakes is important, but one of them explained that lack of such practices might be related to cultural differences

and resistance to admit mistakes in western culture. In support of this opinion, another interviewee said that if lessons learnt are included in the official report, they are most likely to be sanitised, and some interesting details will be removed as being inappropriate or unimportant. And even if they are not, a lot of lessons learnt tend to be lost throughout a lengthy project, if they are being analysed only at the end. Therefore, a number of interviewees considered self-reflection as the project progresses to be the type of lessons learnt worth spending time on.

Even if the lessons learnt are conducted properly, too many of them might not be disseminated, used or put into action. The interviews did not suggest solutions to these problems, but it was possible to identify two major approaches that might complement each other. The first one is practiced by Intel, where lessons learnt are aggregated periodically in in a summary, which is then distributed around the company (Pugh and Dixon, 2008). A similar approach was successfully used by one of the companies interviewed during the preliminary investigation. The second approach is practiced by NASA, where each lessons learnt session is facilitated using the cognitive mapping technic, and produces rich results with a detailed action plan and assigns persons responsible for each action (Rogers and Fillip, 2016). It seems that the first approach works best with a lot of smaller projects, and the second approach is worth investing time and resources in only with large projects that produce a lot of learning.

The review of knowledge sharing in the companies interviewed highlighted two major barriers: lack of time, and distance between offices. Knowledge hoarding or hiding (Connelly et al., 2012) was also mentioned and was observed in one company; however, it was primarily related to restructuring within one division, which generated fear of a job loss. Under other circumstances in all the other companies this problem was not observed. Other knowledge sharing barriers, such as fear of criticism and “losing face” (Ardichvili et al., 2003; Voelpel et al., 2005) were not identified in the companies interviewed.

5.2.4. Creating new knowledge

The last knowledge sharing practice – lessons learnt – partially overlaps with the phase of new knowledge creation, since it might result in new knowledge being created. However, when talking about new knowledge, the interviewees mainly operated within the category of ideas, for which lessons learnt could be one of the sources.

Ideas management could be seen as a subset of innovation management, although sometimes both terms are used interchangeably or are overlapping depending on the definition of innovation. For instance, an idea could be related to a process improvement, but not every company will see it as innovation. In this research ideas management represents PDP, an activity that was studied within the context of KM, and in the companies interviewed ideas management followed the logic of innovating process of Tidd et al. (2005) – the ideas are being collected, selected and implemented, and the results are being evaluated. However,

this research is mostly interested in the first phases, since the evaluation of results is less related to KM.

When we refer to the phase of **ideas collection**, the source of the ideas defines the types of ideas that can be collected, and impacts the ways in which these ideas can be collected. Ideas come from various sources, and through the course of the interviews it was possible to distinguish six broad categories.

1. **Collecting ideas from clients** is among the most frequent and informal ways of collecting ideas, that would normally occur during casual conversations with no feedback mechanism in place. One of the companies had a way to formally track the suggestions (e.g. in a form of submitted requirements by project managers), and to analyse if any requests were repetitive, and therefore can become potential ideas for a new product.
2. **Collecting ideas from employees.** This source of ideas is an extension of the previous one, where ideas can come from anyone and are not necessarily rooted in the needs of the customers. Similar to the previous type of ideas, in all the companies ideas sharing could happen informally; however, it was possible to find examples of a regulated ideas collection process through ideas competitions in some of the companies. This source of ideas was praised and discussed in more detail by the experts.

   One of the companies implemented an initiative called "**Licence to Innovate**", which allowed anyone to submit an idea. If an idea was approved by the innovation committee, the author was given two days of working time to develop their idea further. The company launched various calls for ideas that were either centred on a particular topic (e.g. safety) or open to anything. The initiative was considered quite successful, although several drawbacks were noted. Firstly, selected ideas were implemented by the authors of these ideas, but sometimes they were not the best candidates for that, which resulted in some good ideas vanishing. Secondly, the winning ideas were not publicised well enough around the company, and some interviewees could hardly recall anything related to this initiative. Thirdly, this initiative was not aligned with the activities of the innovation group but existed in parallel, and so the two groups could not benefit from the cooperation. On the other hand, the example of an open innovation initiative that was described by one of the experts engaged the whole company and was well aligned with the company's strategy. Its design helped to avoid the problems that the "Licence to Innovate" initiative has created. It also had surprising positive side effects on KM in the company, such as facilitated knowledge sharing and improved visibility of work, which proves that different phases of the KM roadmap have a mutually reinforcing influence on each other.

3. **Facilitating ideas creation** is similarly structured as a controlled process, but in this process the ideas are generated by the participants during a facilitated session (e.g. brainstorming).

   One of the companies frequently ran **Hackathons** as a way to collect new ideas for new product development, or to test a new product as an alternative to ordinary trials. For instance, the participants can be given a new product to play with and asked to find flaws in it or new areas of application. Sometimes, these events were open to an outside audience; however, in these cases the rules of engagement were more detailed. This initiative gathered a lot of interesting ideas, but had one drawback as well. Though the initiative was open to all employees, the organisers were not very successful at attracting employees from outside the headquarters.
4. **Collecting ideas from the ground** resembles collecting ideas from employees, but focuses on employees working on the ground. In one of the companies this initiative was linked to the Japanese philosophy of continuous improvement and generated mostly ideas in the area of process improvement and optimisation. The factories would make a suggestion box available for ideas on continuous improvement, where each employee can put a brief description of their idea.

   One of the experts suggested a more interesting solution and shared a story of an oil refinery factory, which wanted to start collecting ideas from its workers, but could not use a conventional ideas management platform, because most of the workers did not have access to computers. The factory decided to use mobile phones instead and to collect ideas through text messages. This initiative was a success and generated substantial cost savings.

   Within the boundaries of PDP that is being studied, these scenarios are less likely to occur, but the examples above were too interesting to be excluded from the review of the results.
5. **Analysing lessons learnt** after each project and implementing actions that are derived from them, leads to outcomes similar to the previous type of ideas collection, and is mainly driven by the philosophy of continuous improvement. As was mentioned above, all the interviewed companies attempt to conduct lessons learnt and understand the importance of this activity, but only a few could provide examples of using the outcomes of lessons learnt to supply the ideas pool with new ideas.
6. **Formal research activities,** which are also traditionally associated with R&D, were only explicitly described by some of the companies interviewed, and they included coordinating collaboration with universities and conducting technology scouting. Though other sources of ideas, such as open innovation initiatives, can produce a lot of interesting ideas, several interviewees admitted that these initiatives can only produce incremental innovation, suggesting that traditional forms of research such as technology scouting are still crucial. Grandiose innovations, such as a space programme, do not happen on the margins, and as one of the experts noted, they have not seen a single breakthrough idea coming from the open innovation initiative.

The ideas generation phase is followed by the **selection**. The companies interviewed did not have a common approach to filtering the ideas. Some of them used a set of criteria, such as value, demand, differentiation factor, time limitation, resources required, and potential revenues for the company and for the clients. Others looked at the technology readiness and estimated the sensibility of the idea. However, there was one common pattern for all the companies that had a well-established filtering process and were satisfied with the quality of ideas that were selected, even if a company did not have a predefined set of criteria – **selected ideas had to be aligned with the business strategy**.

Companies that have their innovation related activities concentrated in one department also have a board of experts who select the best ideas, but once a company opens ideas collection up to all employees, experts that can give a proper evaluation would more likely be spread around the company, which requires a different approach to reviewing ideas. The companies interviewed did not provide any more specific examples, but one of the experts shared an elegant solution. A company implemented a "review acceptance" button, which allowed experts to either accept or reject an idea for review, and therefore served as a psychological pressure point: if the expert does not want to review the idea anyway, it is better to learn about it early, but if they accept to review it voluntarily, they take responsibility and therefore are more likely to do it.

Another aspect of this phase of ideas management is **handling rejected ideas**. The interviewees considered it important, because according to the interviewees sometimes the ideas might become relevant if the context changes (e.g. the law, the standards, new technology), and because the same rejected ideas tend to be brought up again, having them recorded would save time on filtering new ideas. But no systematic approach for handling rejected ideas has been identified so far.

Interestingly, a lot of effort is put into generating new ideas, but many interviewees commented that there is generally an abundance of ideas and the main problem is not to find and not even to select them, but to **implement** them, and some of the problems have already been mentioned (e.g. the wrong person put in charge of the implementation, or resistance to change). Though there are no specific examples of the implementation of ideas, throughout the course of the interviews it was possible to identify the following groups of problems or barriers to implementation:

1. The ideas are too **detached from the main business.**

"So where we started as a project we were too ahead, too outside of the business as usual norm."

2. **Resistance to change** can occur, even when the benefits of adopting a product are obvious.

"You went to these guys, pointed this out to them, proved the concept, that one button would gather up all this network, export it. And it just didn't put things exactly how they wanted, they didn't really want to get involved in it, we couldn't sell it to them for some reason."

Some of the interviewees were trying to address this problem upfront by blogging about their projects and delivering information to potential users in a more sociable and less formal way, and therefore trying to generate early interest and intrigue other parts of the business.

3. **No time allocated** to implement the idea. This problem usually occurred with smaller scale projects, such as small process improvement ideas and action plan from the lessons learnt.
4. **The author of an idea might be not the best person to implement it.** This problem was discussed in the example of the initiative "Licence to Innovate", where some of the ideas were not successful because the author of the idea was not the best person to implement it.
5. **Ideas are not new**. This problem has occurred within the facilitated ideas generation initiatives, where due to lack of visibility of work the employees addressed problems that had already been solved in other parts of the business.
6. **Lack of visibility of the results of the competitions demotivates future participants**. Though this problem does not affect the implementation of a specific idea, it damages the evolution of the initiative as a whole.

The overview of innovation management experience in the companies showed that none of the companies have reached full potential, and a lot of the problems that interviewees related to this aspect of KM link back to the previous phases of the KM roadmap, and knowledge sharing in particular. In the review of the model the technology aspects were referenced multiple times, and Section 6.1 provides an overview of the findings and compares them with the state of the literature. The rest of this chapter attempts to locate these findings in the body of KM literature and discusses some of the curiosities that were brought up by the interviewees, such as the role of national and corporate culture.

5.3. Knowledge Management: Theory vs. Practice

The analysis of the findings of the multiple case study resulted in a model of KM that describes the way KM evolves in innovative companies in the energy sector. Figure 42 shows the extended organic roadmap of KM, which also includes the major aspects of KM that were recognised as an essential part of each phase of this roadmap. With regards to the first phase, the literature review has shown a mixed attitude to formalisation and document management, and the results have demonstrated that in companies of the chosen type neither too many rules nor too much freedom of self-regulation help to introduce KM practices to a company. The right balance has to be maintained. Starting from the second

phase, KM practices become increasingly complex and diverse. Knowledge sharing was confirmed to be the central knowing process, as was suggested in the literature review, and it was observed in many forms, which resembled the knowledge restaurants presented in Section 3.1.1 in the literature review, and are discussed below. The creation of new knowledge proved to be inseparable from innovation, which could be expected in companies that are involved in product development and are considered innovative, but the observed KM practices intertwined with innovating activities suggest that innovation has to be at the core of KM strategy. The literature suggests that KM supports innovation, but, as the findings have demonstrated, the positive impact is mutually reinforcing. These ideas are elaborated further below.

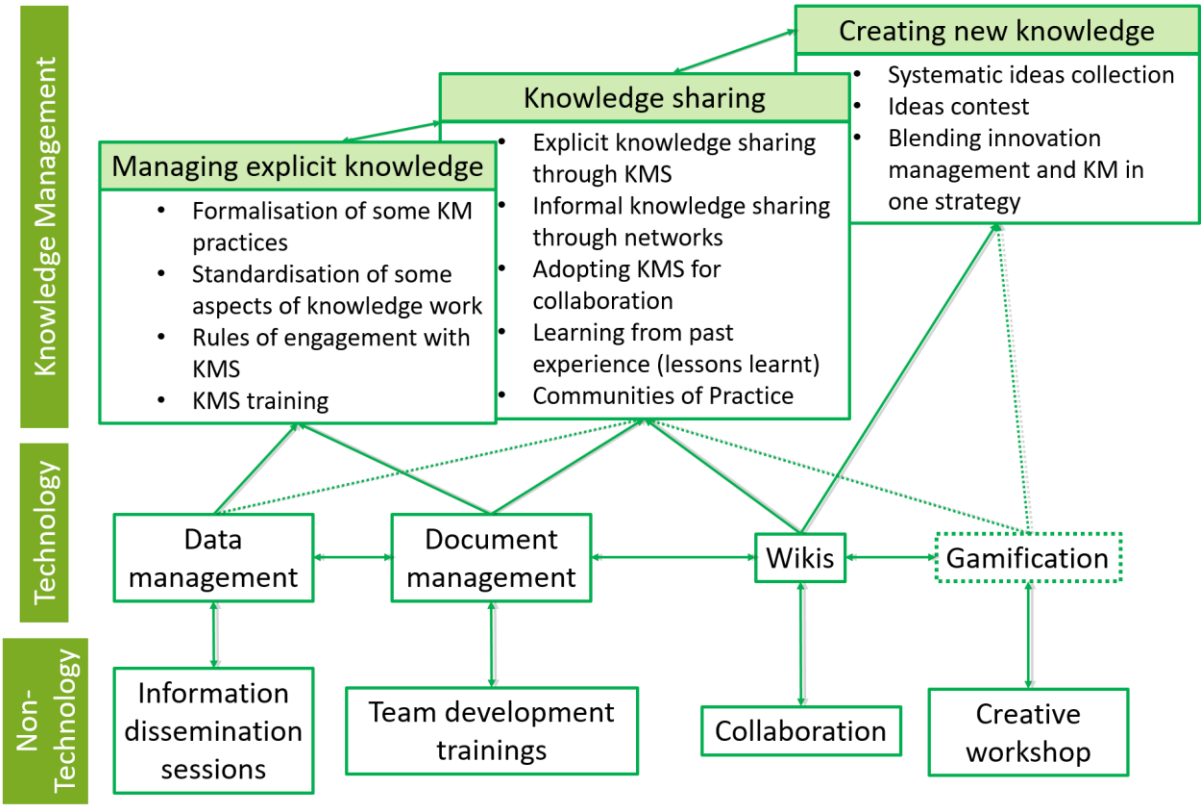

Figure 42. Expanded organic roadmap of KM.

When the model started emerging, it resembled the framework of Nancy Dixon (2010), the director of the KM programme in the US army (Figure 43), which was mentioned by one of the experts. This framework is based on her practical experience and is practitioner oriented. It consists of three levels, two of which resemble the first two levels of my model, and the third shifts from the individual to the group level of knowledge. This framework did not influence the analysis of the interviews that resulted in the model, but rather served as a validation framework and a sense-check. The organic roadmap of KM was developed using a robust methodological approach and presents the first KM model in the academic literature that is grounded in theory and puts KM in the time frame. The resemblance of this model with the one used by practitioners adds credibility to it and proves that it can be useful to both

academics and practitioners. Below more details are provided on the usefulness to academia as well as practice.

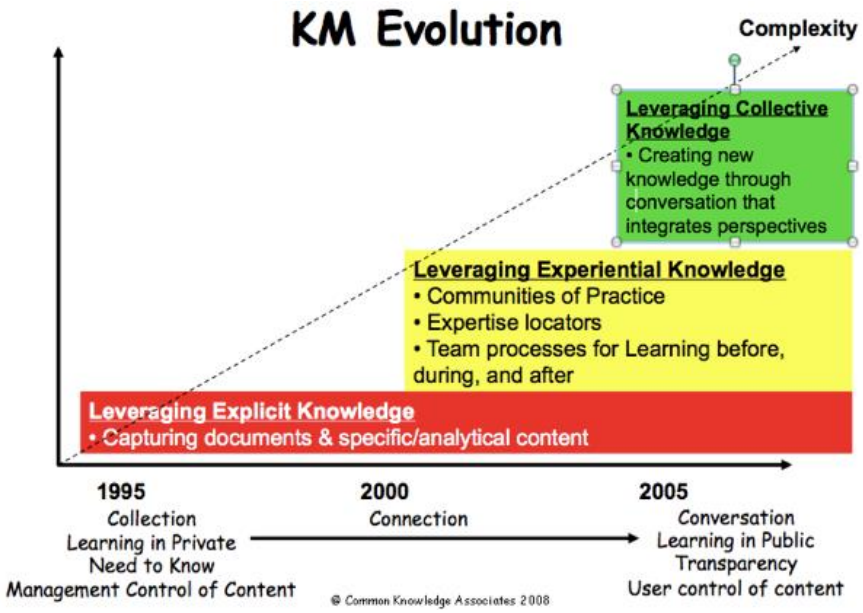

Figure 43. KM framework of Nancy Dixon. Source: (Dixon, 2010).

The difference between this framework and my model is likely to be caused by the difference in the types of companies, the experience of which was used in the development of my model, which is centred on project-oriented innovative companies, and therefore novel knowledge has to play a major role. Dixon's framework is more generic and aims to cover a wide range of companies, which are not necessarily driven by innovation, and for them managing collective knowledge might be a logical next step.

For practitioners this model can serve two purposes: it broadens the scope of KM by demonstrating a wide range of activities that should be considered in the planning of KM, and it provides a clear path to follow when improving KM. For academics this model suggests a paradigm shift by presenting KM as a continuous process. With the change in perception KM initiatives should not be reviewed in isolation, but in relation to past experiences. Then the reasons for failure or limited success of KM projects might not be in project design, but in the state of a particular company that might not be ready for that type of project yet.

5.3.1. Knowledge restaurants inside the company

With the following two subsections I analyse the observations further and link the emerging themes to the theory that was discussed in the literature review or that was further explored following the themes. It might appear that these bits of finding are quite distant from the organic roadmap and the research questions, but they were too interesting to be left out and can be rather regarded as possible directions for future research.

The analysis of knowledge sharing practices in the companies interviewed demonstrated examples of different depth and varied success. All of the companies engaged in informal knowledge sharing in one way or another, which seems to be the major binding force of knowledge work in companies with less KM experience, and a natural part of everyday activities in more experienced companies. The companies also tried to progress in sharing the articulated knowledge and making it available to others. Less experienced companies struggled to set up a document repository that would be commonly accepted and used, whereas more experienced companies demonstrated a more diverse approach to managing articulated knowledge. Learning from past experience seemed increasingly important for more experienced companies. And finally, all the companies reported having communities in one form or another, but only one of them demonstrated a more formalised approach to managing them, with communities being officially recognised and represented on the corporate portal.

Communities of practice have been praised by world-leading companies in the oil and gas industry (Grant, 2013); however, the communities observed were rather a simplified version, mainly being involved in exchanging news and articulated knowledge, and providing support to each other. Communities of practice refer to a group of people united by a common interest or practice, interacting regularly and learning together through real-life problems and negotiating the meanings of this practice (Wenger-Trayner and Wenger-Trayner, 2011; Wenger, 1998). In line with this definition, among all the communities observed only two could be considered grass-root communities of practice, of which one faced certain resistance in the company and the other interacted more spontaneously when developing a new practice. Apart from that, the whole innovation team of company 6 resembled a community of practice, which not only worked on solutions, but also discussed problems and ideas, and also tried to reimagine the future of their area of work, though it seemed that this community was powered primarily by the enthusiasm of one man. These examples will become relevant in a moment.

If we look at the theory of knowledge sharing and the analogy of different forms of sharing with knowledge restaurants (Velencei et al., 2009), the development or “a la carte” knowledge restaurant produces an output valued by the company. Other forms of knowledge sharing produce the output which will eventually become an input for the development, and therefore the benefits of these forms of knowledge sharing might not be as obvious.

“A la carte” knowledge restaurant was observed in the form of informal knowledge sharing predominantly through networks and periodic meetings, in which knowledge is being modified, adjusted, re-contextualised and eventually reused and applied. Informal knowledge sharing took place in all the companies, possibly because the benefits were obvious for everyone. The input comes from two other forms of knowledge sharing: “knowledge buffet” and “recommended by the chef”.

"Knowledge buffet" was observed in the form of document repositories that aimed at storing articulated knowledge for further reference, and portals, blogs or community forums that streamlined the activities of a company, a particular community, or project / initiative updates. This form of knowledge sharing was taking place in all the companies in one way or another. But less experienced companies were preoccupied with creating a properly functioning document repository, while more experienced ones were taking it for granted and experimenting with new forms of knowledge broadcasting, as well as focusing on the other form of knowledge sharing – the research of "recommended by the chef".

"Recommended by the chef" knowledge restaurant results in producing new knowledge, and in this study it was observed in two forms: lessons learnt and ideas management, which however are performed relatively poorly, as was shown in Section 5.2.3 of the previous chapter. All the companies recognised the importance of lessons learnt, but only company 6 was satisfied with its implementation. Similarly, most of the companies tried to implement ideas contests, but only companies 5 and 6 integrated ideas management well enough to be able to demonstrate the significant impact that it had on them.

The last knowledge restaurant – the "coffee-room" – supplied the "recommended by the chef" knowledge restaurant with input such as problems or vision. In the researched context it should be represented by the communities of practice that are meant to be concerned with such questions. But as was discussed before, the communities that were identified in the companies have not reached the state of being able to shape practices and engage with problems (except company 6). However, one such example was described by one of the experts. An open innovation program, that was being developed and had been evolving for two years, has eventually created a community of innovative thinkers in the company, who would discuss and influence the innovative direction of development of the company.

This example contrasts with the example of company 1 that was mentioned before, in which a community emerged around a new technology and recognised its great potential and possible implications for the business, but was not supported by the company. The difference between the last two examples suggests that knowledge sharing should grow organically, and uneven development of different forms of knowledge sharing would potentially lead to the conflicts that company 1 is facing. This structure also supports the reinforcing nature of KM phases. Namely, when the three phases of the KM roadmap were described in the previous section, it was also shown that these phases are interconnected and reinforce each other. From the expert's example the open innovation initiative (the creating new knowledge phase) facilitated the emergence of a new community (the later stage of knowledge sharing phase). Similarly, informal knowledge sharing is slowed down without proper support in the form of a document repository (the managing explicit knowledge phase).

One could ask whether connecting observed practices with the metaphoric knowledge restaurants is necessary at all, but looking at these practices through the lens of the

restaurants helps to explain why certain knowledge sharing practices are better developed that others. It could also reveal to the companies which of these practices might be missing in the chain of interconnected knowledge sharing forms and what consequences it might have.

5.3.2. Innovation philosophy at the core of KM

Up to this point the phase of creating new knowledge of the KM roadmap was seen as part of innovation management, but the interviews revealed certain challenges that stand in the way of organic evolution to the third phase, as well as wider implications that this phase might have on this model. These observations are not directly related to the research questions, however, this research is focused on the innovative companies, and the organic roadmap of KM demonstrated that KM practices and innovating activities become more intertwined the further a company progresses in its KM journey. These observations were further confirmed by some particularly interesting discussions with some of the interviewees, and thus the following subsection elaborates on the idea of inseparability of KM and innovation and suggests directions for further research. This part of the section aims at exploring this topic further.

The conflict of innovation

Innovation is often taken for granted as something universally good that is accepted and praised by everyone as a source of growth and competitive advantage. On the other hand, resistance to change, and acceptance of innovative ideas in particular, is a common problem regardless of the country (Jaruzelski et al., 2015). Several interviewees mentioned resistance to change among their colleagues on the way to adopting innovation, and this problem is partially related to companies where innovation strategy is discussed only at the top. According to one of the experts, the success of an ideas management project could be predicted based on who the internal executers of the project are. If the initiative was delegated to the middle managers, who did not share the vision, the initiative was meant to fail. And the other expert considered the time spent on educating middle managers and sharing the new vision and strategy with them to be one of the key success factors of the open innovation initiative. The literature on KM tends to contrast the top-down approach, where the initiative is driven by top management (Liebowitz, 2001; Paik and Choi, 2005), with the bottom-up approach, coming from employees (Brown and Duguid, 2000; Vaast, 2007). But to others middle management is seen as a key component in any system (Mintzberg, 2009), which tends to be forgotten within the context of innovation management, as was demonstrated during the interviews.

These problems can occur if a company has an innovation strategy which is not properly translated across the organisation. But an even bigger problem occurs if a company does not have any vision and therefore underestimates the potential of innovation management in

relation to the strategy. In relation to the organic roadmap of KM, the lack of vision on the earlier phases leads to innovation activities being a collection of disjointed efforts to get ideas and create something new. These efforts will show some results, but their impact will be limited, as was shown from the experiences of companies 1 and 2.

> *"There is a possibility to do this evaluation, but it's not done currently. There are little bubbles of projects within the business that don't talk to each other. They are stuck in their own bubble, because they've got to deliver that as their goal."*

But KM does not only support innovation (Swan et al., 1999; Swan and Scarbrough, 2001), but innovating has to be deeply embedded in KM, because it relies on seeking new knowledge, creating new knowledge, learning from past experience and sharing ideas and learning. This idea was shared by two of the experts, and those companies that have shown a superior performance in these aspects have also demonstrated more coherent and successful achievements in their innovation strategy (companies 5 and 6).

And here appears the conflict that was not visible before. From the experience of one of these companies, **process improvement and optimisation thinking conflict with innovative thinking**. Though the other company did not explicitly share the same vision, they strongly emphasised the importance of innovative thinking and the need to nurture a different mindset in engineers from as early as their university education. It was not possible to find any discussion of this dilemma in the literature, but the explanation could be intuitively clear. Innovating culture requires employees, and especially managers, to be more accepting of risks, tolerant of mistakes and flexible as to how time is being spent. And it requires a new way of thinking, which is very different from continuous improvement thinking with waste reduction at its core.

A famous Pareto principle has proven to be true for innovation as well, saying that **4 out of 5 ideas will fail**, and various attempts to reduce this number only resulted in the reduction of the quality of ideas. And accepting the reality that in 4 out of 5 cases the time and resources spent on creating, evaluating and developing an idea will be wasted, requires rethinking what waste is and how it is valued. It also requires rethinking the definition of success, because continuous improvement is measured in small continuous incremental successes, whereas success in a more innovative approach is only possible through lots of failures.

Up until now it has been mentioned several times that the phases of the KM roadmap can reinforce as well as restrain each other. One of the most interesting and less obvious examples was shared by one of the experts who gave an example of an open innovation initiative which not only supported innovative activities in the company, but also facilitated knowledge sharing and improved visibility of work. And this example suggests that ideas management initiatives, such as ideas competitions, are also a KM practice in a broader sense.

Ideas management as a KM practice

Ideas competitions are not new, and have been widely discussed in the innovation literature (Bogers and West, 2012; Ebner et al., 2009) as a form of ideation within the context of innovation, but not as a KM practice. In contrast, the interviews with experts have shown that this practice can have very wide implications. In particular, the open innovation initiative described by one of the experts openly invited employees to participate by not only suggesting the ideas, but also rating and commenting on the ideas of others, with the intention to encourage employees to read the each other's ideas and to conduct a sense check of them through rating and comments. As a result, employees had a chance to receive feedback from the relevant departments, and through this feedback they would naturally find out what was going on around the company, and even join projects that they were genuinely interested in. This example showed not only the way in which ideas competitions tend to evolve, it also demonstrated that ideas competitions, when the process of collecting them is transparent and open to everyone, can improve work visibility across the company and promote knowledge sharing.

Transparency is also achieved by levelling the organisation, where every employee gets a voice and every voice is equally important in this kind of competition regardless of the ranks. If feedback is properly maintained, it helps develop trust in the longer-term and creates a sense of belonging to a community and something bigger. Additionally, it helps to study the organisation, its dynamics and its problems. According to one of the experts, the ability to study the organisation was even more important for some of the companies than the ideation.

> *"There was a strike in an oil town, they had a huge problem… but they didn't talk much about it. Then… the guys who are at the high position there, told me: 'you know, if we had your system, then the ideas would be good, but we would get a signal from there. We are sure, something would leak from there in a form of partial payment interruptions or something like that. And we would understand that they have a problem there. The local manager closed everything, and the temperature was increasing there, but we didn't see it in the centre. Otherwise we would have seen, that's for sure. Your innovations and stuff are good, but we would have caught this thing as well.' Therefore, it's a real way to reveal big-big problems.'*

The elements that empowered ideas competitions and extended their potential beyond innovation can be identified as gamification elements. The rating was a mechanics that moved the employees to participate by expressing their opinion, and consequently to learn about other activities in the company. A sense of belonging to something bigger is equivalent to the epic feeling that is believed to be the source of the so engaging and even addictive nature of massive online multiplayer games (McGonigal, 2011). The dynamics of the competition itself is that of gamification dynamics. Some examples of gamification elements were also

identified throughout the interviews. For example, one of the companies used surprise awards to reward their employees for ideas sharing. Another company implemented a points system with different types of points (expert points, redeemable points or virtual money, which can be exchanged for goods), which were given for various knowledge sharing activities and served various purposes.

These examples are new and exciting, and the importance of gamification will be emphasised further, using a number of examples in Section 6.1. Thus by the time the reader reaches Chapter 7, these examples will have formed a preliminary understanding of what gamification is. The remaining part of this chapter discusses the peculiarities in relation to KM that emerged during the interviews and that are not directly related to the roadmap of KM, but rather to acceptance of KM in a company.

5.4. KM and organisational parameters

In this section I continue the discussion of the findings, and in particular, the aspects related to the sampling. Since this dissertation employed as somewhat non-traditional structure, the questions of sampling were discussed in two Sections: 2.2.2, 3.6.1 and 5.1.1 (in more detail). When the boundaries for the sample were discussed, a number of different criteria naturally arose as being the determinants of a relative homogeneity of the chosen companies, e.g. the size and structure. But a number of criteria could influence the similarities or differences as well, but the nature of these similarities or differences was not always clear from the literature, and therefore most of them were left aside. Moreover, the lack of attention to these parameters was noted as gaps in literature in Section 3.2.6. The scope of this research could not possibly cover all the gaps identified. But some of these factors were mentioned and elaborated upon during the interviews, in particular industry, corporate and national culture. The findings appeared to be interesting and therefore worth discussing in more detail and potentially suggesting directions for further research.

5.4.1. Industry differences

Industry specifics can have an impact on KM in many ways: companies in different industries can have different organisational structures, different pace of development, etc., and therefore the sample was limited to one industry in this study, in order to limit the influence of this factor. Through the course of the interviews several participants touched on the topic of industry specifics in relation to industry dynamics and generation profile. These criteria were not taken into account during the sampling phase, but they could become an interesting direction for further research. This section aims to elaborate in more detail on these characteristics and point to the potential link between industry specifics and KM.

Eisenhardt and Martin (2000) suggested that markets and industries might differ by the level of dynamism of the external environment, and consequently the dynamic capabilities (DC)

that they require might be different. DC affects ordinary capabilities (Teece et al., 1997), and this study also showed that KM has an impact on such ordinary capabilities as project management and PDP, though this influence is more indirect and less obvious. Therefore, from this perspective KM is a DC. If this is the case, then the level of dynamics will have an effect on the KM design as well.

In support of this idea, one of the interviewees shared his experience of working in a company with a much shorter product development cycle, where one project would typically last for four months, and thus the approach to PDP and project management was different as well. The process had to progress faster, requiring situation-specific knowledge, and Eisenhardt and Martin (2000) characterise it as learning by doing, where the crucial skill is selection. In this setting KMS are needed to provide fast connectivity and flexibility. On the other hand, the energy sector moves at a slower pace, with an average project duration of 1-2 and sometimes 5 years, and relies heavily on existing knowledge and the complex structure of processes. For them the crucial skill would be variation, and KMS is needed to primarily give access to existing knowledge and support complex processes.

This dynamism might be related to the generation profile of the companies as well. Fast, dynamic industries, such as retail and telecom, tend to have a higher proportion of millennials. The reasons might be different: this generation might be naturally inclined to work in faster moving sectors, or they are being deliberately attracted by these sectors, because they are more flexible and adaptive (Kalinauskas, 2014; Raines, 2003). As a consequence, they are more accustomed to the new types of KMS as they proved to be useful, and more receptive to them. And this suggestion was supported by the experts. All three experts shared experience of successfully implementing such software as CSN in this type of company, and one of them related it to the younger generation, because for them this environment seems native and intuitive. This topic is developed further in Section 6.2 during the discussion of KMS implementation.

As was suggested in the previous section, the demographic profile of the energy sector is likely to change in the next decade, leaning towards the distribution seen in the fast industries, and KM practices will therefore need to adjust as well in order to accommodate the preferences of the new type of knowledge workers.

With regards to the meaning of the industry specifics for the KM roadmap, the literature disagrees on whether DC are unique to each company (Teece et al., 1997) or repeatable and even industry-specific, influenced by market dynamics (Eisenhardt and Martin, 2000; Winter, 2003). If KM is a DC, then on one hand, this capability is unique to every company, because their knowledge is unique. On the other hand, the practices that help put this knowledge into action are likely to have some similarities, and the industry is likely to influence some parts of the KM roadmap, as the companies in other industries (e.g. those that are not perceived as innovative) might need other KM practices at the core of their KM strategy.

The two other aspects that are discussed in this section – corporate and national culture – did not influence the sample, but they definitely affect KM in various ways, which are sometimes difficult to articulate or even observe. The findings in the interviews suggested that they might be interrelated, and this aspect is elaborated on further below.

5.4.2. Corporate culture

Corporate culture has not been discussed by any of the interviewees, possibly because the practitioners rarely think about such seemingly abstract and high level matters. However, corporate culture was mentioned by all three experts as one of the crucial aspects in knowledge and innovation management, and therefore it is worth discussing it in more detail.

According to the experts, the corporate culture unconditionally defines the success of an initiative and can be used as a predictor of success, which is, according to one of the experts, synthesised in one person – the leader. In his opinion a new initiative has a chance to be successful if the company has either a charismatic leader and a driving culture, or a recently appointed leader who does not carry the inherited sceptical and passive culture and is ready to break it. Similarly, the Zappos case in Section 7.2 shows how important culture is and how much value is put on it to the extent that all the employees are evaluated against ten core values by their peers and are given a Krunky badge to visualise the value that they are associated with the most.

Similarly, the researchers acknowledge the importance of corporate culture, because it shapes assumptions about what knowledge is important, and establishes the mindset as a pre-requisite for questioning existing knowledge. It mediates the relationship between different levels of knowledge and creates context for social interactions (De Long and Fahey, 2000). For instance, in companies that value individual and novel knowledge, employees will be reluctant to contribute to organisational knowledge, because then they will lose opportunities by giving away what is valued the most. But in a hierarchical organisation knowledge is less likely to flow vertically from employees to managers than in the levelled organisation. Other scholars went further and suggested that an organisation does not have culture, it is the culture (Meek, 1988, p. 459, cited by Weick, 2001, p. 78).

Culture in a broader sense is defined on three levels: underlying assumptions, beliefs and values, and behaviours and artefacts (Schein, 1985), in which the behaviour and artefacts that mediate these behaviours are guided by the values and norms of the organisation and are the easiest to observe, and in turn values are defined by the underlying assumptions (Alavi et al., 2006). With regards to corporate culture, when we discuss culture, we intuitively associate it with corporate values, whereby behaviour is perceived as a consequence governed by the culture. The definition above does not contradict this understanding, but instead it only indicates that these two aspects are inseparable, and it would be naïve to attempt to design

any organisational initiative that aims at changing the behaviour of employees without considering corporate culture.

In relation to KM, knowledge sharing could be a behaviour, and when it is mediated through KMS, KMS becomes an artefact. But knowledge sharing happens only if the values and beliefs allow it, and the examples of individual knowledge-centred values illustrated that such values can become a barrier, assumptions that direct actions and decisions (e.g. whether to share knowledge or not) are invisible and preconscious, and values are a mere reflection of them (Alavi et al., 2006).

Researchers as well as practitioners are in agreement about the importance of the corporate culture for KM, and this raises the question of whether it can be managed. Some researchers suggest that it can and should be managed (Deal and Kennedy, 2000; Martin, 1985), but this position does not explain the conflict of values that might occur between the subcultures within one company (Meyerson and Martin, 1987). Other scholars define it as a combination of emerged local cultures (Dougherty, 1992; Schein, 1985), but is it then different from the national culture? The compromising view suggests that culture is subject to gradual evolution rather than radical change (Ashkanasy et al., 2000), and this view is consistent with the opinion of one of the experts, who argued that one cannot buy a culture, instead you can identify and unite like-minded individuals, who in turn will become local ambassadors and power the change.

With regards to KM, some researchers suggest that one needs to align KM with the culture rather than change the culture (McDermott and O'Dell, 2001; Park et al., 2004), and this is true to an extent. If the culture discourages knowledge sharing, the only way to progress is to change the culture, and the examples above as well as the opinion of the expert showed that gradual change is possible.

Though the importance of culture for KM seems obvious, practitioners find it difficult to articulate the connection between knowledge and culture, and therefore to identify cultural barriers. For instance, in consulting companies, with the prevailing culture of billable hours, employees might be reluctant to spend time on learning or self-reflection, such as lessons learnt (De Long and Fahey, 2000). A similar problem was observed in one of the companies interviewed, where knowledge sharing activities were perceived as something that is useful, but has to be done outside office hours. And the solution to this cultural peculiarity would be billing the time spent on these activities. In contrast, in the company which practices ideas competition quite successfully, the perception was very different:

> *"Everyone is allowed to come up with the ideas, end then you'll be allowed the time to develop those and put them at place."*

Organisational culture is composed of different aspects including functional lines, ranks, professions and national culture (Dougherty, 1992; Schein, 1985), and one of the experts kept

referring to some cultural differences that are heavily influenced by national culture. Sometimes it might be difficult to distinguish between the aspects of the two, and therefore it is worth discussing national culture and the relation between the two in particular.

5.4.3. National culture

There is a relatively unified opinion that corporate culture can be influenced, and the right corporate culture supports KM practices, and the major challenge lies in understanding the aspects that need to be changed, whereas national culture is a given and is not a subject to change. There is no question of whether national culture is right or wrong, but rather that KM practices have to be adjusted accordingly.

The most commonly used framework to evaluate and compare national cultures is that of Hofstede (1980). This framework is widely adopted in many areas of organisational research in the culture-related studies, however the framework has been criticised for the lack of face validity in determining the culture scores and for creating cultural ignorance as a result of overreliance on such popular model (Venaik and Brewer, 2016). In the KM research scholars tend to explore the influence of national culture without limiting the study to the above mentioned framework or others alike (Ardichvili et al., 2006), or comment on the emerging observations complementary to the main findings in a case study (Paik and Choi, 2005; Voelpel et al., 2005). The findings vary as well: sometimes the differences in adapting KM practices and reacting to new initiatives are expected, like that of China or India, at other times the behaviour is surprisingly similar between foreign divisions, like Russia and Brazil.

The opinion of the experts on this matter is inconsistent as well, and some of their examples have been provided in this chapter and Section 3.4. Similarly, the opinions of some of the interviewees who touched on this topic varied across the companies. Some interviewees have not noticed any difference in the approaches to working found in different offices in the US, and parts of Europe or New Zealand, and referred to it as the Anglo-Saxon culture. Other interviewees could not observe any differences between more distant cultures, when interacting with their colleagues from different offices, be it Canada, Chile or China, but they have experienced cultural misunderstanding with external partners from these counties.

In contrast, the interviewees from another company shared very different experiences in different countries.

> *"India was one of the best experiences in my life. The cultural difference is very much, people would go into the offices and work 12-13 hours, but it's much more."*

They could see that in some locations, like Dubai and India, people were much more open to any kind of reward and much more inclined to comment, which however can be just a few words of support rather than more constructive and critical feedback. Whereas in Europe the same behaviour would be meaningless and the same amount of rewards would be worthless.

The major difference between these companies is the number of employees, with the companies that have experienced no cultural differences tending to be smaller (up to 600 people) and therefore have smaller foreign divisions (up to 10-15 people), while the company that has experienced significant differences has foreign subsidiaries of the size of a medium or large company on their own. One explanation of this phenomenon could be the relationship between corporate and national culture.

It seems that in companies of a relatively smaller size (up to 700 in our sample) and multiple small foreign divisions the corporate culture of the headquarters tends to outweigh the potential differences in national culture. And in the company of much larger size with larger divisions, the divisions develop a corporate culture of their own, which might be heavily influenced by the national context. However, these observations were made from a few comments from several representatives of a small number of companies, since cultural differences were not the primary focus of this research, and therefore we cannot derive firm conclusions from these observations.

The effect of national and corporate culture combined has been studied in other fields and from different perspectives. For instance, researchers have looked at corporate culture within the context of multiple divisions of one company, where a unified corporate culture being a subject of change might conflict with a deeply embedded national culture (Schneider, 1988). Other researchers have looked at them within the context of several companies, and studied the impact of national culture on the adoption of corporate culture (Weber, 1996), or contrasted the importance of one over the other (Dong and Glaister, 2007) in mergers and acquisitions. But the relationship between corporate and national culture within the context of KM has not been studied yet, and further research in this direction could shed light on this issue and provide potential explanations for the contradictory findings with regards to national culture, e.g. in implementing KM practices and KMS. These aspects will be discussed in more detail in the following chapter.

5.5. Implications

This chapter has presented the first part of the analysis of the multiple case study interviews that resulted in a major contribution of this research. The negative survey findings that were discussed in Section 4.4 of the previous chapter made me rethink the approach to analysing the interviews in order to find patterns and make sense of them. As a result, I have observed that KM experience does undergo a natural evolution in the companies, but this path is unrelated to the maturity level. The evolution path consists of three overlapping phases: managing explicit knowledge, knowledge sharing, and creating new knowledge. These phases are interrelated in a way that improvements on the consequent levels generate improvements on the preceding levels, while in a similar way problems on a preceding level might inhibit progress on consequent levels.

In the first phase a KM initiative needs to establish the formal structure for KM practices in the companies: standards and procedures, rules of engagement with KMS, KM and KMS training for everyone at the beginning of the initiative and for new hires on an ongoing basis. Apart from improving the consistency of work and creating a common environment of knowledge sharing, these first steps help add legitimacy to the new initiative and to the time spent on KM practices, if done properly. In the second phase the companies continue exploring the variety of knowledge sharing practices that can be found in an organisation. Knowledge workers most likely engage in informal knowledge sharing regardless of whether the company actively tries to improve KM, and the whole approach to KM practices in this phase is less direct and formalised than in the previous phase. For instance, instead of trying to formalise knowledge sharing, the companies should concentrate on creating opportunities for employees to expand their networks. Simple formalisation of types of knowledge sharing such as lessons learnt is not effective, more effort is required from the management side to make the results productive. The third phase of the model blends with innovation management, and one such practice that can shape it to a large extent, is ideas management.

This model is specific to the type of companies that were specified in the sample, or in other words, project-oriented companies driven by innovation and involved in the development of highly complex products, and these findings do not suggest that the resulting model can be extrapolated to other types of companies without any adjustments. On the contrary, it is likely that the external environment and types of knowledge workers that are typically found in other types of companies will alter the KM practices that are required to support primary functions in other companies, and the following chapter will elaborate further on some aspects of it, such as industry specifics and generation differences.

This chapter also explored the interrelation between innovation and KM and demonstrated that the two are inseparable from each other in innovation-driven cultures. Additionally some aspects that are indirectly related to the KM model, and that were mentioned during the interviews, were explored as well, and they include industry differences and the impact of the corporate and national culture. In particular, the findings suggest that in relation to KM the corporate culture of the headquarters outweighs national culture in international companies with foreign subsidiaries of a relatively small size, whereas larger subsidiaries tend to develop a corporate culture of their own which is heavily shaped by their national culture.

This chapter answers the first research question by identifying the needs, the variety of KM practices that address the needs in an innovative company in the energy sector, and the way that these needs and practices evolve with time. The technology aspect was mentioned several times throughout the discussion and is explored in more detail in the next chapter in an attempt to answer the second research question regarding the role of technology in addressing KM needs.

6. Locating Knowledge Management Systems on the Roadmap of Knowledge Management

This research project was initially driven by an interest in KMS and understanding their purpose and unique features. But since then the research had to step beyond the technology component of KM, and KMS became a technological layer on the KM roadmap. The literature review in Section 3.2 provided opposing views of the role of KMS; in particular, many researchers have criticised KM initiatives in companies for being too technology-centred (McDermott, 1999), and rightfully so. However, the interviews showed that though KMS still play role of enabler rather than facilitator, their role changes as KM progresses.

This chapter is the continuation of Chapter 5, presenting analysis of the interviews conducted using concept mapping and Gioia's (2004) method establishing second order themes. The methodological aspects of the analysis were explained in more detail in Section 5.1.3, and this chapter makes further use of it. The chapter answers the second research question regarding the role that KMS play in addressing KM needs by defining the purpose of different types of KMS, and suggests how the role of technology changes as KM practices progress, thus locating KMS on the organic roadmap of KM. It discusses some of the aspects of KMS that have been reviewed in the literature review, such as motivation and implementation, and opens up the discussion about topics that are not being focused on by scholars at the moment. Though during the preparation I used literature review as an input to the design of interviews (e.g. when synthesising the types of KMS), the discussion in this chapter is mainly driven by the themes that emerged during the interviews. It might seem that this chapter covers a broad range of concepts, but these are the topics that came up during the conversations with practitioners, and thus the literature was used to further understand and analyse the findings.

This chapter also provides more hints to why gamification becomes an important part of this research, thus being a logical transition to Chapter 7. The chapter is structured as follows: the first part provides an overview of the findings with respect to the organic roadmap of KM and discusses various types of KMS and the KM needs that they address. The second part of the chapter discusses other KMS related themes that emerged during the conversation, all of which are broadly related to the aspects of KMS implementation, and which suggest directions for further research. And finally, the last part of this chapter discusses the implications of these findings for this research.

6.1. KMS support

With regards to KMS, during the interviews the participants were asked to share their experiences of using different types of KMS and to give their opinion about their advantages and disadvantages with a focus on those KMS that were highlighted in the survey. The analysis

of the interviews has shown that in the first phase – managing explicit knowledge – document repositories play a crucial role in helping to organise explicit knowledge and make it retrievable. Starting from the second phase the role of technology shifts to the periphery of the KM initiative and rather becomes an extension of the document repository in the form of wikis, but the application of wikis and other WEB 2.0 tools expands beyond document management.

This section provides an overview of the findings with a particular focus on KMS types. The literature review in Section 3.2 gave an overview of a wide variety of KMS, and this section focuses on discussing which of them were useful and in what context. It is important to acknowledge that the findings based on the interviews with six companies, and other companies might be using successfully other types of technology, therefore we might have not covered all types of KMS. Apart from that, certain types of KMS, such as document repositories, might have got a good response whilst others might not have been so user friendly.

6.1.1. Document repositories

Document repositories have been both praised and criticised in the literature, while the interviews showed that documents management is the initial problem that the companies face when they come to understanding the importance of KM.

> *"Wikis and forums is something that we'll do, but I think, what it is at the moment, is we really want them just to engage in the SharePoint library to upload the knowledge and learning and documentation before we start pushing other tools at them."*

Of the companies interviewed Company 1 has only started to realise the scope of the KM related problems that they were facing at work, Company 2 was in the process of implementing a document repository and saw it as their primary objective at the time, and Company 3 had a document repository in place and was trying to make it work. Other companies were less concerned with document management related issues as they already had functioning systems in place.

The literature tends to have either too high expectations of document repositories, or to not see any use in them at all. Similarly one of the practitioners interviewed in the preliminary investigation saw a document repository as a solution to all KM problems after having read one book on KM, and this project turned out to be a disappointment for him. But the interviewees, not being familiar with the theory of KM, had more realistic expectations of a document repository and required the system for the following four reasons: the support of versioning, tracking, back up and file sharing, and less frequently for access control.

Document repositories are an important starting point in the KM journey and can be very useful as long as their limitations are understood, but their absence may limit the KM

progress. This insight emerged from the centrality analysis of concept maps (Figure 27), which was the initial step in building the organic roadmap of KM. This finding was also supported by the analysis obtained from machine learning that was run for the process maturity parameters with the KM maturity and KMS criteria (Section 4.3.1), and for most of the parameters a document repository was an initial branching criterion. This finding is intuitively clear, given how much articulated knowledge is being produced in technology intensive companies. If knowledge workers are not supported in navigating through it, trying to find relevant information and knowledge might consume all their time, which would have been spent on knowledge sharing and creating new knowledge otherwise.

However, installing the system alone is not sufficient. The interviewees shared problems related to information being duplicated or outdated in the system, the lack of an information management process, and poor search function support. Some of these problems are related to aspects that were discussed in the managing explicit knowledge phase, such as the need for standardisation and formalisation, while others are related to the implementation of KMS and are discussed in Section 6.2 of this chapter.

One company used wikis as an alternative to a document repository. They addressed some of these problems, because they were more flexible, but structured enough to control the flow of contents, they have a better search function and provide collaboration support in managing the documents.

Another type of KMS that this research reviewed was a knowledge repository. Sometimes knowledge repositories are seen as a separate type of KMS, but the interviews showed that people refer to them as a place with a collection of scientific articles, methodological notes, technical documentation, and therefore they are not substantially different from document repositories. Knowledge repositories can organically be integrated as a subsection of a document repository and do not need to have a separate name.

6.1.2. Corporate portals / Intranet

Corporate portals are not discussed much in KMS literature. All the companies interviewed had a corporate portal with a limited customisation potential, and in most cases it was used as an extension of document repositories for storing generic documents, such as formal policies, or HR documents, for posting high level news from the CEOs, and for providing links to other job related systems and databases. Portals can become an integrating component for other KMS and play a role in disseminating information, e.g. hosting newsletters. Most of the interviewees described skimming through the news in order to be aware of major changes in the company, while the experts emphasised the importance of promoting various initiatives in the company. Newsletters could naturally become a place to raise awareness of new initiatives and for reporting of results. However, as corporate portals are becoming more

widespread and elaborate (Conroy, 2013) they may come to play more significant role – therefore this topic may be relevant for future research.

6.1.3. Coordination tools

Coordination tools in the context of the chosen companies are technically Project Management (PM) tools: as PM tools are used to help coordinating KMS efforts, in use they become coordination tools. PM tools are quite widespread and software vendors offer an abundance of tools of various levels of complexity. However, among the companies interviewed only one used a purposely designed PM tool, which also served as a document repository, and its implementation was mainly driven by business need – integrating project costing and billing in the accounting system. Though the convenience of project managers might not have been the main driver behind the implementation of this system, it offers a number of advantages, such as automated project tracking for each employee and customer, and good collaboration support including the ability to attach emails to a particular task or update, which simplifies the documentation of the project progress.

Other companies used email, spreadsheets or MS Project to coordinate project progress and as a document storage system, or used a document repository for document storage. Though the need to use a project management tool as a collaboration technology was less obvious, it was observed throughout the interviews that the respondents had a need for a systematic storage of project documents in a dedicated place which could be easily searchable and accessible in the future. Comments that were made regarding project management are related to the observations about document repositories described above and the need for formalisation, which will create clear rules of engagement and a sense of obligation, as was discussed in Section 5.2.2 of the previous chapter.

One of the companies was using wikis as a project management tool. It was utilised as a collaboration and coordination tool for the team, to replace email for sending updates to interested parties about the project status, and as a document repository and a dynamic document co-creation tool, which proved to be more convenient than shared files. This is the second reference to wikis in this section so far, which clearly indicates the variety of applications that this tool might have.

6.1.4. Profile library

The view of profile libraries is positive in the literature overall, but of all the companies interviewed only one was using profile pages which included brief description of prior experience of their employees. But this system was introduced because of the need to send CVs of team members to clients. In all the other companies the libraries were limited to a contact book-type profile library, and, moreover, interviewees did not see the need for an extended one. In their opinion profile libraries would most probably not be regularly updated,

while title and a brief description of their job would not be particularly informative, e.g. the same title could mean a very different level of experience and depth of expertise in different countries in a large organisation, and in a smaller company employees would rather seek a recommendation through their network.

However, the experience of one company shows that if the need arises employees can refer to LinkedIn, since people are most likely to update their LinkedIn profiles anyway, and if they do not, then they will most probably not update their internal profile page either. The company used LinkedIn in addition to the contact book, since it was being maintained by half of the employees for their personal use anyway. Also the background information of the person provides a better insight into their past experience both within the company and outside it.

The last example indicated yet another case of using social computing for KM purposes, but in this example employees referred to an actual social network. And as was discussed in Section 3.2.3, the proportion of companies that adopt social computing for corporate needs keeps growing. Some researchers and practitioners call it a new hype, others report substantial improvements. Through the course of the interviews I observed examples of using wikis, blogs and forums, of which wikis were the most popular tool. Several examples of using wikis have already been mentioned, and therefore it is worth starting the review with this tool.

6.1.5. Wikis

From a KMS perspective, wikis are probably the most interesting Web 2.0 tool of those observed. Among the companies interviewed wikis were the most adopted Web 2.0 tool for a wide range of applications, with most of the interviewees being satisfied with them. The users of wikis adopted them to record information about projects for future reference, to document best practice, lessons learnt, or issues related to the project, to conduct initial research and find documentation, to track updates by subscribing to a particular page (e.g. changes in technical requirements), to collaborate with other members of the team, to distribute training materials, or to aggregate document repository entries and summarise information about a particular topic.

Wikis were mostly praised for being flexible, easy to use and having a simple structure, allowing staff to work on the same documents and distribute information by letting people subscribe to the page of a project, whenever someone becomes interested in it. This reportedly led to a significant reduction in emails. This principle creates a knowledge pull dynamic, giving people a choice of what to follow. But ease of use and a straightforward structure were also seen as a drawback of wikis. Wikis were also reported to be messy and contain redundant information due to the lack of rules of engagement. However, this problem

can occur in other systems as well, e.g. document repositories. Apart from that wikis raised trust concerns among sceptics precisely because they are less formal.

Overall wikis could be an interface of a document repository or even replace it, and can be used as a project management tool and a collaborative environment for employees, or for promoting initiatives, replacing a news platform. The impact that wikis might have extends beyond the first phase of the KM roadmap, since they add a collaborative element to the management of explicit knowledge and allow employees to co-create knowledge, therefore contributing to enabling knowledge sharing.

One of the companies also reported an intention to add gamification elements in wikis to allow employees to rate the posts and to give points to the contributors, which when accumulated could organically identify the experts, thus extending the capacity and range of applications of wikis even further and advocating the importance of gamification for KM.

6.1.6. Blogs

Blogs were discussed much less than wikis by the interviewees, and the usefulness of this tool was revealed only in the centrality analysis, in which the blog was the fifth most influential concept in Company 5. This finding suggests that blogs might become a useful and powerful tool primarily in the later phases of KM, being something that companies need to be aware of, but keep for later.

In the companies interviewed blogs were mainly used to downstream high level corporate news and were seen as a high profile news feed. Some companies adopted Twitter and LinkedIn to streamline news, of which LinkedIn was also used internally. Two companies saw them as a way to democratise information about ongoing activities or the most interesting projects. One of the companies used a blog as a marketing tool to offer more sociable and less dry information about some of their projects to an outside audience, and asked various project teams to write not only an update on project but also a narrative about their experience (e.g. about problems with customs or weather challenges). The other company used it to provide updates about a new project inside the company, generate interest in different divisions, excite people and prepare the ground for implementation. Similarly, these updates were written in a more human and engaging language, and were a way to receive feedback from peers.

Experiments with formats showed that video blogs were viewed four times more often on average than text entries; however, creating just one video post was significantly more time and resource consuming.

Overall, it was possible to find far fewer examples of blog application than wikis; they create room for collaboration as opposed to newsletters on the portal, but their perception is still

limited to being a more sociable form of newsletter, which however becomes increasingly important, as KM evolves in an organisation.

6.1.7. Forums

The companies interviewed use forums mainly to post news (instead of blogs) and sometimes as a question & answer (Q&A) page, being a preferable alternative to emails. Forum-type software vendors (e.g. Yammer) promote it as a tool to help create communities of practice; however, in one company that has online communities the activities were mostly limited to posting news and updates. One type of update is related to internal job searches, and this application (e.g. seeking a new team member for a new project) addresses the problem of creating a too narrow specialisation of the employees (as was expressed by an employee of another company), and helps them to find new opportunities if they are willing to expand their area of expertise and are looking for new challenges. Some companies use it as a communication platform with their partners, where they can share information about ongoing projects and find information about past projects. And from the experience of one of the experts, forum software was adopted instead of a purpose-built crowdsourcing platform in order to support the open innovation initiative.

One of the major problems associated with implementing a forum is gaining and sustaining momentum by creating a stable and sufficient number of active users so that those who are willing to share are not discouraged by low participation, and others keep coming back because the space is actively maintained. This problem was expressed by employees from Companies 1 and 2. One of these companies shared their experience of implementing a forum, which was very popular during the first two months, but was forgotten afterwards. This problem is rooted in the natural distribution of users in online communities. According to various estimates the percentage of non-contributing members or so-called lurkers (readers only) varies from 45 to 90% (Nonnecke and Preece, 2000), and of the remaining 10% only 1% are heavy contributors, creating up to 90% of the posts (Jakob Nielsen, 2006). Various attempts to change this distribution did not succeed, and therefore it is recommended this fact is accepted as inevitable.

In this situation major contributors can be understandably demotivated, and visualising the activities of the silent users could help to make the system more transparent. Implementing some elements of gamification would help to create visibility of activities, e.g. rating or liking posts can indicate that others read them and find them valuable. As a side effect, rating can help move the most valuable contributions to the top, therefore helping the rest of the community see the most important and relevant contributions first. Rewarding contributors with expert points for their contribution might motivate them to keep writing, and help identify experts in various fields. And finally, if a forum space is used for posting questions

and receiving answers, appropriate tagging can connect a knowledge seeker with the knower by sending the request automatically to the relevant expert.

Overall, the interviews showed that though forums can be adopted for various purposes, they are most appropriate and convenient for posting news and updates (including job searches) in a community, or as a Q&A space. But the benefits for the type of practitioners involved in this research were less obvious than that of wikis.

6.1.8. Corporate Social Networks

None of the companies that were interviewed used Corporate Social Networks (CSN), and this tool is unlikely to be useful as a stand-alone system, but it can be easily merged with any other Web 2.0 tool and serve as a complementary social layer. The reasons for that might be that CSNs were mainly praised for their speed and connectivity (Clapperton and Vanhoutte, 2014; O'Dell and Huber, 2011), which is relevant in highly dynamic industries, but less so in moderately dynamic ones such as the energy sector, especially in the area of product development, where larger projects can last for years, and having commitment and progress recorded is much more important.

Overall social computing tools can be characterised by the ease of use and user-friendliness of the interface, their flexibility, ability to self-organise and a knowledge pull approach as opposed to push. Posted contents are much easier to search and retrieve than emails, and therefore their use might reduce the amount of duplicated communication, since, if a question has already been asked, the answer can easily be found. Social computing tools are also appreciated for their more informal and social nature, but this advantage also turns out to be a disadvantage: some of the interviewees suggested that not everyone takes them seriously since they are associated with social media, and therefore they are reluctant to use them, but these concerns tend to be raised among the older generation.

If we summarise the findings about KMS support, the interviews helped set the priorities and understand better the fit of each KMS type within KM. Some of the types that were reviewed in Section 3.2.3 were not brought up during the interviews, which might mean that they are not associated with KM by practitioners, and are rather seen as applications for specific areas of work (e.g. expert systems or analytical application). Discussing them in the literature within the scope of KMS might distort the reality, since they are more likely to be applied and adopted to address specific business needs, and so have different issues associated with them.

With regards to the KMS types reviewed above, if we think of them using a house as a metaphor, a document repository would be the foundation of the house and wikis would be its walls and front door, constituting the major part of the technology infrastructure for KM. LinkedIn could replace traditional profile libraries and become windows, through which one

could get a glimpse of the inhabitants of the house. A forum could be a balcony, where knowledge workers share thoughts and seek help as well as interact with their neighbours. And finally, as the house is being built, it needs a roof and a chimney in the form of blogs and newsletters, which streamline activities and show that the house is inhabited.

6.2. KM and KMS implementation

The analysis of the interviews led to the emergence of the KM model, which was described in Section 5.2, and which suggests the process that KM naturally follows in the companies interviewed. Though the model suggests a natural progression through these phases, the phases are also interconnected and mutually reinforcing. In particular, practices in the consequent phase might facilitate improvements in the preceding phase; however, they cannot create the practices on the preceding phase, if those were absent.

This model can potentially help explain the reasons why the same KM initiative might be successful in one company, but is a failure in another, the reasons being the lack of practice on the preceding phase which should serve as a foundation for the consequent phase. But this of course cannot be the only explanation.

This model also defines the role of technology in KM, which might also help to solve the conflict between the advocates of a techno-centric approach and their opponents. The first phase of the model does rely heavily on technology, though it is also acknowledged that technology alone cannot be the solution. Starting from the second phase the importance of technology decreases, as its potential is too limited to support the rich and diverse knowledge that the company starts to recognise. Additionally, the model clarifies the areas of application of different types of KMS, where document repositories and wikis are believed to make most impact, while other types have more specific areas of application and can be a useful addition to the technological core.

The analysis of the interviews also noted the example of using gamification elements in KMS as an extra layer, which could influence the dynamics of a group and expand the potential of the technology. The next chapter explores gamification in more detail and shows that gamification might have a much greater impact on knowledge work, and its influence extends beyond the added functionality of KMS.

This part of the chapter provided an overview of the findings with regards to specific types of KMS. The review of the literature in KMS in Section 3.2.6 pointed at the gaps and deficiencies in the literature, which are mostly related to the implementation and adoption of KMS. These issues were brought up during the interviews together with some aspects that have not been previously explored, such as generation differences. The rest of this section continues discussing these findings.

The interviews with both practitioners and experts have harvested a lot of interesting insights that are related to KMS in general, and this section aims at summarising them and engaging the reader in a dialogue between academic literature and practice, driven by practice. The aim of this section is not to provide a comprehensive literature review of the chosen topics, but rather to explore the themes that emerged from the interviews, and to support them with the insight from literature where appropriate. All the insights were somewhat related to the implementation of KMS, so it is worth looking at the insights through the theory of IS implementation that was discussed in the literature review in Section 3.2.4.

Lapointe and Rivard (2007) suggested that the success of IS implementation is defined on three levels: group, individual and organisational. In relation to the companies interviewed, the individual and group level play the same role as in the study described by the scholars: perceived usefulness and ease of use influence the adoption of the system, but are not enough if the system is not accepted at the group level. For instance, some of the interviewees reported that they were reluctant to adopt a new system, which they admitted to be user-friendly, because they did not see others getting involved with it. With regards to the third level, the organisational structure of the interviewed companies predominantly resembles adhocracy, characterised as being organised around the projects and being composed of highly-skilled professionals. In this setting the professionals tend to group around skills and hold a relatively high degree of decision making power; however, they are also grouped around projects, and if a PM process is routinized in the company, then it is possible to align the system with these routines, which increases the chances of a successful adoption. Lack of integration of the system in everyday routines has been highlighted in the literature as one of the reasons for KMS not being adopted, and this was noted by the participants as well. Some of the participants argued that the system required extra effort to add it to everyday routines, others did not have a similar approach to the same routines in the company to start with. The material obtained during the interviews is not sufficient to suggest a new approach, but as the findings showed this framework could be a good starting point for future research.

In addition to these findings the participants and even more so the experts have shared their thoughts and experiences with regards to more specific problems in the implementation and adoption of KMS. Among the problems they have encountered were lack of training (since video tutorials are hardly enough) and lack of rules of engagement. The need for training only emphasises the importance of technology acceptance at the individual level: even if KMS are easy to use, the lack of time required to learn might cause resistance to adopt, and this factor is discussed in more detail later in this section. The lack of rules of engagement corresponds to technology acceptance at the group level and includes several aspects: it starts with creating rules as to how the system should be used and what for, it also includes making the benefits of using the new system obvious for everyone, and finally, it includes the need for a certain level of formalisation (e.g. officially recognising someone for contributing to the new

system, like a blog, and therefore signalling that it is an important activity and is not seen as a waste of time by the managers).

Other aspects highlighted by the participants include PR in KM, change management, motivation and the impact of the generation gap, and each of these aspects is discussed in more detail in the rest of this section, followed by the implications of these findings on the overall research.

6.2.1. KM promotion

The issues of internal promotion or marketing of KM initiatives are not typically discussed in the KM literature, but the experts considered this to be one of the crucial elements of the implementation process and referred to it as internal PR. Not disseminating any new strategy throughout the whole organisation not only limits the outcomes, it also may create barriers for the adoption and implementation of changes, and resistance to change has already been mentioned several times in this study. Therefore, according to the experts interviewed, any initiative that is part of a strategy should be supported with a thoroughly planned internal promotion campaign.

One of the experts shared an example in a railway company. The company implemented an ideas competition and popularised the initial results by sharing success stories in their quarterly corporate magazine, which was a perfect place for this type of information dissemination, since the majority of employees read it regularly. These personalised success stories were accompanied by details of the impact that participation in the competition had on the hero of the story, and the list of actions that one could take in order to become more successful in their career. This internal promotion through stories that were sticky and rich in context, as opposed to dry information, helped to change the culture and allow employees to become more involved.

This example comes from a different context, but the expert who gave it and who himself works in the energy sector, saw the issue as equally important any industry, though the implementation (e.g. the choice of information channels) might vary. Similarly, several interviewees reported that the lack of feedback around certain initiatives was discouraging for them:

> *"I could imagine people sitting beside me and work, genuinely just don't know how we work, think, that we just dream things up, and for them, when I collect all the ideas at the conference, they might think: "well, I gave her 6 ideas and they've all just disappeared into her inbox."*

While others anticipated this problem by blogging about their projects and trying to generate early interest before the project was ready to be implemented.

"I'm trying to get people excited about what we are doing and where it is going before we have to go and approach them."

One could think of different reasons for the absence in the academic literature: the researchers might consider this topic too obvious to discuss, or too unimportant, or even not academic enough. Regardless of the reasons this aspect of KM needs to attract more attention from researchers, since they are the voice of best practice. The high failure rate of KM projects demonstrates vividly the need to further our understanding of implementation related problems, and the lack of internal PR might contribute to this failure rate as much as any other aspect discussed in this section.

6.2.2. Training

The aspect of training has already been mentioned in this section, and similar to KM promotion, this topic does not receive much attention in the literature. During the interviews training was discussed in various contexts, e.g. as a tutorial on how to use a new KMS. The companies that have reported mixed results about the success of KM initiatives have also reported that employees were not provided with any training or were referred to online tutorials, and the interviewees saw the link between the two. The training could be not only to the place to learn about technical aspects of the software, it could also be a chance to learn about the rules of engagement with the system and opportunities and advantages that the system provides.

Secondly, training was discussed as a place to educate interested parties about new initiatives, ideas competitions in particular. Similar to the KM promotion aspects, the opinion about this aspect of KM implementation comes from the experts, who outlined two purposes that training should serve. Firstly, training is a place to engage middle-managers and educate them about upcoming initiatives. The importance of middle management has already been emphasised several times, and one of the experts saw training for middle management as one of the key success factors of the open innovation initiative. It is middle managers who either approve or discourage their subordinates from spending time on non-job related activities, such as knowledge sharing and proposing new ideas. Therefore, they need to be educated about a new strategy of the company and be shown the bigger picture. Apart from that, quite often new initiatives of this kind are welcomed enthusiastically by top management, but are then delegated to middle managers internally, and with a lack of support from their side poor execution will most certainly lead to failure of the project.

Finally, training might be required for the moderators of the activities, such as experts who are going to evaluate ideas during the ideas competition, and this need was best illustrated by one of the expert:

"If you say: 'I'm organising an ideas factory, I'm going to review everything.', then the guys will be dealing with nonsense for 4/5 of the time. And the experts will be writing negative things all this time. Experts will be stressed, and then you say that you are an open company and everyone should see what the experts have written. Then you need to teach an expert how to write, because quite often he/she can write: 'it's a ridiculous idea, let's fire the author. Where did you find this idiot?'"

6.2.3. Change management

Change management is a widely researched and well-established field in its own right, but it is not often discussed in the context of KM. Nevertheless, implementing a new KM initiative requires change management, as one would expect when new practices and supporting systems are being implemented. The issue of change management was mentioned by several interviewees, and it is also possible that poor change management might be partially responsible for a high failure rate of KM initiatives. Therefore it is all the more surprising to see how little attention has been paid to it in the literature. Some researchers have raised the issue of change management within the context of KM projects (Davenport et al., 1998), but most of the literature is focused on the design of the initiatives only, rather than aspects of implementation such as change management. It would not be possible to explore this issue in depth within a small part of a chapter, but still I would like to point out another interesting finding. The interviews with experts as well as Zappos' employees (the case discussed in Section 7.2) could suggest a bi-directional impact of change management and KM on each other, and therefore open new directions for further research.

Section 5.4 discussed the importance of corporate culture and its influence on KM acceptance, and some of the researchers suggested that the culture needs to be changed or adjusted in order for KM to be accepted (De Long and Fahey, 2000), which in turn requires change management. However, KM can play a role in shaping corporate culture as well. In particular, communities play a role and spread the change in culture (McDermott, 1999) acting as local ambassadors for the change. Similarly, one of the experts shared the experience of implementing an internal open innovation initiative, and as the initiative matured, the company was able to identify employees who were genuinely interested in innovation and formed the core of an innovation community in that company, therefore promoting a more open-minded and innovative culture. This initiative allowed identification of those key people who would have been in the shadows otherwise. In this example ideas competition was not intentionally used to implement the change, it was rather a relatively unexpected outcome, whereas BMW deliberately used ideas competition to facilitate a change in the company (Klein and Lechner, 2009).

As is shown in Section 7.1.2 of the next chapter, contests were described as one of the gamification mechanics elements, hence the above examples could be related to the role that

gamification might play in change management. The Zappos case, described in Section 7.2, has shown how gamification was used to identify key people and build a community while transforming the organisational structure. For instance, the company used gamification (experience badges) to generate a requirement for new competences by inviting enthusiasts to educate themselves about a new organisational structure and to become local ambassadors for the change. This example relates to previous examples and demonstrates another way of identifying key people, therefore being a mediator for initiating an organisational change. Similarly, a former VP of customer experience in Yahoo! initiated organisational change by making slight changes in the gamified system, and he claimed that the flexibility and responsiveness of the gamification layer accelerated the speed of change several fold (Rimon, 2015). Though he does not provide any details that would illustrate the mechanics behind it, the examples above suggest ways of doing it.

These examples illustrate that it is not only KM and KMS that require effort dedicated to change management, but KM can facilitate the change as well, and the layer of gamification added to KM could be a powerful accelerator mediating the relationship between the two.

6.2.4. KM and motivation

The topic of motivation was peripheral to this research, but it was raised several times during the interviews. The review of KM literature has shown quite an active discussion around motivation with positive (Grant, 2013; Voelpel et al., 2005) as well as negative (Vassileva, 2012; Voelpel et al., 2005) effects of certain incentives (rewards) on the outcome, and the factors that drive people to certain actions, such as knowledge sharing (Hsu and Lin, 2008). Such factors are often divided into extrinsic and intrinsic motivation, but the border is being blurred, and such factors as personal ties (Wang et al., 2011), or the sense of altruism and enjoyment of helping people (Ardichvili et al., 2003; Hsu and Lin, 2008; Kankanhalli and Tan, 2005), are often mistaken for intrinsic, though they are certainly closer to intrinsic motivation on this spectrum than monetary rewards.

The interviews with the experts that were discussed in Section 3.4 did not add clarity to the diverse and contradictory findings in the literature. One of the experts shared the experience of attempting to measure the effect of rewards with varying nominal value on the quality of ideas, but there was no effect. In another example a company would give an author of a good idea a bucket of apples as a surprise gift on their desk. This way the company aimed at three goals: rewarding ideas sharing which did not cost the company much, taking care of its employees' health, since apples are full of vitamins, and encouraging knowledge sharing, since a bucket of apples on the desk would the attract attention of the peers and they would start discussing their ideas with each other and come up with something new. This example showed that non-expensive rewards can be very effective, but the experts also shared contradictory examples of the impact of expensive rewards. In one company an expensive

monetary award (a car) had a corrosive effect on the employees in the company, while in another company a high value award (a trip) had an overall positive outcome, and the expert explained the differences by types of reward that can or cannot be accumulated.

The second interviewed expert suggested that the same person is motivated differently at different points in time. And the third interviewed expert saw rewards as being monetary and non-monetary, and considered a combination of the two to be the most effective.

> *"Before you start giving your idea, you see what's in for you, and if there is a monetary aspect, you are more motivated to participate. Then if there is a non-monetary incentive, you are motivated to give a good idea."*

Similarly, the observations in the companies interviewed were very different. In some companies, being able to spend part of your working time on developing your idea was a sufficient motivation for people to participate, while in another company people were offered a substantial monetary reward for their ideas, and both approaches were successful. In Company 5 rewards appeared to be one of the most central concepts in the centrality analysis.

The contradictions in the literature and in the examples discussed above prove that the current way of looking at motivation has its flaws and does not help companies to make decisions. Nor does it help to explain phenomena observed. For example, the expectation to be rewarded for innovative ideas might be driven by a sense of fairness of being rewarded for profiting the company, which is related to a sense of trust (Cropanzano and Mitchell, 2005), as opposed to the motivation where knowledge sharing is related to helping individuals rather than the company and its profits. And in this case the willingness to share knowledge is linked to reciprocity (Konstantinou and Fincham, 2011) and the expectation of receiving help in the form of knowledge sharing in the future. There might be a lot of other reasons for sharing or not sharing, such as hidden blocks in the corporate culture, and creating incentives in order to improve motivation rather than looking at the problem as a whole. This is similar to battling the symptoms that are easy to observe, instead of searching for the root-cause of the disease.

However, the problem of motivation could also be seen as an excuse for making others do a job that they do not want to do in the first place. For instance, intrinsic motivation has been acknowledged as being the strongest type of motivation (Ryan and Deci, 2000), and it cannot be manipulated or reinforced externally, but it can only come from inside; therefore, regardless of how much time we spend discussing it, we cannot change it. Giving recognition to experts is a type of reward that has proved to be an effective extrinsic motivation (Grant, 2013; Hsu and Lin, 2008; Voelpel et al., 2005). But should recognition be their due anyway, does it have to be driven by a need to motivate someone? Similarly, Zappos thinks that:

"Motivation is necessary; however, when I feel that I need to motivate myself, it's usually to do something that I really didn't want to do in the first place. It may seem that motivation is a good thing, and it is, if it's coming from the right place."

As is shown in Section 7.1, motivation is also being widely discussed in the gamification literature (Zicherman and Cunningham, 2011), and it seems that this focus stops others from seeing a wider potential of gamification, and even a small case-study of the company called Zappos that was included in this research was able to prove that.

6.2.5. Generation gap

The issue of generational differences and the impact that these differences might have on KM has not been widely explored in the literature, but they are likely to exist. Preferences, the acceptance of KM practices, or the types of KMS tools are likely to shift with time or to vary in different industries and sectors because of the differences in the generation profile (e.g. between oil & gas and retail industries, where the former is concerned with retaining the knowledge of retiring employees, and the latter is focused on retaining young and ambitious employees). The most detailed research might have been presented in the report of The Conference Board (2008) which has examined the influence of generational differences on knowledge transfer. This report has described observed differences in adapting various means of communication and knowledge sharing as well as the preferences and attitude to learning and knowledge sharing among the Veterans, Baby Boomers, Generation X and Generation Y / Millennials. My research was not initially focused on these differences, but this suggestion was opened up by the experts and developed further by some of the interviewees.

The experts compared the experience of their colleagues in the retail and telecom industries with one of their own in the high-tech industries, the former tending to employ millennials that need constant "drive" and new challenges, as opposed to older generations, who are able to concentrate on one problem and are better at immersing themselves in an in-depth analysis. In some of these companies the managers started experimenting with mixed project teams, where the younger team members can quickly grasp the core of the problem, and then older colleagues take over the first findings and continue with more thorough research.

Similarly, the literature on the generational differences in the work place notes that millennials tend to be good at multi-tasking, striving for challenges, are goal-oriented, tech-savvy and praise connectivity and collaboration (Raines, 2003; Wagner, 2009). However, these differences are the product of modern times and can sometimes be misinterpreted. In particular, they have to adapt to new technologies, because even basic everyday tasks often require the use of internet and communication technology. The unstable environment (economic, labour market) taught them to react faster in order to cope with changes. As a by-product of this environment this can result in boredom and being easy distracted (Kalinauskas, 2014).

These differences potentially have wide-ranging applications for KM and KMS in particular. Different generations have different learning styles: baby boomers prefer formal settings, whereas generation X learn better in action and millennials seek learning among their connections and adopt mixed learning styles including learning by themselves (Piktialis and Greenes, 2008). Different generations might have different approaches to knowledge sharing as well. Millennials do not like the long and colourful stories favoured by the baby boomers and prefer a short distillation with minimum context, because they can ask for more details later if needed (Piktialis and Greenes, 2008).

Some researchers suggest that the penetration of technologies into all areas of our lives including many KM practices has only widened the generation gaps, since millennials are more accustomed to adopting new tools (Wagner, 2009). Millennials prefer instant messaging and sharing experiences through blogs and wikis as opposed to formal face-to-face gatherings (Piktialis and Greenes, 2008). Similarly, some of the interviewees noted that the younger generation is more sociable and open to collaborative tools, such as wikis, and that open challenges and initiatives would be welcomed by younger employees.

> *"...setting challenges for people internally and externally to solve problems, hopefully will push them more towards it. I think it would be a really good platform outside the older generation."*

Since baby boomers are increasingly retiring from the companies in the energy sector, the demographic profile of the sector will change in the next decade, and this change might accelerate technology acceptance of the tools that could be hugely beneficial to the companies, but experience difficulties with adoption at the moment. As is the implementation and adoption of gamification in a company, which could be perceived as fun, intuitive, engaging and interesting by the millennials and support their goal-orientation, but might not be taken seriously and therefore not be accepted by others, who care more about external opinions (Sheahan, 2005). This quick review combined with the ideas taken from the interviews has opened doors to the vast area of KM that would need further research and could produce interesting results.

6.3. Implications

The findings in this chapter are a continuation of the multiple case study analysis which was presented in Section 5.2 of the previous chapter. They add a technology layer to the organic roadmap of KM (Figure 42). This chapter has also discussed some of the implementation related aspects that were brought up by both the experts and interviewees and that suggest directions for further research.

The technological support for the KM initiative and its importance vary with phases just like KM practices. Based on the interviews I have analysed different types of KMS that had been

identified throughout the literature review, and two types of KMS were found to be the most important: document repositories and wikis. The first phase is centred on the KMS which aims at organising data, information and articulated knowledge as a part of data and document management. Document management in turn helps to facilitate explicit knowledge sharing with the help of document repositories, creating an overlap with the second phase of the KM roadmap. As KM evolves further, the role of KMS becomes secondary. One type of KMS that was found particularly useful is wikis, which can be utilised both complementary to document repositories and as a replacement for them. They were mostly praised for their collaborative environment, which can support certain types of knowledge sharing, and for their ease of use and flexibility. The next element of KMS support that could be transformational is a gamification layer that can be added to any type of KMS. The exploratory case study in the Section 7.2 of the next chapter investigates the role of gamification in KM, but it might have a profound effect on innovating activities as well, which are integrated with the third phase of the KM roadmap, and the next chapter explores the impact of gamification on innovation as well.

This chapter has answered the second research question by investigating the use of different types of KMS in the companies and identifying the aspects of KM that have proved to be useful. The reader will have noted the reference to gamification in various part of this chapter, which indicates that one way (but not the only) of adding gamification to KM is through blending it organically with KMS. Though originally gamification was at the fringes of this research, it became one of the main research streams when it became evident, that this area might have a potentially significant impact on KM and KMS. Thus the following chapter aims at answering the third research question and exploring the connection between gamification and KM in more detail.

7. Exploring the role of Gamification in Knowledge and Innovation Management

Gamification was not in the original scope of this research, but after the interviews with knowledge and innovation management experts it emerged as a way to advance KM further, and the topic of the potential influence of gamification on KM and innovation management was added as a third research question. The results of this part of the research complement the organic roadmap of KM by showing the direction of technology development in KM, and open new areas of research in KM and innovation management. The analysis of the literature review on gamification and the findings of the case study draw on the literature that was discussed in Sections 3.1 and 3.2. Thus it demonstrates how gamification might influence the dynamics of knowledge workers, what impact it might have on KM and innovation practices, how it can be used in KMS and how it is related to motivation in the context of KM. This part of the research became central to the whole research, because it is underexplored in KM, but it seems that it has a huge potential improving KM, KMS and innovation management. This chapter is in a way a detour from the main context of this research, it is not coming from the energy sector but it is relevant to it.

This chapters answers the third research question regarding the impact that gamification might have on KM and innovating activities. The first section gives an introduction to this field, provides an overview of various definitions and discusses the elements that compose gamification. Since the field of gamification is still very new and the amount of academic literature available is limited, this review refers to non-academic sources as well. The second section presents an exploratory case study that demonstrates a variety of ways in which gamification impacts KM. The consequent sections discuss the role that gamification might play in KM and innovation management, and the implications of these findings for this research.

7.1. Literature review

The use of games for purposes other than entertainment can be traced back to ancient times. In the book *The Histories*, Herodotus says that when famine struck Lydia in Asia Minor, the king of Lydia ordered that people should engage in games rather than eat on alternate days in order to stretch the stocks of food, and apparently this rule lasted for 18 years, during which a lot of well-known games such as dice were created (McGonigal, 2011; Rawlinson et al., 1880). In more recent times, in 1902 Lizzie Magie created a game called “The Landlord’s Game” to illustrate the disadvantages of the current land tenure system. However, this game had quite a different effect. It was rebranded as “Monopoly” and became one of the best-selling board games of all time (Ferrara, 2013). And with time researchers started exploring

the role of games in education and learning (DeVries and Edwards, 1973; Gee, 2004; Malone, 1980).

The early experiments with introducing game elements at work can be traced back to the early Soviet Union in the form of competition between different factories (Nelson, 2012), but embedding game elements in the non-gaming environment really took off with the development of information technologies, and this process was then given the name 'gamification' (Pelling, 2011). If we look at the gamification elements, such as leaderboards, badges and points, they were borrowed from video games, which in turn were taken from real life (ranks and medals in the army, or grades and degrees at university). Therefore, one can say that these elements made their way back into real life with a new twist.

Loyalty cards and frequent flyer programmes are one of the early examples of gamification as we know it now. It was first introduced by American Airlines, and soon other airlines, hotel chains and car rentals started using the mechanics of collecting points and redeeming them for other products and services or upgrading of status with all the sweeteners accompanying it, as a tool to increase the return rate of customers (O'Malley, 1998). It became a very powerful marketing tool, at least for a while.

A more recent example is Foursquare, a search service for leisure activities. The whole service is built around the idea of gamification: apart from leaving feedback and rating a place, users can check-in every time they visit a place, and collect badges for their activities. Users can gain the status of mayor if they are the most frequent visitor to a place, which can then be lost as soon as someone else beats their score. Sometimes this leads to friendly rivalry (by number of visits) between those who want to retain the status they have achieved (McGonigal, 2011).

Gamification found its way to the corporate environment as well. For example, Spotify replaced annual reviews for its employees with a gamified app, and voluntary participation increased 90%, while Google introduced "Goobles" currency to be spent on one of the most scarce resources in Google – server time (Dale, 2014).

Games are usually associated with fun and leisure time, but given how much time both children and adults spend playing games ('Collectively, the planet is now spending more than 3 billion hours a week gaming' (McGonigal, 2011, p. 6)), some practitioners have suggested that instead of shaming the gamers and fighting their addiction we should learn from the games, understand what is so engaging about them and try to replicate it in real life, for example, at work, and more specifically in the work of knowledge workers.

Since its recent entrance into the arena of both practice and scholarship of management, 'gamification' is rapidly gaining ground as a tool for practicing managers, or often specialised consultants, and also as a promising research area for management and organisation scholars. Today it has acquired sufficient legitimacy to claim that it is more than just another

management fad. One of the major developers of corporate software solutions – SAP – introduced a beta version of a gamification module in 2015, therefore acknowledging that gamification should be taken seriously. However, this area of application is still at an early stage of development and lacks adequate conceptualisation of research problems and agendas. The following section attempts to bring clarity to the existing confusion.

7.1.1. Definition of Gamification

The original definition of Pelling (2011) was narrowly focused on adding game experience to electronic transactions, but the examples provided above illustrate a much broader range of applications. Later he revisited his own definition and interpreted it as systems that call for social action, such as Kickstarter and Alibaba (Pelling, 2015), but this definition leaves out a range of personal applications, such as Nike Plus: a running app that tracks user's progress and provides instant feedback in various forms, for example in the form of an animated avatar that changes mood and shape depending on progress (McGonigal, 2011). Therefore, it would be more appropriate to say that gamified systems can generate a call for social action, but do not exclusively lead to it.

Other definitions (Table 11) emphasise the use of game elements (Burke, 2012; Deterding et al., 2011; Werbach and Hunter, 2012; Zicherman and Cunningham, 2011) in order to engage users (Burke, 2012; Huotari and Hamari, 2012; Zicherman and Cunningham, 2011) in a non-gaming environment (Burke, 2012; Deterding et al., 2011; Werbach and Hunter, 2012), and the last aspect is very important, because it draws a line between games and gamified systems, and therefore shifts the focus from entertaining and creating a full gaming experience to studying the ways in which individual game elements and their combinations influence behaviour. But these definitions are incomplete, too restrained, or misleading for the following reasons.

Table 11. Definitions of Gamification.

Reference	Definition
(Pelling, 2011, p. 1)	'Applying game-like accelerated user interface design to make electronic transactions both enjoyable and fast.'
(Zicherman and Cunningham, 2011, p. xiv)	'The process of using game-thinking and mechanics to engage users.'
(Deterding et al., 2011, p. 1)	'The use of game design elements in non-game contexts.'
(Burke, 2012, p. 1)	'The use of game mechanics and game design techniques in non-game contexts to design behaviours, develop skills or to engage people in innovation.'

(Werbach and Hunter, 2012, p. 26)	'The use of game elements and game-design techniques in non-game contexts.'
(Huotari and Hamari, 2012, p. 19)	'A process of enhancing a service with affordances for gameful experiences in order to support user's overall value creation.'
(Werbach, 2014, p. 266)	'The process of making activities more game-like.'

In particular, Zicherman and Cunningham (2011) did not explain what they understand by game-thinking and did not distinguish between gamified systems and serious games (such as business simulators), which are a completely different category. Burke (2012) defined the purpose of the application of gamification (e.g. behavioural change) well, but gamification can serve other purposes, such as triggering organisational change (Rimon, 2015), therefore, this definition is too restraining. Huotari and Hamari (2014) developed their definition for marketing applications, and so it cannot be used for a broader range of applications either.

Werbach (2014) revisited his earlier definition and, as well as Huotari and Hamari, shifted the focus from the use of game elements to the nature of gamification being a process, but at the same time he removed 'non-game contest' from the definition and even suggested that games can be gamified too, repeating the mistake of Zicherman and Cunningham. Therefore, the final definition, which also serves as a working definition for this research, is a combination of the two definitions stated by Werbach.

'Gamification - the process of making activities in non-game contexts more game-like.'

Defining a new concept that was introduced in this chapter was important, because it can help to recognise examples of gamification in the case study that follows. This case study advocates for the use of gamification in KM and thus helps to answer the third research question.

7.1.2. Decomposing Gamification

Game elements have been mentioned a number of times up to this point, and even were included in the definition of gamification; therefore, it is essential to review them in more detail. When researchers mention game elements, they usually refer to such components as points, badges, ratings, leaderboards, or progress bars, but one can find many more examples. And with the variety of these elements comes confusion. Is everything that is remotely related to games an example of gamification? Or should it be restricted to a much narrower range of applications? Deterding et al. (2011) drew a parallel with Caillois' (1961) concept of paidia and ludus or "playing" and "gaming", where playing refers to a broader category incorporating improvisational and expressive behaviours and meanings, while gaming refers to the playful systems bound with explicit rules and driven by goals. By adding

a second dimension – parts/whole – they divided the game/play area into four categories (Figure 44).

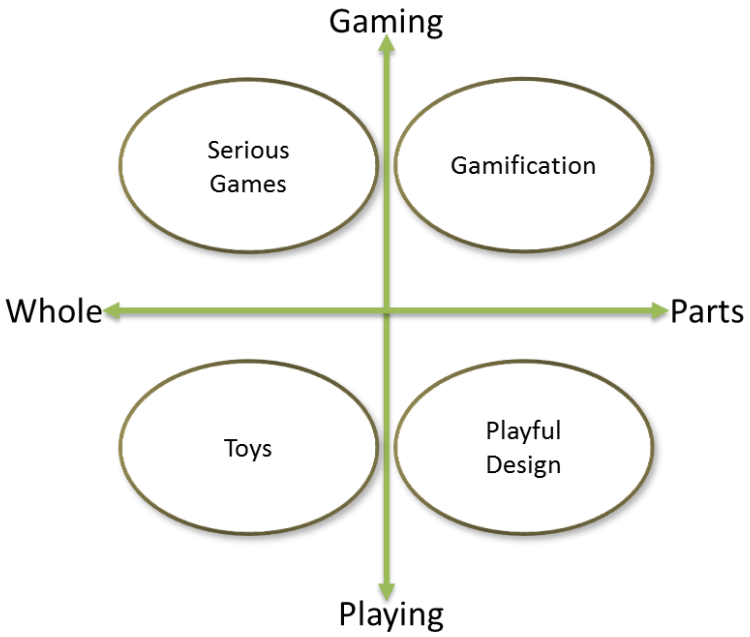

Figure 44. Classification of game/play area. Source: (Deterding et al., 2011).

This classification makes a clear distinction between gamification and serious games (e.g. business simulators or educational games), but the latter are commonly mistaken for gamification (Halan et al., 2010; Salcu and Acatrinei, 2013). The distinction between gamification and playful design is less obvious. For example, a Speed Lottery system that was introduced in Stockholm tracks the speed of drivers and gives a portion of the speeding fines back to some of the law-abiding drivers via a lottery (Volkswagen, 2010). This system has a set of rules, but does it have goals? It does for the system designers and maybe for some of the drivers, who are keen on winning the lottery, but for the majority of drivers it does not. Therefore, according to Deterding et al. (2011) it will not be classified as gamification, because it does not have clear goals for all the participants, but for Werbach and Hunter (2012) it will, because it uses game elements, initiates behavioural change and generates an enjoyable experience. The main question here would be: is it important to make a distinction between the two?

Another source of confusion comes from attempts to classify game elements. Most scholars classify game elements by their level of abstraction, but disagree on the levels (varying from two to five) and terminology (Table 12). The authors of the two most widely cited gamification books, Zicherman & Cunningham (2011) and Werbach & Hunter (2012), define three levels, but in a different way. For example, what the former call mechanics (e.g. points and badges), the latter name as components. Zicherman and Cunningham refer to the MDA (mechanics, dynamics and aesthetics) framework of game design (Hunicke et al., 2004), which is cited by a number of other scholars, but they do not elaborate on the third aspect of it. They also

misinterpret the meaning of the first two levels that the original authors assigned to them. Hunicke et al. (2004), the creators of the MDA framework, refer to mechanics as actions and control mechanisms, not simple interface elements, while dynamics was the underlying behaviour. On the other hand, Werbach and Hunter (2012) share the same understanding with Hunicke et al., but instead of adopting and adapting it to gamification needs, they concentrate on the components that comprise the interface and are visible to us (one level below the mechanics), and leave the aesthetics aside (the top level in the MDA framework).

Deterding et al. (2011) define five levels, but their understanding is quite different from other classifications. Some of the examples provided by the authors are included in different levels by other authors, and the explanation for this classification is not sufficient to allow understanding of the authors' logic. For example, challenges that are presented as a game model are included in game mechanics by Werbach and Hunter (2012), and the whole MDA framework is included in the game models. Apart from that, some levels seem to stand above and be applicable to all the games, e.g. game principles and game design methods. These aspects have to be taken into account, but do not refer to a specific game, and therefore including them in the classification of gamification elements is not justified.

Other researchers distinguish between two levels of game elements: game mechanics and game dynamics (Blohm and Leimeister, 2013; Pedreira et al., 2015), and their definitions partially overlap with all three levels of the MDA framework, as well as misinterpreting the original meaning of each level of Hunicke et al. (2004).

Table 12. Classifications of gamification elements.

Source	Game elements	Examples
(Zicherman and Cunningham, 2011)	Mechanics	points, levels, progression bar, leaderboards, badges
	Dynamics	pattern recognition, collecting, surprise, creating order, gifting, flirtation, recognition for achievements, leading others, fame, heroism, gaining status, growing
	Aesthetics	sensation, fantasy, narrative, challenge, fellowship, discovery, expression, submission (Hunicke et al., 2004)
(Werbach and Hunter, 2012)	Components	achievements, avatar, badges, boss fights, collections, social graph, virtual goods, combat, content unlocking, gifting, leaderboards, levels, points, quests, teams
	Mechanics	challenges, chance, competition, cooperation, feedback, resource acquisition, rewards, transactions, turns, win states
	Dynamics	constrains, emotions, narratives, progression, relationship
(Deterding, 2012)	Interface design patterns	e.g. badge, leaderboard, level

	Design patterns and mechanics	e.g. time constraint, limited resources, turns
	Design principles and heuristics	e.g. enduring play, clear goals, variety of game styles
	Game models	e.g. MDA, challenge, fantasy, curiosity, game design atoms, CEGE
	Game design methods	e.g. playtesting, play-centric design, value conscious game design
(Blohm and Leimeister, 2013)	Mechanics	documentation of behaviour, scoring systems, badges, trophies, rankings, ranks, levels, reputation points, group tasks, time pressure, tasks, quests, avatars, virtual worlds, virtual trade
	Dynamics	exploration, collection, competition, acquisition of status, collaboration, challenge, development / organization, motives

All the authors mention such elements as points, badges and leaderboards, giving them different names, and these elements constitute the basic building blocks, the objects, that users see and interact with. It seems logical that the next level should link different building blocks with each other (rules) and describe various actions that can be performed with them. And finally the top level binds the elements of the previous levels together. Of all the classifications, the one suggested by Werbach and Hunter (2012) corresponds most to this logic, namely: components, mechanics and dynamics, but the components that have been included in this classification might need further revision and can be complemented with examples from other frameworks.

The most listed elements of the gamification **components** (the interactive components) are badges, levels, leaderboards and points (Blohm and Leimeister, 2013; Deterding et al., 2011; Werbach and Hunter, 2012; Zicherman and Cunningham, 2011). Among other components are avatars (Blohm and Leimeister, 2013; Werbach and Hunter, 2012) and virtual goods (Werbach and Hunter, 2012) or trophies as an example of goods that can exist within virtual trade (Blohm and Leimeister, 2013). Less frequently mentioned components are collections, social graphs, teams (Werbach and Hunter, 2012) and ranks (Blohm and Leimeister, 2013).

With regards to other building blocks suggested by authors, scoring system, time pressure (Blohm and Leimeister, 2013) and limited resources (Deterding et al., 2011) are a form of rules (mechanics). Achievements (Werbach and Hunter, 2012) and virtual world (Blohm and Leimeister, 2013) are abstract terms for levels, badges, ranks or virtual goods. Gifting (Zicherman and Cunningham, 2011), documentation of behaviour, group tasks (Blohm and Leimeister, 2013), quests, content unlocking, boss fights and combat (Werbach and Hunter,

2012) imply an action or are a type of challenge (call for action), and therefore should refer to the game mechanics.

The second level of the gamification elements classification – the **mechanics** - defines the interactions between the basic building blocks (Werbach and Hunter, 2012) and their effects on the users (Blohm and Leimeister, 2013). A number of the elements of mechanics have already been discussed above. Among others, some of the elements are easy to recognise as a form of action, such as collecting, flirtation, fame, hero being, gaining status (Zicherman and Cunningham, 2011), creating order or organizing, growing or developing (Blohm and Leimeister, 2013; Zicherman and Cunningham, 2011), collaboration or cooperation (Blohm and Leimeister, 2013; Werbach and Hunter, 2012), rewarding / recognition of achievements and feedback (Werbach and Hunter, 2012). Petersen and Ryu (2015) suggested *betting* as one of the ways to predict the most innovative ideas. With regards to other elements mentioned in the literature, the turns (Deterding et al., 2011; Werbach and Hunter, 2012) and win states (Werbach and Hunter, 2012) are a form of rules. Surprise (Zicherman and Cunningham, 2011) or chance (Werbach and Hunter, 2012) is a reverse action or an intervention in the system, praised by Vassileva (2012) as a form of persuasive application in gamification, and therefore can also be included in this level.

The interpretations of the top level of gamification elements – the **dynamics** - vary the most, from aspects of the game that cannot be implemented and managed directly (Werbach and Hunter, 2012), to the emotional responses of users (Hunicke et al., 2004; Zicherman and Cunningham, 2011) and conceptual models / patterns of components and game experiences (Brathwaite and Schreiber, 2009; Deterding et al., 2011). The second and (partially) the third interpretation are shaped by the game design industry, while the gamified systems in a non-gaming contest seek to influence behaviour and engagement. Therefore, this level should be characterised as *conceptual models of game components and user engagement that cannot be managed directly.*

The elements described by various authors, include expression (Hunicke et al., 2004), relationship / fellowship (Hunicke et al., 2004; Werbach and Hunter, 2012) and discovery / curiosity (Deterding et al., 2011; Hunicke et al., 2004), and these resemble Kim's types of social engagement (2012): express, collaborate, compete and explore, in a framework that was developed to demonstrate a diversity of experiences that users might be willing to obtain in a gamified system. Both competition and collaboration were already included as elements of mechanics, but in a narrower interpretation, therefore in the previous level they could be substituted with contest and teaming respectively. Other elements mentioned by the scholars include the progression (Werbach and Hunter, 2012), the narrative (Hunicke et al., 2004; Werbach and Hunter, 2012) and the fantasy (Deterding et al., 2011; Hunicke et al., 2004), of which the last two elements overlap. And finally, the sensation and submission (Hunicke et al., 2004) refer to types of video games and might be irrelevant for a non-game contest. Table

13 presents the suggested list of elements on each level, and these elements proved to be useful during the analysis of the exploratory case study of a gamified system in a corporate environment that is presented in the next section.

Table 13. Classification of game elements.

Level	Element
Components	avatars, badges, collections, leaderboards, levels, points, progression bar, ranks / status, social graphs, teams, virtual goods
Mechanics	betting, challenges, chance / surprise, collecting, contest (competition), fame, feedback, flirtation, gaining resource / access, gaining status, gifting, growing / developing, hero acting, interventions, organising, pattern recognition, ranking / rating, rewarding, rules, teaming (collaboration), transactions
Dynamics	collaboration, competition, exploration, expression, narrative, progression

7.2. Zappos case

After gamification was included in the scope of this research it was possible to find a company that illustrated gamification in action in its full potential inside a corporate environment. This section presents the exploratory case study conducted in a company called Zappos, which, as is shown, demonstrated many examples of implementing elements of gaming in the work of its employees without even referring to it as gamification at any point. Subsequently, by building on this empirical study and further examples from the literature this study explores the work and practices of knowledge workers and the possibilities of using gamification to support them.

Zappos is an online shoes and accessories retailor operating in the U.S., established in 1999 and acquired by Amazon in 2009. The company is famous for its customer-oriented service, for example, special return shipping assistance, surprise free upgrades to overnight shipping and the “Ask Zappos” service that promises to find a pair of shoes matching a photo sent by a customer within 24 hours. But what this company is mostly famous for is its fun-oriented corporate culture. In 2009 Zappos featured in Fortune’s Top 100 companies to work for and has never left the list since. This fact made it an interesting case for the purpose of this research, as the company seems to be the right place to search for meaningful examples of implementing game elements in the corporate environment, and potentially in KM in particular.

The research framework is designed as a qualitative exploratory case study research based on the analysis of primary data collected in the form of semi-structured interviews, and

secondary data from the blog ZapposInsight (ZapposInsights, 2015) which gives examples and insights from the employees of Zappos about their everyday work. The analysis is drawn from 5 semi-structured interviews and 80 blog posts and is based on Gioia's method (2004) establishing second order themes that was described in Section 2.5.3. The interviews were conducted via Skype, audio recorded and transcribed for further analysis in NVivo.

7.2.1. The ecology of gamification in Zappos

Zappos does not use the term 'gamification' to describe its various work practices, but throughout the interviews it was possible to find quite a lot of examples of game elements that are integrated in their work. The summary of the codified interviews and blog posts is presented in Appendix 5. Some of the most widely used elements are badges, points and the mechanics of rewarding. Among others the company uses gifting, surprises, contests and quests, teams (groups), interventions and visualisations. This part describes the use of each of these elements in the company in more detail, followed by the interpretation of the findings.

The *badges* take four forms in the company: experience, skills, fun and Krunky (core values) badges. Experience badges are the most difficult to obtain and represent a set of skills and competences that give a person the status of an expert in a particular area of work. This system is not fully implemented yet, and after it is, each badge will be linked to the compensation of an employee. Skill badges can be obtained after completing training and passing a test, and are more likely to represent a set of theoretical knowledge that an employee has gained. Fun badges can be created by anyone and granted to anyone, and are mainly used for fun or to acknowledge someone for something in an unusual way. And finally, Krunky badges are avatars that visualise which of the ten core values an employee represents most based on yearly peer-evaluation.

Points come in the form of: power points that demonstrate the performance of each member of the customer loyalty team, e.g. they accumulate faster during busy times, encouraging employees to help their colleagues during that period; people points, that represent time that can be distributed among different departments and projects, and are equivalent to percentages; and Zollars which, being an internal currency, are mainly earned for education related activities, but can be given to anyone for anything, and can be spent in an internal shop or donated to a charity.

Rewarding is given a very high importance in Zappos and exists in a variety of forms. The most widespread reward is a co-worker $50 bonus, which can be given to anyone by anyone once a month, as long as the reason is linked to one of the core values. All the bonus awards enter a competition for a Hero Award, which is selected by a committee for the most outstanding contribution. Employees can also be nominated by their peers for WOW parking – free one-week office parking, or they can reward each other with Zollars, as was mentioned before.

Some departments have their own rituals, e.g. the tech department passes a Mystical egg on from the most outstanding worker of the month to his or her successor, who then needs to add decoration to the egg.

Among other mechanics the company uses *gifting* in a form of WISHEZ program, where any employee can leave a wish, and others can try to grant it, e.g. baby-sitting or helping to paint a house. If the wishes are more demanding, then a team of magic fairies steps in and tries to find ways to grant this wish. And along with gifts come surprises, when gifts are delivered in an unexpected manner.

The company also uses the mechanics of *contests* and *quests*. The contests are mainly used to select the best ideas and are conducted in the form of an event, e.g. Hackathon for the tech department, where anyone can pitch their ideas, and others can vote for them. The quests mainly have a fun element in them, for example a theme or costume party, or a New Hire Scavenger Hunt, when new employees have to take photos in different parts of the office campus or in downtown Las Vegas. But it could also be a call for help in a charity event, such as a Thanksgiving dinner for the homeless, and this particular quest contains some elements of hero acting in it.

The company also uses some forms of *intervention*, e.g. FaceMail, a game that asks a recipient to recognise a random employee and describe how well they know them.

And finally, all the departments and project teams are turned into *groups* or circles that are located within each other in one big circle, and each circle represents the company, and their location visualises all the connections between different departments and projects. This way of arranging activities is similar to Google Plus Circles, but the employees think that Zappos had this idea first.

This section provided a brief overview of gamification examples that were found in Zappos, and showed that it is an exciting and fun company. However, apart from being fun Zappos is also a very successful company determined to create a friendly and fun working environment, convinced that this in turn will drive profits forward. A sophisticated gamification system was part of the solution for them, but curiously, gamifying the working environment was as successful as gamifying the customer experience was a complete failure (Kleinberg, 2012). But the following section focuses on the successful part of the story and discusses what these examples mean for KM.

7.2.2. Interpretation of the results

Most of the gamification examples that were found in Zappos aim at establishing better connections and giving employees more chance to interact with each other and acknowledge the each other's contribution. To better understand the effects gamification might have on

knowledge workers, the examples above were reviewed through the lens of the frameworks of the knowledge workers that were discussed in the literature review in Section 3.1.2.

With regards to the framework of Davenport (2005a), Zappos employees mostly belong to the first group – transactional workers. This group of workers certainly has less need for collaboration naturally, but they could benefit from it as much as workers who are more drawn to collaboration. The company understands that and actively creates collaborative dynamics through using the mechanics of peer-to-peer rewarding, gifting or rating through the FaceMail game.

Through the lens of the framework of McIver et al. (2013) Zappos employees could be classified mostly as enacted information category workers, and this category overlaps with the Davenport's transactional workers, though reviewed through different parameters. But the company is more likely to see its employees leaning towards the apprenticeship category, and there are several reasons to believe this. For example, the customer loyalty team does not have any script when answering calls, but instead they are encouraged to be creative with customers and establish a personal connection, and they have a great degree of freedom to do so. Apart from that, various departments run "Shadow sessions" (following another person at work for several hours) in addition to or instead of training to learn about the work of others. Employees can also become a Z'apprentice (Zappos apprentice) for six months in a different role in order to learn new skills.

This degree of flexibility is supported by several gamification elements. Since the departments and projects have been replaced by circles (groups), it became much easier for employees to belong to several communities. And the system of people points helps to formalise this by distributing the points between the circles that employees want to be a part of.

> *"Circle structure has allowed people to follow their passions on side projects…"*

Apart from that the company organises various ideas competitions which allow employees to both participate in someone else's project and pursue their own ideas.

> *"The Zprize was a great example of a company-wide competition… The team who ended up winning the mock commercial was then in charge of helping create a national Zappos TV advertisement… Hackathon (ideas competition) was primarily for our Technical employees who spend a lot of their time maintaining and fixing our e-commerce infrastructure. This could give them a chance to be creative and let loose so to speak."*

In this way one can see that gamification was used as a tool to change the nature of work of knowledge workers in the company taking them from a boring routine towards being more creative.

With respect to knowledge worker roles, if the activities of knowledge workers are exposed to gamification, the primary purpose of the knowledge worker types, as Davenport and Prusak (1998) define them, might change. Of the roles discussed above, the knowers and the seekers will stay the primary types, though they can rarely be found in their pure form, whereas other types will change in various degrees. For example, when the knowers become more visible, the need for connectors who can help to identify knowers and direct knowledge seekers to them decreases. The connectors become more visible as well, if their connections are visualised, and therefore they could play the role of initiator of a new connection by introducing both parties to each other.

The knowers can become more visible if their activities are tracked and rewarded, for example, the projects they participated in, the comments and reviews that they wrote and that were acknowledged as of good quality, and if these rewards are represented with such elements as badges and experience points. One could argue that mediocre specialists might attempt to play the system and gain rewards such as badges, while the real experts stay in the shade, not being interested in participating in this system. But the combination of rewards that are actively achieved and that are being tracked in the background reduces the likelihood of this scenario.

As was mentioned before, connectors are traditionally perceived as the ones fulfilling the role of points and badges presented above. But in the new setup the role of connectors shifts from knowing the relevant people towards being able to introduce them to the knowledge seekers. This is no less important, but it becomes distributed to a wider range of people, if the connections are recorded by the system and are shown by various tools, such as social graphs. As a result, the outstanding connectors become visible as those that have a much larger network of connections, and identifying them as well as being able to see the knowers remains important for knowledge managers.

Apart from other responsibilities the knowledge manager is a designer of the working knowledge environment, becoming, or working closely with, the technology steward. But designing this environment is an iterative process, and on top of other benefits that were discussed above, gamified systems can be a testing ground for experiments with various initiatives and for checking the reaction of the knowledge workers to it, for example the effectiveness of the awards, statuses, and contests.

Unlike the types of knowledge workers, all types of knowledge worker roles can be found in any organisation. Therefore, unlike the previous examples, where gamification was a tool for addressing the limitations of each type, the role of gamification will also be different. As was suggested before, gamification could make different roles as well as each knowledge worker more visible, and this is mainly achieved through the use of badges and groups (circles) that visualise and map organisational knowledge, and interventions (FaceMail) and peer-to-peer

rewards that among others help identify more socially engaged workers and facilitate knowledge sharing.

This analysis suggests the immediate implications that gamification elements have on knowledge workers based on the theoretical frameworks that were reviewed in Section 3.1.2. However, one could find a much wider range of implications, such as improved trust as a result of higher transparency, higher flexibility and ability to generate requirements for new skills. These and other implications are explored in the discussion below.

7.3. Gamification and Knowledge Management

The Zappos case illustrated various gamification elements that were implemented successfully internally in the company. The discussion of this case demonstrated the influence that they have on the dynamics of a certain type of knowledge worker that Zappos employees are. That type is quite different from the type of knowledge worker that participated in the interviews for the main empirical part of this research, and therefore, there is no ground to suggest that this experience could be transferred to other organisations. However, this area is still very new with few examples to be observed in practice. It is unlikely that such examples would be found in the energy sector yet, but this case study can suggest the directions for further experiments in the companies of this type and build avenues for further research. Testing the findings in the context of the energy sector is something that I am planning to do as the next research or knowledge exchange project.

For example, the immediate function of the compensation and skills' badges is to show a worker's skills and competences to others, and to create transparency with regards to salary in particular. But they can potentially have much wider implications. For example, they could generate new requirements for a particular expertise, if there is a shortage in the company. They could also facilitate easier relocation of employees to areas that they are more interested in, without the fear of losing their social status in the organisational hierarchy, because the badges and compensation that are linked to them stay with them. They are no longer tied to the perception of moving up and down the career ladder. With ease of movement, enabled by badges, the combination of people points and circles becomes a powerful tool to record and show the concentration of employees' interest in certain areas. And potentially, by understanding the underlying reasons, one could find ways to make other areas that need more attention, more attractive. In addition to that, the ease of movement creates "a melting pot" of expertise, facilitating an easier flow of knowledge across the organisation.

With regards to other elements, on an individual level the FaceMail game reveals the level of connectivity of different employees, as well as helping them to get to know each other better.

"And that it gives us the way of knowing, how many people know this person, is this person sociable, do these people trust this person, do the people like this person, can this person handle the work? And that a kind of gives us a feel of whether this person lives up to the core values."

On the other hand, as happens with any initiative, it will not be attractive for everyone.

"Embarrassed to say that I've never tried FaceMail in all my years at Zappos. I don't have a problem getting to meet and know people, so I don't feel compelled to play the game."

A lot of gamification components and mechanics support competitive dynamics, and when they are applied, competitive dynamics can occur naturally. In order to change this, one needs to put emphasis on other types of game elements, and as we see from this case, the company puts a lot of emphasis on rewarding mechanics to promote collaborative dynamics with some elements of competition. Gamification could also initiate dynamics, if it is absent, for example, start a conversation, especially if the knowledge workers are distant from each other, e.g. sales representatives. One retail company launched a game "The hunt – reveal the secret customer", during which sales-people were given some code words, which were updated through the intranet and which they had to incorporate in their speech, on greeting a new customer. In return the secret customer would reply "I'm a mystery man". In addition to improving performance and increasing sales this game initiated collaboration between sales-people from different outlets by making them discuss various ways to incorporate each new word, and therefore sharing their experience (Eunen, 2015).

Gamification could also be used to identify types of knowledge worker who are not necessarily covered by any of the classifications. The company is already using power points as one of the indicators of people who make good decisions locally.

"So I think original they chose the people who were fit, who were making good decisions locally. Because usually it's busy and you earn the power points… It's not completely based on them, but it's one of those criteria to see, gaining high points."

The rewards could reveal helpers as well as altruists, and they are vital for creating trust in the corporate environment which is believed to be key for improved knowledge sharing (Davenport and Prusak, 1998). There are other ways to use gamification in a corporate environment. For instance, a company could create a platform where employees could share their ideas and rate ideas of others, provide feedback and earn points for submitting ideas, giving feedback and suggesting improvements. This system could help identify those who are good at generating, critically evaluating or improving new ideas. Similar experiments have already been conducted, but they were mainly focused on identifying whether competitive or collaborative behaviour would prevail and which would be most rewarding (Hutter et al., 2011).

At the moment Zappos is going through a major organisational change and shifting its organisational structure towards holacracy, where employees take on all the responsibility and managers are being replaced with lead-links, meaning that they do not manage anymore, do not have the final say, rather they facilitate activities and help to resolve tensions. The hierarchy is being levelled, and it shows once again that gamification is one aspect, but not the core, of the success of the company.

Apart from that, gamification is praised for improving motivation and user engagement, and the topic of motivation has been extensively researched in the field of KM. This topic was deliberately avoided in this part of the research, partially because gamification can offer much more than that, and this paper tried to demonstrate some of its potential, and partially because trying to motivate demotivated people with games is similar to trying to treat the symptoms instead of the cause of an illness. Similarly, Zappos thinks that:

> *"Motivation is necessary; however, when I feel that I need to motivate myself, it's usually to do something that I really didn't want to do in the first place. It may seem that motivation is a good thing, and it is, if it's coming from the right place."*

Of course, there are examples of monotonous routine jobs that are boring, but need to be done, for example, calibrating a sensor (Flatla et al., 2011) or digitalising a library (Roth et al., 2015), and we see examples of successful gamification of these processes, but one could argue that this work can hardly be called that of a knowledge worker, and the majority of knowledge worker jobs are more sophisticated and interesting.

But even now we can find early evidence of a positive influence of gamification on KM practices. Apart from increased motivation and engagement, which gamification has been praised for (Burke, 2012; Werbach and Hunter, 2012; Zuckerman and Gal-Oz, 2014) and which KM researchers have studied extensively (Collins and Smith, 2006; Hsu and Lin, 2008; Quigley et al., 2007), there is early evidence that gamification has an impact on such knowing processes as thinking and learning. Additionally, gamification is believed to create social connectivity employees (McGonigal, 2011), and therefore encourages conversations and knowledge sharing, and a sense of belonging to something bigger, such as the purpose of the organisation.

While the context of KM gamification might seem to be creating a rigid system, since it has to be regulated by rules and aim at specific goals, the case study showed that it can offer a lot of flexibility. Some elements are defined from the top-down (e.g. experience badges), but others evolve from the bottom-up (e.g. a mystical egg or fun badges) and become an organic part of the whole system. This case study opened up a discussion that is on the edge of KM and gamification, and further research can take place in multiple different directions.

Since the research was focused on innovative companies and their innovative activities, and gamification has marked its presence in the area of innovation management, the review of

gamification was also extended to the ways in which gamification has had or might have an impact on innovation. Unlike this section, the following review is purely based on secondary data, which does not make it less interesting. The remaining part of this chapter talks about the role of gamification in innovation and concludes by discussing the synergy between the two, the implications of these findings on this research and the main contributions of this part of the research.

7.4. Gamification and Innovation

In 2012 Gartner predicted that by 2015 more than 50% of innovation processes would be gamified (Burke, 2012). But this prediction seems to have been too ambitious (the major game platforms have a base of only 800 clients all together (Herger, 2015)), possibly because in order to change a process (e.g. gamify), one needs to define it first, and defining the innovation process has been an ongoing struggle for both researchers and companies.

Similar to the approach to innovation, the relationship between gamification and innovation is two-fold: gamification is regarded as an innovative approach in certain areas, for example education (Baker et al., 2012; Jorge and Sutton, 2017), and the innovative component of gamification is added to a product in this stream of research. On the other hand, gamification is believed to improve innovation as a process (Roth et al., 2015) and could be seen as a process innovation of an innovating process. The theory of innovation seen from both perspectives has been assessed in the literature review in Section 3.1.3 and it proved to be useful in this review, as the following discussion adopts some of the concepts in order to add gamification as an extra layer to them.

Gamification and innovation as an output

If we look at the *structuralist* type of gamification-innovation interaction, we could view it along the dimensions of innovation. The decision to classify an innovation as being incremental or radical, or sustaining or disruptive, is judgemental and arbitrary, and is based on past experience. Gamification is a relatively young phenomenon, and therefore it might be too early to provide examples that can be definitely classified as disruptive or radical. One could make assumptions, but time will tell whether the impact was truly large, and among them are some of the crowdsourcing platforms.

Nick Pelling (2015) revisited his original definition of gamification and suggested that its purpose is a call for social action. Though this definition leaves outside a large number of examples of gamified products/systems for individuals, such as Nike+ or DuoLingo, it sheds light on some examples, such as Alibaba and KickStarter that changed the landscape of the markets they operate in quite radically. The success and driving power could not be fully attributed to gamification, but the contribution is noticeable.

Identifying product – process – business model innovation is much easier and we can observe a lot of successful examples along this dimension. One could argue that this separation is not needed, because very often different types of ideas reinforce each other (Damanpour and Evan, 1984; Rothwell, 1992) and sometimes they are not possible without each other (Ruttan and Hayami, 1984). E.g. gamification in education could be seen as service innovation, but gamifying an educational process requires changing the underlying processes of the way the service is provided, in particular creating an infrastructure, changing the evaluation matrix and giving more freedom of choice to the students, which demonstrates that one is not possible without the other.

One prominent example that illustrates these relations and provides multiple examples of innovation is DuoLingo. This example has already been mentioned before, but it is worth reviewing it in more detail. DuoLingo is a web-based service for learning foreign languages that promises to bring some fun and enjoyment to the process of studying, as well as teaching a foreign language. Conventional electronic-based self-learning services provide content in blocks of exercises with the mechanism of simultaneous auto-marking, and developers either sell the content in full or provide the basic material for free and charge for unlocking advanced content. But the developers of DuoLingo, apart from building a friendly and pleasant interface, embedded game elements into it. A user collects coins to track their progress and receives badges as an acknowledgement of completion of the next language level, all of which are graphically displayed on a tree. One can have as many attempts as needed to finish the exercise, and after achieving a certain level, learners can test themselves on a real piece of text, and this constitutes the second curious aspect of DuoLingo. The service is entirely free and instead the company is paid for the translation of documents that it crowdsources to its learners through an algorithm that combines several translated versions together and has proved to be as accurate as produced by professional translators. This example illustrates at least two types of innovation – service innovation in the form of a teaching process and the business model innovation that accompanies it.

Education is probably one of the most interesting sectors to search for examples of gamification. It is being adopted relatively slowly, but the impact is truly significant. Schools and universities have long been using elements that are now associated with games, such as grades (points) and honours degrees (badges), but gamification changes their perception. In early experiments school work was broken down into different aspects, such as reading extra material, completing home-work on time, or asking the most interesting questions. And each of these activities could be rewarded, meaning that more than one person can be the best in different things. Earning points also changes the perception of grades: students earn them for doing things correctly, rather than lose them for making mistakes (Sheldon, 2011), and they feel there is more equal treatment in an environment where everyone can be heard (LeBlanc, 2004). Not only that, but students can be involved in rewarding as well, by evaluating each other. A teacher is not the only empowered person at school anymore (Lee and Hammer,

2011). Such experiments showed improvements in the students' performance (Laster, 2010; LeBlanc, 2004).

One school – Quest to Learn – went further and fully gamified its teaching processes: instead of being graded the pupils are upgraded, instead of completing assignments they acquire super powers and complete secret missions (McGonigal, 2011). Assessing the results and implementing such experiments at a large becomes difficult due to the long time period required to observe the results. But higher engagement from pupils can already be observed.

Marketing is another area of application, with companies ranging from trying to involve their users in the co-creation process to involving users into more conscious use of their product, like Nike+ that created a gamified running app to track progress and interact with other users (Zuckerman and Gal-Oz, 2014). Among others Nike implemented animated avatars, which change their appearance and demeanour depending on the progress a runner makes, such as being sad and tired after a long break, or bouncing off the walls after a few good runs (McGonigal, 2011). This feature becomes a motivator and provides simultaneous feedback, and the service transforms the perception of the company from selling shoes to supporting a lifestyle.

When looking at the applications of gamification, one could find mainly examples of product/service and business model innovation. Process innovation takes place inside the company and we do not observe many examples of this type of gamified process yet. However, early examples can already be found. The rest of this section provides an overview of examples of gamifying *innovating process*, being a process innovation of innovating process, that were found in the literature. The cases that are described in this section employed different approaches and different methods to studying gamification, and they were not filtered by any criterion, because gamification is a relatively new field and examples of applying it in the innovating process are scarce.

Gamification and innovating process

The innovating process is often described as being fuzzy and highly unstructured; its flow depends on the nature of the innovation and of the company as well as on external events. Numerous attempts to conceptualise this process, as we saw in the literature review, have not provided a perfect solution, though they demonstrate that the process is neither entirely random, nor perfectly structured (Garud et al., 2013). In an attempt to structure this process to a certain extent, companies refer to a PDP that becomes part of the development of an innovative product after a certain point. Similarly, in order to investigate the ways in which this process can benefit from gamification, it needs to be formalised to a certain extent. Firstly because, to understand how something can be gamified, it needs to be determined, and secondly, we can discuss what can be gamified only if we have control over it. Thus it is not sensible to focus on the external environment and shock events, which we have no influence

on. This position does not imply that innovation is a strictly regulated sequential process, it rather suggests what phases are likely to take place and what role gamification can play in them. Therefore, it seems more logical to apply the model of Tidd et al. (2005) with the main focus on the first two phases, as the development of an innovative product is more uncertain the earlier it is in the development process. This is the point where the innovating process could benefit from gamification the most. This model restricts the output to the product/service and possibly process type; but so do all the models reviewed.

As was reviewed in the previous section, this model consists of four stages: search, selection, implementation and capture, and this section will proceed following this structure.

A **search** or **ideation phase** of the innovating process has received most attention and has been linked to the gamification of crowdsourcing (Hofferbert et al., 2015; Roth et al., 2015; Solf et al., 2014) and open innovation (Cherinka and Prezzama, 2013) communities with an intention to increase participation. But we should be careful with what we understand by crowdsourcing. If the crowd is used to complete routine work via a gamified environment, such as the digitalisation of the Finnish National Library (Roth et al., 2015), it can hardly be considered an example of a gamified ideation process. If the crowd is invited to generate multiple ideas to solve a challenge, it is rather an open innovation. However, if multiple ideas were a result of a group work, where new participants could improve and build on what was previously suggested, this type of crowdsourcing could be considered an approach to an ideation phase, but gamified examples of such an environment are yet to be seen.

Typically, crowdsourcing and open innovation platforms are gamified with the use of standard components, such as points, badges, social graphs and leaderboards, linked together through rewarding mechanics, challenges and contests. Collaboration and competition are often seen as two sides of the same coin and are two major dynamics that the games and gamified systems are based on. Though many companies take competition on board as a way to motivate their staff and promote further engagement, the research suggests that a larger proportion of people prefer cooperation or a combination of the two (El-Nasr et al., 2010). This pattern is even more distinct if we compare gender preferences: women are less driven by competition and achievements than men, while on the other hand they are more attracted by games that include an opportunity to socialise and collaborate (Hartmann and Klimmt, 2006; Williams et al., 2009).

Competition has historically been used by companies to spur innovative ideas among the employees or attract them from outside (Hutter et al., 2011). The development of WEB 2.0 tools boosted the spread of online communities, which in turn attracted the attention of the researcher as a phenomenon of collaborative innovation, based on the principle of free revealing of ideas and sharing of knowledge (Hippel and Krogh, 2003). Further research demonstrated that running a contest inside a collaborative environment can decrease drastically collaboration between participants (Franke and Shah, 2003), but on the other

hand, introducing a competitive element inside a community increases overall innovative activities (Füller et al., 2007), and the participants that get involved in both types of behaviour achieve better results innovation-wise (Hutter et al., 2011).

These findings do not demonstrate examples of applying gamification in the ideation phase, but they prepare the ground for experimentation, since gamification can successfully reinforce both the competitive and collaborative environment, as well as combine the two. These findings also show that system designers need to develop a system centred on the behavioural dynamics that the company wants to promote.

The next phase – **the selection** –could be potentially gamified through the classical mechanics of rating the ideas (Leimeister et al., 2009) either by peers or by experts, and one of the experts shared an experience of using ratings in order to get more employees involved in the open call for innovation. In this phase dynamics might be less important, since the most important and challenging part is developing an algorithm that would accurately aggregate the rates of the users and translate them into an indication of the quality of the idea. However, simple rating is not the only mechanics that could be used at this stage.

Petersen and Ryu (2015) suggested using betting to predict the most promising ideas during a contest, and showed that although all three best ideas of concept design could not have been identified until the very last betting round, two of the best ideas as well as the worst ideas could be predicted relatively early. Though the research was conducted on students, the researchers opened an area for further experimentation involving practitioners. The mechanics of betting could be potentially more efficient than simple rating, because it reduces the effect of "nepotism" in local networks, as well as helping to identify potential experts who are capable of predicting the winners accurately. Apart from that, though this mechanics could facilitate interesting dynamics in the system, a system designer should be aware of its highly competitive nature, which might trigger potentially undesirable behaviour, if collaboration is a priority for an organisation. Limiting the bet size can potentially mitigate this risk.

A milder version of betting is investing points in ideas. The UK Department for Work and Pensions implemented a gamified platform for collecting and sharing cost saving ideas called Idea Street (in parallel with Wall Street for ideas). On this platform employees could post their ideas, were rewarded with virtual coins for sharing them, could invest their coins in the ideas of others and received profit in virtual coins if the idea they chose was selected and implemented (Vezina, 2011). By the end of the first year cost savings generated from implemented ideas amounted to £20 million, and this amount could have been even higher if the agency had had the capacity to implement more worthwhile ideas (Lawrenson, 2013). The success of the initiative was enabled by the dynamics created with the help of game elements, primarily virtual coins. Virtual coins were not linked to any monetary rewards, and curiously this rule was the key to success: the developer of the initiative had trialled the same

initiative in a bank with the only difference being that the coins could be exchanged for money, and the initiative turned out to be a disaster. Similarly, if betting is not linked to monetary rewards, its application might prove to be effective and without negative consequences.

A new way of funding projects is offered by platforms such as Kickstarter and Indigogo, and some practitioners consider them to be not the most obvious but excellent examples of gamifying a social action network (Pelling, 2015). This approach has not yet been explored in the literature, but could be worth testing in a corporate environment with decentralised decision making and employees empowered with higher levels of responsibility. It could be realised through the departments and divisions allocating parts of their budgets to projects that could be of interest to them, as well as through employees committing their time to these interesting projects.

The next phase – **the implementation** – refers to the actual development and implementation of the innovation, and especially if it involves product development. PDP frameworks have been discussed in Section 3.3.1, and that of Ulrich and Eppinger (2000) has been chosen as the most detailed and which reflects the processes in the companies interviewed. Of the phases defined in this framework, *the concept development* phase resembles the search and selection phase to a certain extent, as well as having echoes of the stages of *detailed design* and *testing* within the product development process. It includes a set of activities such as identifying and collecting customer needs and translating them into the initial product requirements, exploring design concepts and investigating their feasibility, and building and testing experimental prototypes. Emphasis can be put on one activity or another depending on the nature of the product, and this part of the section will share examples of gamifying these activities that were found in the literature.

Collecting the technical requirements could be one aspect that distinguishes concept development within the implementation phase from the previous phases, as at this phase the product becomes more detailed and specific from technical point of view. An interesting example of gamifying this stage was found in the application iThink (Fernandes et al., 2012). Participants were asked to share new requirements as well as to comment on the ones that had already been shared and were rewarded with points for each new idea or comment. In order to regulate the nature of the comments the designers embedded the technique of "The Six Thinking Hats" (De Bono, 1989), whereby commenters had to choose which perspective they were taking when submitting a comment. This technique allowed regulation of the flow and quality of the comments as well as indicating that comments of different types were appreciated. This mechanics might seem similar to the rating mechanics that was proposed in the selection phase, but in this example it is more structured and regulated, as is the whole process of product development. But similarly to the selection phase, the dynamics level of gamification seems less important than properly designed mechanics of rating and

commenting, though it needs to be taken into account in order to avoid the negative side effects of the new features of the system.

The testing phase is usually quite well-defined and it might seem that there is not much room left for gamification, but it was possible to find one example. This phase is harder and more time-consuming for the software developers. Microsoft approached this process by launching a contest between divisions on the number of bugs each of them managed to find in a new version of Windows, the only prize being the pride and prestige of one's division, but it generated a viral effect and the developers engaged in a fierce competition to beat their colleagues (Werbach and Hunter, 2012). In this example, though simple in its realisation, the main focus was put on the dynamics of the groups involved in testing.

The last phase of PDP refers to *production ramp-up* and has little to do with the innovating process, therefore it will not be reviewed in this paper.

The last phase of Tidd's et al. (2005) model refers to **capturing** the benefits of a newly developed innovation, and if gamification were to play a role in this phase, it would more likely be used as an innovative component of a product as part of a package, for instance, as an innovative approach to marketing. With regards to the process phase no examples were found in the literature, nor could any ideas be suggested for further experimentation.

The area of gamification is relatively new and its range of applications in an organisation, and its innovation development process in particular, has not been fully explored yet. We see that the prediction of Gartner, that at least 50% of innovative processes would be gamified by 2015, was too optimistic, but early examples can already be found, and more research and experimentation is needed to contribute to this area of innovation research.

The examples above could also be seen as a new approach to managing innovation where innovation practitioners are provided with tools for more autonomy and self-regulation. However, more research needs to be done in order to look in-depth at the dynamics of the group of innovation practitioners in the gamified setting, in order to understand gamification's full potential.

7.5. Implications

This chapter has initiated a conversation about the role of gamification in KM by providing an overview of the gamification field and an illustrative case study which suggested gamification can support knowledge workers and enhance KM. The case of a company called Zappos was interesting because this company stands out from most large organisations with a strong corporate environment. This company has a levelled hierarchy and informal environment, its employees enjoy a lot of freedom of expression and choice, and it seems that the company

puts the wellbeing of its employees above its customers. Its unique organisational setting is composed of many elements and gamification is only one of them. However, it appeared to be a very complex system, and though the profile of this company did not match that of the companies from the principal investigation, I have not come across anything as elaborate, and this system was interesting to me to investigate further. I found a lot of examples of using various game elements and mechanics for different purposes, all of which were aimed mainly at creating a collaborative and supporting environment, where knowledge is shared and this kind of behaviour is rewarded. The analysis of these examples was conducted through the lens of the types of knowledge workers and has demonstrated that employees of Zappos are mainly involved in transaction-based type work, which tends to be isolated, and all the gamification elements in place encourage them to overcome this isolation and to be more collaborative and creative. But the impact of this system extends beyond these knowledge workers, as was discussed at the end of the case study analysis.

In addition, this chapter has suggested ways in which gamification could support innovation and innovating activities. Creating new knowledge was found to lie at the core of the highest level of the KM roadmap and therefore largely comprises innovating activities. Apart from that, the experience of one of the experts has demonstrated that innovating activities could in turn support knowledge sharing, thus revealing the synergy between the two on several levels. These findings answer the last research question and lead to the last main contribution: since it has been shown that gamification supports both KM and innovation, it could become a powerful new element of knowledge and innovation strategy for companies in the future. The evidence of the importance of gamification for KM and innovation was found in the companies that are quite different from the types of companies in the principle investigation, therefore the examples presented in this chapter cannot be treated as a recipe to follow. However, gamification is already used successfully across different sectors, which suggests that one can find areas of application in technology intensive companies as well. Further experiments in this direction would help to identify the peculiarities of gamifying knowledge work and innovative activities in such companies and in the energy sector in particular. Furthermore, gamification activities can also provide feedback to managers about the dynamics among knowledge workers and can thus become an alternative way of evaluating the performance and KM initiatives[9], which at the present seems to be incompatible with more traditional performance management practices (Bititci et al., 2012).

[9] At the moment we are working on a project proposal for a grant application that would examine the impact of gamification on KM practices in the energy sector, which we are planning to submit to Oil and Gas Innovation Centre.

8. Conclusions

The previous chapter addressed the third research question, and this final chapter of the thesis summarises the answers to all three questions. In this chapter I discuss the contributions of this research in a broader context and the implications of these findings on academic knowledge and the work of practitioners. The chapter starts by outlining and answering the research questions, and discussing the meaning of the findings for companies who were not part of the research. Then it continues by summarising the main contributions of this research being answers to the research questions that were posed in Section 3.6.2. This is followed by the reflection on the limitations of the findings due to the process of conducting this research. The third part of the chapter presents the implications of the findings for practitioners or the role that the developed model might play in the work of knowledge workers, followed by the trends in KM that were observed and should be explored further. And finally, I will conclude this chapter and the thesis with the impact that this PhD journey has had on my life.

8.1. Answering the Research Questions

This section summarises the answers to the research questions that were formulated at the end of Chapter 3, and provides the evidence for the suggested answers. A short summary is presented in the Table 14.

Table 14. Summary of answers to the research questions and supporting evidence.

Research question	Answer to the research question	Source of evidence
1. How do the KM needs of technology companies involved in innovating activities evolve with time in the context of PDP?	The answer to the first research question is summarised in the model of KM – organic roadmap of KM, which consists of three phases: managing explicit knowledge, knowledge sharing and creating new knowledge. The phases of the model correspond to the evolution path of KM in an innovative technology company.	These findings are drawn from a multiple case study analysis with six companies from the energy sector. The phases were derived from the centrality analysis and analysis of concept maps of each company, and the summary KM practices that constitute each phase came from the analysis of interviews using Gioia's method.
2. How can technology, especially with respect to KMS, be used effectively to support these needs?	The answer to the second research question constitutes the technology layer of the resulting model, which shows	The applicability of particular tools in each phase of the KM model were identified through centrality analysis and analysis of

	that document repositories are a very important KM tool on the first phase, which should be complemented or replaced with wikis starting from the second phase. The findings also describe the areas of application of other KMS tools that were identified through the literature review, and their limitations.	concept maps. The areas of application of various KM tools and their limitations were drawn from the analysis of interviews using Gioia's methods and were based on the experience of interviewees of using these tools in the working environment in the context of KM.
3. What role might gamification play in the future of KM and innovation?	In response to the third question Zappos case study demonstrated that gamification can have a transformational power on KM by addressing the limitations of a particular type of knowledge workers and empowering them by providing more autonomy and flexibility. Additionally, the literature review demonstrated that gamification can have a positive impact on innovating process, supporting it on different phases.	The answer to the first half of the third research question was derived from Zappos case study (gamification in KM), and literature review of the early examples of using gamification in innovation helped to answer the second half of the third research question.

The first attempt to answer question 1 was via trying building of a MM of KM, which would be derived from a well-established CMMI model for product development and project management processes (SEI, 2002). This was unsuccessful. The analysis revealed no connection between the parameters of the levels of maturity of the CMMI model and KM practices and KMS types (Shpakova et al., 2017a).

In the second attempt to answer question 1, analysis of the interviews with six companies-participants revealed three categories of needs that emerge gradually and form an organic roadmap of KM in three phases: managing explicit knowledge, knowledge sharing, and creating new knowledge. The first phase corresponds to the need to organise articulated knowledge and establish processes for further management of this knowledge by formalising them and introducing standards of practices. The second phase incorporates different forms of knowledge sharing and learning, and includes KM practices that support its informal and organic nature. And finally, the third phase focuses on the creation of new knowledge and

proves that KM and innovation management are intertwined and inseparable from each other (Shpakova et al., 2017b).

The analysis of the interviews in the multiple case study also helped answer the second research question related to the technology aspect of KM. In particular, the analysis demonstrated that one type of KMS – document repositories – is significant on the first phase of the KM journey, but starting from the second phase the role of KMS becomes peripheral, and of the variety of types wikis make the biggest impact by supporting collaboration, enabling collective knowledge creation and shifting interaction with knowledge from push to pull mode.

And finally, the exploratory case study of a company called Zappos helped answer the third research question and demonstrated that the impact of gamification on KM is multidimensional. Gamification can help improve visibility of work and skills in an organisation (Shpakova et al., 2017c). It can create transparency in the contributions of employees thus improving trust among them, also generate requirements for new competences and therefore accelerate organisational change by identifying likeminded people, and impact KM in various other ways (Shpakova et al., 2016a). And since KM is inseparable from innovating activities in innovative companies, the literature review of the field of gamification also highlighted ways in which gamification can support innovation (Shpakova et al., 2016b, 2018).

This section outlined the key findings of this research, while the rest of this chapter puts them in perspective, first by discussing them in a broader context and then by outlining the contribution to the academic body of knowledge and practice.

8.2. Discussing the findings

Many questions were raised through the course of the research, primarily concerned with comparing the theory to practice and bringing fragmented pieces of previous research together. This quest resulted in a model of KM in an organisation – the organic roadmap of KM.

When talking about an organisation, Tsoukas (2008) defined three levels: representation, practices and actions. And in a way the phases of this roadmap help build the levels of an organisation in the context of KM. At the first level, managing explicit knowledge, the company develops standards, policies and rules of engagement in order to formalise and legitimise some of the KM procedures. At the second level, the company nurtures practices centred on knowledge sharing, which power KM and transfer into practices. And finally, practices lead to actions, or within the context of KM, the creation of new knowledge and knowledge application. The actions resemble the third phase of the KM roadmap, but the nature of this phase is more complex, and it is largely intertwined with the second phase. For instance, ideas competition results in new ideas that evolve into innovation later, but finding

new ideas happens through ideas sharing, and so we cannot definitely say when knowledge sharing ends and creating new knowledge begins.

But where is the place for KMS in the organisation? From the literature KMS is believed to have three main purposes: (1) the coding and sharing of best practices, (2) the creation of corporate knowledge directories, and (3) the creation of knowledge networks (O'Dell and Grayson, 1998; O'Dell and Huber, 2011), but none of them proved to be really important. Best practices were only one aspect that had to be shared, and providing knowledge workers with an opportunity to conduct quick initial research would require more types of articulated knowledge being available than just best practices. Networks are not and cannot be created through KMS, as KMS can only serve as a means of recording and enhancing them, whereas networks can only be created through common activities that allow knowledge workers to get to know each other and develop a sense of trust. And finally, knowledge repositories should rather be replaced with document repositories. Creating document repositories alone will not benefit knowledge workers, as they are created with the purpose of easing the retrieval of articulated knowledge, when required, and for the protection of knowledge (e.g. version control). Therefore, the explanation of third purpose is rather the means of satisfying it.

The interviewees appreciated supporting technology for other reasons. For them KMS are required (1) to help manage articulated knowledge (e.g. through version control), and to make it widely and easily accessible when needed. Then KMS are needed (2) to allow collaboration and co-creation, especially for remote knowledge workers. In support of collaboration, certain types of KMS, e.g. wikis, help shift from knowledge push to (3) knowledge pull dynamics, and as a consequence, reduce the amount of emails and information noise. And finally, KMS allow knowledge workers (4) to broadcast and disseminate knowledge and information in a more effective manner.

The types of KMS that were found to be most widely applicable and supportive are document repositories and wikis. If we compare the findings with the frameworks of Davenport (2005a) in Figure 7 and McIver et al. (2013) in Figure 8, engineers fit into the description of the combination of the integration and collaboration model of Davenport, and accumulated information type of McIver et al. The technology recommendations of these researchers agree with the findings. In particular, Davenport suggests applications for knowledge reuse, knowledge repositories and collaboration tools, and similarly, McIver et al. recommend communication tools, databases with advanced search systems, PM tools and other coordination mechanisms, though such recommendations as data mining and real-time collection tools were not applicable. But in addition to these generic recommendations, the KM roadmap helps set the priorities among the variety of KMS and adds more context and details to these recommendations.

It was possible to relate the findings and the KM roadmap to the existing literature. But what does it mean for companies in general? The aim of the remaining part of this section is to discuss the meaning of the organic roadmap of KM for most companies and the differences such as size and structure that might play a role in adopting this model in practice.

8.2.1. The meaning of KM roadmap for most companies

The literature on KM is dominated by case studies of large organisations, often featured in the Fortune 500 and leaders in their field. Though it is important to have a benchmark and learn from the best practices of the field leaders, focus on the accumulation of their experiences only creates a distorted reality of the problems that other companies should be concerned with. Case studies of the brightest examples depict a snapshot of the current situation, of one initiative or of a successful experience, and they are often sanitised and cleansed of findings that the authors might consider less interesting or trivial, but which might be key to progressing in KM for other companies. Such case studies do not shed light on what experience companies had in the past and where the companies are heading. They do not analyse the learning curve of a KM journey. And because of that "ordinary" companies launch isolated initiatives that are disjoined from the strategy and implemented with exaggerated expectations. For example, one of the companies interviewed during the preliminary investigations saw the circulation of knowledge (Nonaka's circle (1995)) as the quintessence of KM; this company had very high and very vague expectations, and did not build any long-term KM plans. Similarly, the KM initiative in the company from my MSc project did not link KM to its strategy, rather the company implemented isolated practices centred on the technology without understanding the goal they wanted to pursue.

The KM roadmap that was developed in this study offers a generic strategy for innovative companies with project-oriented work involved in the development of technologically complex products, and makes them think about KM as a long-term project with a learning curve, rather than a one-time initiative.

A lot of the findings in this study were not new. For example, McDermott (2000) has advocated the importance of personal knowledge sharing and argued along with others that most knowledge sharing happens face-to-face. Wang et al. (2011) have demonstrated the importance of formalising and recognising certain KM practices, such as contributing to the KMS. Davenport and Prusak (1998) have emphasised the importance of "coffee-room" areas, where people can have casual conversations and grow their networks, which are a primary instrument in seeking knowledge from them. The researchers have also been discussing the importance of bottom-up initiative (2000), top-down support (Grant, 2013) and the engagement of middle management (Mintzberg, 2009), and the interviews have shown that all three levels of the hierarchy were important. But this study has gathered these ideas and findings in one model in an attempt to relate them to each other, and also organised these

findings hierarchically through establishing the relationship between the primary business processes of product development and project management, and identifying related KM needs.

8.2.2. The impact of organisational size and structure on KM and KMS

The previous section emphasised that the KM literature is dominated by case studies of bright companies – the field leaders, which might have both positive and negative effects on the state of KM in most other companies. Companies that are ahead of others in KM and are leaders in their field appear to be large multinational organisations. This does not imply that less famous and smaller companies never achieve impressive results in KM, but these are the stories that we do not hear about, and that most readers may not even be interested in. As a consequence, we mostly form an impression about KM based on the experience of companies with tens of thousands of employees, while in the UK alone 99.9% of the private sector consists of SMEs, employing over 60% of the population (White, 2014).

A small stream of research has focused on KM for SMEs with knowledge sharing having been relatively well explored (Durst and Edvardsson, 2012). Unlike large organisations, SMEs are more likely to act in an ad hoc manner in response to KM issues (Nunes et al., 2006). They rely largely on interpersonal communications and on common knowledge being an equivalent of common sense to them, whereas the role of technology is secondary to them (Desouza and Awazu, 2006).

This last point, together with the findings from the preliminary investigation has made them less attractive for this study. Instead, it was interesting to engage with companies between the two extremes. As a result, of the interviewed companies only one had more than a thousand employees and only one could be classified as small, though it was a part of a large organisation. The smaller company demonstrated that certain aspects such as visibility of work were easier to accomplish. As for the rest of the companies, there were no significant differences in the experiences of the companies interviewed compared with the extremely large organisations that would be caused by the difference in size. Therefore, there might be no need for further differentiation in KM approaches with regards to size.

On the other hand, a larger size company might even have an advantage. Due to the scale and visibility of problems these companies are more likely to recognise the need for KM strategy and have resources to invest in a KM initiative. Whereas medium-sized companies are relatively large organisations (with several hundred employees), they are not prepared to make long-term investments in KM even if the leaders understand the benefits that it might bring (Nunes et al., 2006).

The influence of organisational structure on KM is less researched, less obvious and more complicated. One of the most widely accepted structural taxonomies is the structure in 5's by

Mintzberg (1980). It was widely adopted in many areas including innovation, in which other researchers theorised about the ways in which structure could impact innovative activities (Lam, 2000, 2005; Tidd et al., 2005). But this topic has not been explored in the field of KM, and though there is no evidence that organisational structure shapes KM, it was decided to find companies that were structurally alike in order to eliminate the potential influence of this parameter.

The companies that were interviewed operate predominantly in adhocracy mode, or in other words, in a project-oriented environment, and have a strong focus on innovation. Therefore, it is not a surprise that the companies require support in managing articulated knowledge in the form of project documentation, learning from projects and nurturing new ideas. But the needs might be different in other types of company.

Organisational structure affects many aspects, such as the hierarchy in the company. Less centralised organisational structures encourage informal interactions between employees (Kim and Lee, 2006). This factor is also related to the nature of work. For example, in the parts of companies that can be characterised as professional bureaucracies (e.g. technical support or sales), knowledge workers might require a platform that would allow them to quickly get in touch with each other and request help, which they cannot receive otherwise if they work remotely in the field (Brown and Duguid, 2000; Voelpel et al., 2005).

The relationship between the organisational structure and KM is unexplored and could potentially bring fruitful results and explain the roots of some of the problems. It is also possible that certain industries and industry sectors will be dominated by certain organisational structures. For example, consultancies and hospitals are normally associated with professional bureaucracies, while mass production companies operate as machine bureaucracies. This argument contributes to the impact that an industry might have on KM, which was discussed in Section 5.4.1.

Many of the aspects that were discussed in this section and Chapter 7 could become directions for further research. The next section summarises these findings, preceded by the contribution that this research has made to the academic literature.

8.3. Contribution to Academic Knowledge

8.3.1. Implications for research

KM has attracted a lot of research attention in the past decades which consisted of mostly fragmented efforts to contribute to the field by researching particular aspects of it. In this research I aimed to look at KM practice as a whole and at supporting KMS in the environment of innovative companies, which would gather and classify previous findings as a consequence of this effort.

The first contribution of this research is related to the application of maturity models in KM. In an attempt to derive a MM from the well-established CMMI model for product development and project management processes (SEI, 2002). The analysis of the results was presented in Section 4.4 and it has revealed no connection between the parameters of the levels of maturity of the CMMI model and the KM practices and KMS types. This finding suggests that MM and its five distinct maturity levels are not an appropriate model for classifying KM needs and corresponding KM practices, and contributes to the body of knowledge by suggesting that this concept is unlikely to be applicable to the field of KM. Further analysis of the parameters of the CMMI model has suggested that the performance of the parameters of the maturity levels did not necessarily progress in accordance to the hierarchy of the maturity levels. The parameters were correlated to each other and reflected the status of the product development and project management process, but they could have been arranged in many other ways. This finding contributes to the body of knowledge in the field of MM by pointing out the possible weaknesses of the model and suggesting that the parameters that constitute this model should be examined and tested further.

The landscape of MM consists of successful examples of models for the areas of software development and supply chain management, and numerous examples of models in other areas that are much less known. The findings of this research contribute to the understanding of why these models do not have the impact they were intended to. These models are based on mere speculation about the connection between the process maturity and the level of maturity of another subject matter, without any evidence to support these assumptions. At the same time, the models that did prove to be successful might have spread beyond their primary area of application (such as software development) largely due to the resources that were invested in their population, rather than being due to genuine excellence. This however does not mean that the MM framework cannot be used in any circumstances.

The MM for KM that was quite successfully used in one of the companies interviewed during the preliminary investigation was developed for this organisation specifically, and an attempt to generalise it in order to make it applicable to other organisation might affect the usability. The drawbacks of the MM have been highlighted previously in the literature. In particular, MM are based on perception, with its biases and experiences (Biberoglu and Haddad, 2002), and provide an ambiguous link between the current problems and the corresponding actions (Mettler, 2009). But the structured and formalised nature of the model creates an illusion of a well-grounded decision, and ambiguity creates a lot of space for interpretation, which is shaped by the interpreter's own views, including biases. The findings in this research suggest that this criticism should be taken more seriously, and the prevalence of generalised models that were originally intended for a very local and specific application, might lead to them being overused. Perhaps the usability of MMs in KM is much more idiosyncratic than academics and consultants would like to admit.

The second major contribution of this research is related to looking at KM as an evolving set of practices within organisational boundaries rather than a one-off initiative that changes over time, or like fashion (generations of KM). The evolution of KM practices was presented in Section 5.2 and it took the form of an organic roadmap of KM with three phases, namely: managing explicit knowledge, knowledge sharing, and creating new knowledge.

This model contributes to the body of knowledge in KM by taking a holistic view of KM and bringing together different practices that were discussed in isolation before, such as managing explicit knowledge (Hansen et al., 1999; Hickins, 1999; Kankanhalli and Tan, 2005) and its limitations (Alavi and Leidner, 1999, 2001; McDermott, 1999), knowledge sharing practices (Konstantinou and Fincham, 2011; Sveiby, 1996; Wang and Noe, 2010) with the importance of networks in facilitating knowledge sharing (Cross et al., 2001; Mcdermott and Archibald, 2010) and the role of communities of practice in it (Grant, 2013; McDermott, 2000; Pyrko et al., 2017), the aspects of lessons learnt with the importance of admitting mistakes and self-reflection (Davenport and Prusak, 1998) as well as best practices (O'Dell and Grayson, 1998), and finally, innovation at the centre of KM (Swan et al., 2000; Swan and Scarbrough, 2001). But rather than contrasting some of these practices (Hansen et al., 1999), this model suggests that they constitute a roadmap of KM complementing and reinforcing each other, where the consequent phases positively influence the preceding ones. For instance, the ideas contexts can help improve knowledge sharing and visibility of work, or expand informal networks with the help of such tools as gamification. Similarly, the problems in the preceding phases limit the potential of the consequent phases.

These findings contribute to the academic literature by offering the evolutionary path of KM in companies with certain characteristics, as opposed to suggesting a one-time solution or discussing dominating practices in a particular industry without looking at the foundations that enabled these practices to be successful. At the managing explicit knowledge phase the model acknowledges the importance of these practices and emphasises their limitations. At the knowledge sharing phase the model puts knowledge sharing in a broader context and employs the knowledge restaurants model (Velencei et al., 2009), by finding examples of KM practices that correspond to different types of restaurants, in order to demonstrate the diversity of knowledge sharing forms. The phase of creating new knowledge looks at the interrelation between knowledge and innovation management and the synergy between the two.

By locating KM practices on the roadmap these findings suggest a shift in the perception of KM that exists in the literature. Rather than discussing which KM practices are outdated and which are not, and which dominate the discourse in the KM literature, this research suggests that different practices are important at different points in time, as a company's level of engagement with KM progresses. Though the model itself was developed for a specific type of company, this shift in the perception might have wide implications for the literature,

because the findings suggest that KM practices for other types of companies have to be reviewed over an extended period of time, since they are likely to evolve.

The third major finding of this research is related to the technology aspect of KM and contributes to the body of knowledge in the field of KMS. This research has brought together different types of KMS from the literature (Section 3.2), and examined which were in use in practice and for what purpose (Section 6.1). From these findings it appears that the companies are dependent on document repositories, which were both praised (Liebowitz, 2001; Voelpel et al., 2005) and criticised (McDermott, 1999; Swan et al., 2000) in the literature. However the interviews showed that the problem was more likely to be expectations that were too high rather than the repositories themselves. The second most important type of KMS is wikis. These can either serve as an interface for document repositories, where the information can be aggregated and easily searched and kept up to date through collaborative effort, or they can even replace the repositories. All the other tools are complementary and can be utilised for specific purposes, but do not have the same level of impact on KM practices. In relation to the above framework, the first stage of the roadmap is technology-centred, but starting from the second stage technological support becomes peripheral. If the company is distributed geographically technology plays a mediating role, but KMS alone cannot improve KM; they can only support the ecology of KM composed of various practices.

These findings are aligned with the frameworks of Davenport (2005a) and McIver et al. (2013) with regards to the type of knowledge workers that were under investigation, but are more specific with regards to the types of KMS. In KM literature the technology aspect tends to be either central to the discussion (focusing on either positive or negative aspects of it), or be a peripheral, unimportant aspect. This research contributes to the literature by giving it an appropriate place, and demystifies KMS by reducing the judgemental elements and offering a balanced view, focusing on the areas of application instead. The findings show at which stage KMS might be critical for KM strategy and what types of KMS can make a difference in the companies reviewed.

As was discussion in Sections 5.4.1 and 8.2.2, these findings are mainly applicable for the technology companies in the energy sector that are involved in innovating activities, such as product development. The findings might be generalised to other technology companies from outside the energy sector that resemble adhocracy organisational structure and are involved in the development of complex technological product. In these companies the work is likely to be organised around project, and they are likely to operate in a market with relatively slow dynamics (Eisenhardt and Martin, 2000; Winter, 2003). If the companies follow the adhocracy model, but are not involved in product development and are less reliant on innovating activities, then at least the third phase of the model – creating new knowledge – might be different. In other industries, for example those that are characterised by high dynamics (such

as retail), the model with key KM practices and supporting KMS types might be to a large extent different. For instance, in retail providing knowledge workers with opportunities to connect with each other fast in order to solve multiple small urgent issues might be more important that knowledge reuse, and therefore, such tools as corporate social networks might be more appropriate for them. But more research needs to be done in order to verify these suggestions.

Finally, the fourth finding contributes to the body of KM literature by initiating a discussion about the role of gamification in KM, and demonstrating via a case study which was presented in Section 7.2, that this conversation has to be taken seriously. Gamification can be an extra attribute of the technology to enhance KMS, but it can also be a standalone technique to empower knowledge workers. The findings demonstrate that gamification has already entered the arena of KM in practices and is likely to stay there. This research is the first step to initiate this discussion in the academic literature as well. Gamification has attracted a lot of attention in the areas of education, marketing, sustainability, etc. and KM lags behind in this respect, but the directions for further research are discussed overleaf along with its limitations.

8.3.2. Limitations and further research

As any research, this PhD project also has a number of limitations. I do not see these as shortcomings, some are the characteristics of the type of the research undertaken and most are also opportunities for further research. This research was conducted in the companies of a particular type, they were technology intensive companies from the energy sector with the organisational structure leaning towards adhocracy. In other industries and types of organisational structure the KM journey is likely to be different, and these aspects were discussed in Section 5.4 and at the beginning of this chapter. Certain aspects are likely to overlap, e.g. knowledge sharing is likely to be important in almost any organisation, but they might exist in different forms of practice. Generalisability of the results, something that many researchers strive for, might be difficult, but it has never been the primary goal of this research. On the contrary, in the discussion of the research context and sampling issues, as well as in the deficiencies of the literature review, it was noted that results which are generic and aim at fitting any organisation might be of little use due to the loss of context. It is a balancing act between finding an area which is large enough to make the research interesting and small enough to make it meaningful and useful.

With regards to the companies sampled, it is likely that I have not observed the worst and best cases, because the worst companies might not be able to recognise the value of my research yet, whereas the best ones might be too good to see the benefit in it. This issue has been highlighted in Section 5.1.1. For instance, one company that was recommended by several other sources as having achieved excellence in KM has never responded to my

requests. Therefore, my findings might be missing something beyond what has been observed. It is also likely that the employees interviewed had a certain attitude and perception to the studied subject. The interviewees were either self-selected (agreeing to have a conversation with me), or recommended by a contact in each company. In both cases I tried to diversify the sample by experience and position in the company, but in both cases these are likely to be obliging people, who might also have a certain way of seeing things, and therefore they might have presented the activities in the company in a slightly more positive light, with fewer problems disclosed.

This research has also gathered a relatively small sample size for the survey. The survey analysis brought unexpected results: not only was it not possible to build a MM for KM, but the results also suggested that the hierarchy of the parameters and maturity levels that they constitute might need to be revised. The sample is too small to make definite conclusions, so verifying the findings would require a larger-scale research project in order to either confirm or eliminate the concerns that were raised.

Both limitations provide directions for further research. One could examine whether KM related needs in another setting, for example in companies from a different industry but with a similar structure, would be similar to what was found in this research. One could also conduct a large scale study to examine the relevance of MM for monitoring and improving processes, in particular product development and project management processes. If the results prove that the model does not represent the maturing of the processes as they are defined in the CMMI model, then this might encourage further investigation of applicability of MM in other areas, such as supply chain management.

This study was primarily driven by qualitative research, and, as a result, I have gathered a lot of rich data that did not always fit with the primary focus of the investigation, but that supplied me with the ideas that were discussed at the end of each chapter, and that suggested other directions of further research. In particular, the researchers discussed the impact of KM on innovation, but innovating activities might have an impact on KM as well, and the example of the side effects of ideas competition demonstrated the potential. Therefore, investigating the use of ideas competitions as a KM practice could become a promising direction of further research.

Regarding the influence of organisational parameters on KM, the role of both corporate and national culture has been researched in the literature. But still, the findings produced an interesting observation – it seems that in companies with relatively small foreign divisions, the corporate culture found in the headquarters prevails, whereas in larger companies, their larger foreign divisions tend to develop a corporate culture of their own, which is shaped by their national culture. This finding is intuitively sensible, but it requires further research to clarify these observations.

With regards to the implementation of KM initiatives and KMS, this research has elaborated on a number of aspects that have not been discussed in the literature yet, but are considered important by practitioners. They include the promotion of KM initiatives, the importance of seeing a KM initiative as a change management, and the importance of training. For some practitioners it is obvious, for instance according to Roszak (1994), 80% of a technology implementation budget should be spent on training and change management, while the CEO of Buckman labs believes that 90% of the effort should be directed towards the creation of a supportive KM culture (Liebowitz, 2001). But various case studies that describe KM initiatives in large organisations and the experience of implementing them do not raise these questions.

Another interesting factor that might have an impact on KM and KMS adoption in companies is the generation profile of the knowledge worker. In particular, the differences in attitude towards work of the Millennials are studied predominantly in human relations literature, but these differences are likely to influence KM as well, and further research in this area could supply academic literature with interesting discoveries.

Millennials grew up playing video games not only when they were children but also in their teen years, and therefore are more used to playing. For them having fun at work and having certain processes gamified might be an expectation. The exploratory case study of gamification in knowledge work has only slightly lifted the veil of opportunities for further research. Gamification could be seen as an added layer of all the above aspects. It is already being used for training (Herzig et al., 2012; Morschheuser et al., 2015; Webb and Cantú, 2013), it could accelerate organisational change (Rimon, 2015), and it might be perceived differently by the younger generation. Gamification is here to stay, and research needs in the context of KM to progress in this direction as well.

8.4. Contribution to Practitioners

8.4.1. Implications for practices

This research has produced a number of contributions to the body of knowledge in the academic literature, but the findings are important for practitioners as well. KM-related issues have been puzzling practitioners for the past two decades, which however did not result in agreement between the researchers and KM practitioners about the meaning and definition of KM, and even less so among knowledge workers. For some, KM is primarily focused on knowledge capturing for further reuse, for others its primary function is learning from each other. And even learning might mean different things for knowledge workers and practitioners: for some learning is the result of analysis and reflection on past experience, while for others it is new knowledge as an outcome of a project that can be demonstrated afterwards. This research brings clarity to the confusion around the term for practitioners.

The major contribution of this research to practice is in developing a KM process model (a roadmap) and presenting KM as a continuous effort rather than a one-off initiative, which generates a learning curve for an organisation. The KM roadmap consists of three interrelated phases and affects different aspects of knowledge work, which shows that KM is a complex multidimensional phenomenon and has to be taken seriously.

On the first phase of the KM roadmap, the question that concerns practitioners is to what extent KM practices should be formalised and regulated. On one hand, many knowledge managers want to grow KM practices organically, since the practices benefit everyone and their advantages are obvious for knowledge workers. But on the other hand, the interviews have demonstrated that simply understanding the benefits is not enough to engage knowledge workers, whereas formalising and standardising certain activities (e.g. the rules for documenting the project, handling the documents and storing them in a document repository), informs knowledge workers that these activities are valued by the company, and spending time on these activities is not considered a waste.

In the second phase of the KM roadmap the practitioners are concerned with how to share knowledge. Knowledge sharing takes different forms, and this research suggests looking at it as happening on different levels and under different conditions. On the first level, it is articulated knowledge that is shared primarily through the document repository. At this level sharing articulated knowledge requires an adequate level of formalisation that should have been created in the previous phase. Aggregating articulated knowledge, which might happen through a joint collaborative effort of knowledge workers (e.g. mediated through wikis) or through informal knowledge sharing, overlaps with the next phase of the model – knowledge sharing. On the second level, informal sharing stimulates the flow of both articulated and tacit knowledge around the company, and therefore can only be productively facilitated through expanding the networks of knowledge workers, rather than trying to capture and articulate the tacit component. On the third level, knowledge sharing happens through lessons learnt and ideas sharing, and therefore has to extend beyond informal sharing through a facilitated process in order to reach its greater potential. A knowledge sharing improves and becomes more diverse, communities emerge on the fourth level. Communities might exist in earlier phases as well, but with more limited knowledge-sharing practices they are likely to be reduced to information exchange only.

Ideas sharing was suggested as one form of knowledge sharing as well as an essential part of the third phase of the KM roadmap – creating new knowledge. Traditionally, ideas sharing is associated with innovation management, and the experience of the companies demonstrates that KM and innovation management have to be integrated with each other in innovative companies.

The second major contribution of this research to practice is related to technology. The variety of KMS types, presented in the literature review in Section 3.2.3, complicates decision

making about the technological support of a KM initiative in a company. This research defines the priorities and draws the boundaries between different KMS. The primary KMS type is believed to be a document repository; it was acknowledged as a useful and necessary tool by all the participants, and its purpose and limitations were emphasised. IS vendors offer a range of other KMS types, social computing tools in particular, of which wikis are believed to be the second most useful tool for the types of companies under investigation. Wikis can be well-integrated with document repositories and serve either as their interface or even as a replacement for them, and their collaborative functionality can support knowledge workers on other levels of knowledge sharing, if knowledge sharing needs to be mediated through IS.

Other KMS types, and social computing tools in particular, serve complementary purposes at different points in time on the roadmap of KM. For example, blogs can be a better way to disseminate knowledge and information. Forums are a better fit for a Q&A type of platform that encourages a search for knowledge through the knowers and discussions around emerging topics. They can even be adjusted for the purpose of an ideas contest, as one of the experts suggested. But all these systems represent corporate solutions.

Non-corporate social media can complement the technological landscape of KM as well. In particular, LinkedIn was found to be a better substitute for profile libraries in addition to other opportunities that it provides. As a KM tool, social media is mostly researched as a platform that connects an organisation with the surrounding environment (Chua and Banerjee, 2013). Areas of internal application of social media have also been investigated (Ray, 2014; Sigala and Chalkiti, 2015), but this topic lies outside the scope of this research.

The last contribution to practice is related to opening a window of opportunities for using gamification by uncovering the potential impact that it might have on KM. Apart from making a job more engaging and motivating knowledge workers, the aspect of gamification that usually dominates the discussion, it can also impact knowledge work by influencing the dynamics in the group and in the company. This can help identify different knowledge worker types and roles, and therefore map the landscape of knowledge workers, providing instant feedback to help them improve their performance. Among others, all these findings help to clarify the phenomenon of KM for practitioners. But how will KM practices change in the future?

8.4.2. The further of KM practice

As Peter Drucker (1969) said, the main objective of the 21st century will be to improve the productivity of the knowledge worker, just like improving the productivity of the manual workers was the objective of the 20th century. What it will mean for KM is that KM will be perceived as a normal everyday job practice. Prusak has mentioned that interest in KM has decreased since the beginning of the new millennium (Lambe, 2008), what he meant, however, was the loss of interest in the term KM as a consulting selling proposition and

research topic. He also mentioned the emergence of new themes that have a similar meaning, but a different name (e.g. social computing), which are trying to differentiate themselves from KM. As the interviews have shown, improving document management or lessons learnt practices has not become less important to companies.

Among the participants of the preliminary investigation three companies shared positive examples of KM practices, in particular of performing lessons learnt activities and of knowledge sharing. Two of the companies did not relate these practices to KM and rather perceived it as a sensible approach to working practices that would benefit everyone in the future. The third company wanted to improve their KM, and, as a result, they decided to implement a document repository, however this did not meet their extremely high expectations. Curiously, they have already had a successful social network operating for engineers, but they did not identify it as a KM tool.

With regards to new trends, gamification has become a trend, a fashionable practice, similar to KM two decades ago, and just like the majority of KM projects failed (only 26% of the projects reached implementation stage (KPMG, 1998)), four out of five gamification projects will probably fail as well. Some authors express concerns that gamification can be easily turned into 'pontification', meaning that implementing it is limited to introducing game mechanics with no meaningful experience behind it (Werbach and Hunter, 2012). In the case study we could see that implementation of game elements was driven by need rather than fashion, which potentially explains the successful experience of Zappos had with gamification.

Gamification was also criticised for becoming an exploitation tool (Bogost, 2011). Gamified systems allow provision of instant feedback on progress, and instead of creating an enjoyable experience they can be turned into a "Big Brother is watching you" controlling mechanism (Cohen, 2016). But the turning of any useful tool into a means of abuse is a question of a weak implementation of the tool, rather than the tool itself, therefore, these issues are not a matter of concern of this research.

Though this research provides an example of successful implementation of gamification in the corporate environment, the case of Zappos should not be treated as the ultimate solution for everyone; it is rather an illustration of a good in-house application of gamification. The use of gamification only partially contributes to the success of the company as a good place to work, and therefore it cannot be given all the credit. The company has achieved these results primarily due to its informal and friendly corporate culture and values, and levelled organisational structure. In this company employees come first:

> *"It's not the customers, but the employee that come first, because if the employees are happy, they are going to make the customers happy."*

To conclude, KM is likely to be an expectation and a necessity for a normal functioning environment of knowledge workers in the future. Just as an ERP system is an expectation for

any production facility nowadays, though many users might not even know the name of the class of this system, and call it SAP or Oracle instead. KM will survive as a term in the academic literature, as a point of reference and a label that helps academics locate themselves in the landscape of organisational studies. But in practice, KM is likely to be important as an umbrella term only for senior managers that are involved in strategy development and understand the importance of embracing organisational knowledge. For the rest it might merge with innovation management in innovative companies, or some aspects of it might be discussed in connection with a particular area of activities. Gamification is likely to play an increasingly important role in KM, and it might even become the next spark that will generate a new wave of interest in the field of KM.

8.5. Final Remarks

The three years of my PhD have been one of the most fascinating journeys in my life. During this time, I have learnt to appreciate the freedom of choosing the directions in which I wanted to continue my professional development, and the opportunity to pursue my own interests. I started the PhD with a clear idea of what I wanted to achieve at the end, though I did not know how to get there. But as the PhD moved along, I started discovering new themes and concepts that excited me, and sometimes it was not easy to make a choice and focus on the main purpose of the research. The results of the research are similar to my original intentions on a conceptual level, but are very different in the details, leaving a feeling that my research might make an impact, and open new fascinating directions for further research, such as into gamification.

It was not an easy journey; sometimes I did not know how to move forward, at other times I was frustrated with, and even desperate because of, the unresponsiveness of the world around me (e.g. when trying to get access to the companies). But these challenges taught me to always keep my eyes open, look for opportunities and think outside the box, even if it sounds like a cliché.

During this time, I have learnt to use various methods for analysis, such as machine learning and concept mapping, and to observe how they can speak to each other and how each tells a different story that contributes to a beautiful picture. They also taught me to look at the data and be open to what they show, rather than try and find what one expects to find. For instance, when I saw that the MM could not be built, and the links and connections did not exist where I thought they would, I had to find a new way of analysing and making sense of the interviews, which resulted in employing an additional method.

I have also learnt to manage my freedom, as this level of freedom can be challenging. Once you create a project and manage it, it is too easy to get carried away, as no one will tell you what to do and how to do it.

Through this research I have gained a deeper understanding of the field and started forming a clear picture of KM, though there is still a lot more to learn. Now I can look back at my past practical experience and my MSc project, and see what I have not seen before, explain what I have seen, understand the deeper meaning of what people were saying. When I reflect on past experience and look at my interviews, I see what I could have done differently, what I could have asked or discussed.

This journey has helped me learn about myself. I can envisage myself in different roles: as a researcher, tutor, consultant, or entrepreneur, and I understand what really interests me, what I am good at. I have learnt not to be afraid of challenges and the unknown. I know for certain that I would not trade this priceless experience for anything in the world.

9. List of abbreviations

CBM – Competence-Based Management

CSN – Corporate Social Network

CMMI – Capability Maturity Model Integration

DC – Dynamic Capabilities

OS – Information Systems

KM – Knowledge Management

KMS – Knowledge Management Systems

MM – Maturity Models

PDP – Product Development Process

PM – Project Management

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11. Appendices

11.1. Appendix 1. Survey questionnaire.

1. **What are your main responsibilities in the company?** (Please, list in 5-6 bullet points)
2. **What steps does a typical product development / modification process consist of in your company?** (Please, list the stages like specification development, concept development, prototyping…)
3. **To what extent would you agree with the following statements regarding the product development process in your company?** (Please, rate from 1 to 5, where 1 is don't agree at all and 5 is fully agree)
4. **Are there any process improvement activities taking place in your company?** *(if no, skip logic to Q8)*
5. **Is there a system at place to promote process improvement?**
6. **Does the corporate culture promote process improvement?**
7. **To what extent are the following activities performed by the product development team in your company?** (Please, rate from 1 to 5, where 1 is not performed at all and 5 is performed regularly and well.)
8. **What phases does a typical project consist of in your company?** (please, list the phases, for example, project start approval, design approval, lessons learnt…)
9. **To what extent would you agree with the following statements regarding the project management in your company?** (Please, rate from 1 to 5, where 1 is don't agree at all and 5 is fully agree)
10. **To what extent are the following activities performed by the project team in your company?** (Please, rate from 1 to 5, where 1 is not performed at all and 5 is performed regularly and well)
11. **How do you keep information about the previous projects?**
12. **How do you share your experience (e.g. insight from the project you are involved in) or ideas?** (Please, choose **yes / no** for each statement)
13. **Are you rewarded for sharing your experience / ideas?**
14. **Is your company purposefully investing in the event / activities / systems to make experience sharing more convenient for its employees?**
15. **How do you seek for help if you have any issues / problems during the project?** (Please, choose **yes / no** for each statement)
16. **What systems / tools are there at place in your company (excluding highly specialised department specific systems)?** (You can choose several options)
17. **Which of these systems do you use on a regular basis?** (You can choose several options)
18. **How convenient and useful are these systems?** (Please, rate them from 1 to 5, where 1 is basic and inconvenient, and 5 is advanced and useful)
19. **What is the name of your company?**
20. **What is your position in the company?**

11.2. Appendix 2. Survey parameters.

Table 15. Questionnaire parameters.

Theme	Category	MM level	Parameter	Answer values
Product Development Process	Product specification	MM1	Q4_1 The product specification is well defined from the very beginning	ascending
		MM1	Q4_2 If the product specification needs to be changed, the change is well managed	ascending
		MM1	Q4_3 Alternative concepts are being developed, evaluated and selected	ascending
		MM2	Q4_4 The product specification is verified to ensure, that it contains all the necessary details and makes sense	ascending
		MM3	Q4_5 Product design is verified against the specification to ensure, that all the initial requirements are met	ascending
	PDP performance	MM3	Q4_6 Product development process is formalised in the company	ascending
		MM4	Q4_7 The progress of the product development is evaluated against the quantified targets	ascending
		MM4	Q4_8 The phases of the product development process progress consistently well across different projects	ascending
Process Improvement	Process Improvement	MM5	Q7 Are there any process improvement activities taking place in your company?	ascending
		MM5	Q8 Is there a system at place to promote process improvement?	descending
		MM5	Q10 Does the corporate culture promote process improvement?	descending
		MM1	Q12_1 Determine process improvement opportunities	ascending
		MM1	Q12_3 Collect and analysed process improvement proposals	ascending
		MM1	Q12_4 Pilot the best proposals	ascending
		MM2	Q12_5 Develop action plan for further deployment of the best proposals	ascending
		MM2	Q12_6 Measure process improvement effects	ascending
Project Management	Lessons Learnt	MM1	Q12_2 Conduct lessons learnt sessions	ascending
		MM2	Q17_9 Conduct lessons learned sessions at the end of the project	ascending
		MM3	Q17_10 Analyse the results of lessons learned sessions and implement key take-aways	ascending

	PMP performance	MM3	Q16_1 Project management process is formalised in the company	ascending
		MM4	Q16_2 Each project has well defined objectives and quantified targets	ascending
			Q16_3 The level of our project management practices is as good as the world's best practices	ascending
	Project planning	MM1	Q17_1 Define the scope of the project	ascending
		MM1	Q17_2 Estimate the project costs	ascending
		MM2	Q17_3 Develop a project plan	ascending
		MM2	Q17_4 Establish the budget and schedule	ascending
		MM2	Q17_5 Plan and allocate resources required for the project	ascending
	Project Monitor and Risks	MM1	Q17_6 Monitor the project against the plan on a regular basis	ascending
		MM2	Q17_7 Identify, evaluate and prioritise project risks	ascending
		MM3	Q17_8 Develop a mitigation plan for the identified risks	ascending
	Experts and stakeholders engagement	MM2	Q17_11 Identify needed knowledge and skills for the project	ascending
		MM2	Q17_12 Assign responsibilities to the project members who have relevant knowledge and skills	ascending
		MM2	Q17_13 Collaborate with all the parties that have interest in the project, to ensure that their interests are met	ascending
		MM2	Q17_14 Involve external experts, who have relevant knowledge, but don't have direct interest in this project	ascending
KM practices	Knowledge storing		Q19 How do you keep information about the previous projects?	ascending
	Knowledge sharing		Q20_2 We have internal departmental meetings to share our experience	descending
			Q20_3 We share best practices across the teams	descending
			Q20_4 We analyse and share lessons learnt after each project	descending
			Q20_5 We share mistakes that were made during the project	descending
			Q20_6 We share new ideas informally between each other	descending
			Q20_7 We participate in the contest for the best ideas, organised by the company periodically	descending

			Q20_8 We have a system at place to share ideas with a defined evaluation mechanism	descending
			Q20_9 I'm a part of a professional community and we discuss professionrelated questions / ideas on a regular basis	descending
			Q21 Are you rewarded for sharing your experience / ideas?	descending
			Q23 Is your company purposefully investing in the event / activities / systems to make experience sharing more convenient for its employees?	descending
	Knowledge seeking		Q25_1 I ask colleagues to recommend me a relevant person	descending
			Q25_2 We have a list / map of experts which helps to find relevant experts	descending
			Q25_3 I'm looking for other projects that might have had similar problems	descending
			Q25_4 I address this problem to the professional community I'm a part of	descending
			Q25_5 I'm trying to find a relevant expert in my network	descending
KMS	KMS available		Q26_1 Project management tools	descending
			Q26_2 Corporate portal	descending
			Q26_3 Forum	descending
			Q26_4 Blogs	descending
			Q26_5 Wikis	descending
			Q26_6 Chats (text / audio / video)	descending
			Q26_7 Corporate Social Networks	descending
			Q26_8 Document repository	descending
			Q26_9 Knowledge repository	descending
			Q26_10 Patent library	descending
			Q26_11 Profile library	descending
			Q26_12 Crowdsourcing platform	descending
			Q26_13 Advanced search system	descending
			Q26_14 Webased trainings	descending
			Q26_15 Expert System	descending
			Q26_16 Ideas Library	descending
	KMS used		Q32_1 Project management tools	descending
			Q32_2 Corporate portal	descending
			Q32_3 Forum	descending
			Q32_4 Blogs	descending

			Q32_5 Wikis	descending
			Q32_6 Chats (text / audio / video)	descending
			Q32_7 Corporate Social Networks	descending
			Q32_8 Document repository	descending
			Q32_9 Knowledge repository	descending
			Q32_10 Patent library	descending
			Q32_11 Profile library	descending
			Q32_12 Crowdsourcing platform	descending
			Q32_13 Advanced search system	descending
			Q32_14 Webased trainings	descending
			Q32_15 Expert System	descending
			Q32_16 Ideas Library	descending
	Convenience of KMS used regularly		Q33_1 Project management tools	ascending
			Q33_2 Corporate portal	ascending
			Q33_3 Forum	ascending
			Q33_4 Blogs	ascending
			Q33_5 Wikis	ascending
			Q33_6 Chats (text / audio / video)	ascending
			Q33_7 Corporate Social Networks	ascending
			Q33_8 Document repository	ascending
			Q33_9 Knowledge repository	ascending
			Q33_10 Patent library	ascending
			Q33_11 Profile library	ascending
			Q33_13 Advanced search system	ascending
			Q33_14 Webased trainings	ascending
			Q33_15 Expert System	ascending
			Q33_16 Ideas Library	ascending

11.3. Appendix 3. Normality test: Kolmogorov-Smirnov and Shapiro-Wilk significance values.

Tests of Normality[b,c,d]

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.

The_product_specification_is_well_defined_from_the_very_beginning	.181	39	.002	.915	39	.006
If_the_product_specification_needs_to_be_changed,_the_change_is_well_managed	.224	39	.000	.873	39	.000
Alternative_concepts_are_being_developed,_evaluated_and_selected	.201	39	.000	.895	39	.002
The_product_specification_is_verified_to_ensure,_that_it_contains_all_the_necessary_details_and_makes_sense	.235	39	.000	.891	39	.001
Product_design_is_verified_against_the_specification_to_ensure,_that_all_the_initial_requirements_are_met	.279	39	.000	.860	39	.000
Product_development_process_is_formalised_in_the_company	.231	39	.000	.892	39	.001
The_progress_of_the_product_development_is_evaluated_against_the_quantified_targets	.201	39	.000	.899	39	.002
The_phases_of_the_product_development_process_progress_consistently_well_across_different_projects	.248	39	.000	.895	39	.002
Are_there_any_process_improvement_activities_taking_place_in_your_company?	.380	39	.000	.725	39	.000
Is_there_a_system_at_place_to_promote_process_improvement?	.348	39	.000	.698	39	.000
Does_the_corporate_culture_promote_process_improvement?	.350	39	.000	.704	39	.000
Determine_process_improvement_opportunities	.312	39	.000	.847	39	.000
Conduct_lessons_learnt_sessions	.313	39	.000	.867	39	.000

Collect_and_analysed_process_improvement_proposals	.325	39	.000	.857	39	.000
Pilot_the_best_proposals	.241	39	.000	.914	39	.006
Develop_action_plan_for_further_deployment_of_the_best_proposals	.274	39	.000	.891	39	.001
Measure_process_improvement_effects	.246	39	.000	.912	39	.005
Project_management_process_is_formalised_in_the_company	.248	39	.000	.883	39	.001
Each_project_has_well_defined_objectives_and_quantified_targets	.335	39	.000	.812	39	.000
The_level_of_our_project_management_practices_is_as_good_as_the_world's_best_practices	.192	39	.001	.900	39	.002
Define_the_scope_of_the_project	.304	39	.000	.781	39	.000
Estimate_the_project_costs	.279	39	.000	.770	39	.000
Develop_a_project_plan	.300	39	.000	.827	39	.000
Establish_the_budget_and_schedule	.284	39	.000	.811	39	.000
Plan_and_allocate_resources_required_for_the_project	.337	39	.000	.781	39	.000
Monitor_the_project_against_the_plan_on_a_regular_basis	.307	39	.000	.816	39	.000
Identify,_evaluate_and_prioritise_project_risks	.323	39	.000	.834	39	.000
Develop_a_mitigation_plan_for_the_identified_risks	.236	39	.000	.889	39	.001
Conduct_lessons_learned_sessions_at_the_end_of_the_project	.286	39	.000	.857	39	.000
Analyse_the_results_of_lessons_learned_sessions_and_implement_key_take-aways	.268	39	.000	.855	39	.000
Identify_needed_knowledge_and_skills_for_the_project	.353	39	.000	.808	39	.000

Assign_responsibilities_to_the_project_members_who_have_relevant_knowledge_and_skills	.370	39	.000	.765	39	.000
Collaborate_with_all_the_parties_that_have_interest_in_the_project,_to_ensure_that_their_interests_are_met	.259	39	.000	.856	39	.000
Involve_external_experts,_who_have_relevant_knowledge,_but_don't_have_direct_interest_in_this_project	.202	39	.000	.903	39	.003
MM_perception	.274	39	.000	.807	39	.000
How_do_you_keep_information_about_the_previous_projects?	.318	39	.000	.690	39	.000
We_have_internal_departmental_meetings_to_share_our_experience	.411	39	.000	.608	39	.000
We_share_best_practices_across_the_teams	.358	39	.000	.635	39	.000
We_analyse_and_share_lessons_learnt_after_each_project	.437	39	.000	.581	39	.000
We_share_mistakes_that_were_made_during_the_project	.345	39	.000	.637	39	.000
We_share_new_ideas_informally_between_each_other	.528	39	.000	.350	39	.000
We_participate_in_the_contest_for_the_best_ideas,_organised_by_the_company_periodically	.475	39	.000	.522	39	.000
We_have_a_system_at_place_to_share_ideas_with_a_defined_evaluation_mechanism	.519	39	.000	.395	39	.000
I'm_a_part_of_a_professional_community_and_we_discuss_profession-related_questions_/_ideas_on_a_regular_basis	.509	39	.000	.433	39	.000
Other	.528	39	.000	.350	39	.000

Are_you_rewarded_for_sharing_your_experience_/_ideas?	.463	39	.000	.545	39	.000
Is_your_company_purposefully_investing_in_the_event_/_activities_/_systems_to_make_experience_sharing_more_convenient_for_its_employees?	.411	39	.000	.608	39	.000
I_ask_colleagues_to_recommend_me_a_relevant_person	.539	39	.000	.233	39	.000
We_have_a_list_/_map_of_experts_which_helps_to_find_relevant_experts	.528	39	.000	.350	39	.000
I'm_looking_for_other_projects_that_might_have_had_similar_problems	.487	39	.000	.497	39	.000
I_address_this_problem_to_the_professional_community_I'm_a_part_of	.509	39	.000	.433	39	.000
I'm_trying_to_find_a_relevant_expert_in_my_network	.371	39	.000	.631	39	.000
Other	.498	39	.000	.467	39	.000
Project_management_tools_	.371	39	.000	.631	39	.000
Corporate_portal_	.411	39	.000	.608	39	.000
Forum_	.385	39	.000	.626	39	.000
Blogs_	.450	39	.000	.564	39	.000
Wikis_	.463	39	.000	.545	39	.000
Chats_(text_/_audio_/_video)_	.398	39	.000	.618	39	.000
Corporate_Social_Networks_	.487	39	.000	.497	39	.000
Document_repository_	.424	39	.000	.596	39	.000
Knowledge_repository	.437	39	.000	.581	39	.000
Patent_library	.498	39	.000	.467	39	.000
Profile_library	.498	39	.000	.467	39	.000
Crowdsourcing_platform	.538	39	.000	.150	39	.000
Advanced_search_system	.487	39	.000	.497	39	.000
We-based_trainings	.437	39	.000	.581	39	.000
Expert_System	.538	39	.000	.150	39	.000
Ideas_Library	.528	39	.000	.350	39	.000
Other:_	.528	39	.000	.350	39	.000

Project_management_tools_	.281	39	.000	.757	39	.000
Corporate_portal_	.233	39	.000	.798	39	.000
Forum_	.369	39	.000	.699	39	.000
Blogs_	.441	39	.000	.603	39	.000
Wikis_	.448	39	.000	.578	39	.000
Chats_(text_/_audio_/_video)_	.251	39	.000	.778	39	.000
Corporate_Social_Networks_	.474	39	.000	.518	39	.000
Document_repository_	.328	39	.000	.715	39	.000
Knowledge_repository	.420	39	.000	.629	39	.000
Patent_library	.498	39	.000	.467	39	.000
Profile_library	.487	39	.000	.486	39	.000
Crowdsourcing_platform	.538	39	.000	.150	39	.000
Advanced_search_system	.474	39	.000	.518	39	.000
We-based_trainings	.423	39	.000	.632	39	.000
Expert_System	.538	39	.000	.150	39	.000
Ideas_Library	.528	39	.000	.350	39	.000
Other_name	.521	39	.000	.351	39	.000
Project_management_tools_	.374	39	.000	.717	39	.000
Corporate_portal_	.406	39	.000	.669	39	.000
Forum_	.516	39	.000	.345	39	.000
Blogs_	.533	39	.000	.307	39	.000
Wikis_	.491	39	.000	.435	39	.000
Chats_(text_/_audio_/_video)_	.338	39	.000	.744	39	.000
Corporate_Social_Networks_	.514	39	.000	.406	39	.000
Document_repository_	.271	39	.000	.811	39	.000
Knowledge_repository	.497	39	.000	.448	39	.000
Patent_library	.538	39	.000	.150	39	.000
Profile_library	.535	39	.000	.230	39	.000
Advanced_search_system	.526	39	.000	.364	39	.000
We-based_trainings	.531	39	.000	.304	39	.000
Expert_System	.538	39	.000	.150	39	.000
Ideas_Library	.538	39	.000	.150	39	.000
Other_name	.529	39	.000	.297	39	.000

a. Lilliefors Significance Correction

b. We_talk_informally_to_each_other is constant. It has been omitted.

c. I_have_a_blog is constant. It has been omitted.

d. Crowdsourcing_platform is constant. It has been omitted.

11.4. Appendix 4. Analysis of the MM parameters through KM parameters only

Each question is characterised by analysis obtained from machine learning parameters and indicated the correlation index for them in the brackets, and by correlation analysis parameters that were not shown in CBR.

Maturity level 1

Product specification Q4_1: The product specification is well defined from the very beginning (MM1)

CBR analysis:

- Using Project Management Tools regularly (insignificant)
- Using Document repository regularly (insignificant)
- Lessons learnt (insignificant)
- Using chats regularly (insignificant) (-.295*) – have chat
- Being a part of professional community (-.324*)
- Having departmental meetings (-.381**)

Correlation analysis:

- Ideas contest (-.297*)
- Ideas sharing system (-.407**)
- Look for similar projects (.360*)
- Forum (-.341*)

Product specification Q4_2: If the product specification needs to be changed, the change is well managed (MM1)

CBR analysis:

- Using Project Management Tools regularly (insignificant)
- Using Document repository regularly (insignificant)
- Using Corporate portal regularly (insignificant)
- Share new ideas informally (insignificant)
- Have chats (-.358*)
- Have knowledge repository – unclear (insignificant)

Correlation analysis:

- Department meetings (-.383*)
- Forum (-.455**)
- Ideas library (-.335*)

Concepts Q4_3: The product specification is verified to ensure, that it contains all the necessary details and makes sense (MM1)

CBR analysis:

- Using Document repository regularly (insignificant)
- Using Project Management Tools regularly (insignificant)
- Have chats (-.353*)
- Using chats regularly (insignificant)
- Keep information about the previous projects (on PC or in a dedicated system) (insignificant)
- Share best practices (insignificant)

Correlation analysis:

- Ideas sharing system (-.305*)
- Invest in experience sharing events (-.385**)
- Use wikis regularly (.372**)

Process improvement, Q12_1: Determine process improvement opportunities (MM1)

CBR analysis:

- Using Project Management Tools regularly (insignificant)
- Invest in knowledge sharing events (insignificant)
- Share best practices (insignificant)
- Using chats regularly – unclear (insignificant)
- Have CSN (-.306*)

Correlation analysis:

- Profile library (-.392**)

Process improvement, Q12_3: Collect and analysed process improvement proposals (MM1)

CBR analysis:

- Using chats regularly (insignificant)
- Using Project Management Tools regularly (.275*)
- Using Document repository regularly (insignificant)
- Have advanced search system
- Share best practices (-.357*)

- Keep information about the previous projects (paper docs or in a dedicated system) (insignificant)

Correlation analysis:

- Share mistakes (-.349*)
- Professional communities (-.350*)
- Address problems to professional communities (-.299*)
- Use profile library regularly (.310*)

Process improvement, Q12_4: Pilot the best proposals (MM1)

CBR analysis:

- Using Document repository regularly (insignificant)
- We-based trainings (insignificant)
- Lessons learnt (insignificant)
- Professional communities (-.375*)
- Have Corporate portal – unclear (insignificant)
- Using Project Management Tools regularly (insignificant)

Correlation analysis:

- Forum (-.364*)
- Profile library (-.370*)

Lessons Learnt Q12_2: Conduct lessons learnt sessions (MM1)

CBR analysis:

- Using chats regularly – unclear (insignificant)
- Using Document repository regularly (insignificant)
- Have professional communities – unclear (insignificant)
- Using Project Management Tools regularly (insignificant)
- Have a corporate portal – unclear (insignificant)

Correlation analysis:

- Share best practices (-.476**)
- Share mistakes (-.348*)

Project planning Q17_1: Define the scope of the project (MM1)

- Using Knowledge repository regularly (insignificant)
- Using Document repository regularly (insignificant) (-.362*)
- Have department meetings (insignificant)
- Invest in knowledge sharing events (insignificant)

- Have Corporate portal (insignificant)
- Using chats regularly – unclear (insignificant)

Correlation analysis:

- Project management tools (-.305*)
- Patent library (-.316*)
- Advanced search system (-.353*)
- Ideas library (-.362*)
- Use blogs regularly (.305*)

Project planning Q17_2: Estimate the project costs (MM1)

CBR analysis:

- Using Document repository regularly (insignificant)
- Using chats regularly – unclear (insignificant)
- Using Project Management Tools regularly – unclear (insignificant)
- Ask colleague for recommendation (insignificant)
- Keep information about the previous projects (paper docs, PC or in a dedicated system) (insignificant)

Correlation analysis:

- Share best practices (-.367*)
- Ideas library (-.351*)
- Use Advanced search system regularly (-.348*)

Project Monitor and Risks Q17_6: Monitor the project against the plan on a regular basis (MM1)

CBR analysis:

- Using Project Management Tools regularly (insignificant)
- Using Document repository regularly (insignificant)
- Reward experience sharing – unclear (insignificant)
- Using chats regularly – unclear (insignificant) or
- Have professional communities (insignificant) or
- Lessons learnt (insignificant)

Correlation analysis:

- Share best practices (-.378*)
- Share mistakes (-.366*)
- We-based trainings (-.304*)

Maturity level 2

Product specification Q4_4: The product specification is verified to ensure, that it contains all the necessary details and makes sense (MM2)

CBR analysis:

- Using Chat regularly (.314*)
- Using Project Management Tools regularly (insignificant)
- Using Document repository regularly (insignificant)
- Keep information about the previous projects (on PC or in a dedicated system) (insignificant)

Correlation analysis:

- Department meetings (-.528**)
- Share best practices (-.396**)
- Address problem to the professional community (-.311*)
- Forums (-.425**)
- Ideas library (-.341*)

Process improvement, Q12_5: Develop action plan for further deployment of the best proposals (MM2)

CBR analysis:

- Using Knowledge repository regularly (insignificant)
- Using Document repository regularly (insignificant)
- Using Project Management Tools regularly (insignificant)
- Invest in knowledge sharing events (insignificant)
- Using chats regularly (insignificant)

Correlation analysis:

- Professional communities (-.352*)
- Address problems to professional communities (-.352*)
- Patent library (-.368*)
- Profile library (-.346*)
- Use blogs regularly (.346*)

Process improvement, Q12_6: Measure process improvement effects (MM2)

CBR analysis:

- Using Project Management Tools regularly (.339*)
- Using Document repository regularly – unclear (insignificant)
- Using Wikis regularly – unclear (insignificant)

- Lessons learnt (insignificant)
- Have Corporate portal – unclear (insignificant) (.299*) use regularly

Correlation analysis:

- Share best practices (-.340*)
- Professional communities (-.324*)
- Profile library (-.419**)

Lessons Learnt Q17_9: Conduct lessons learned sessions at the end of the project (MM2)

CBR analysis:

- Using Document repository regularly (insignificant)
- Using Project Management Tools regularly (insignificant)
- Lessons Learnt (-.448**)
- Using chats regularly – unclear (insignificant)

Correlation analysis:

- Share best practices (-.482**)
- Share mistakes (-.369*)

Project planning Q17_3: Develop a project plan (MM2)

CBR analysis:

- Using Project Management Tools regularly (insignificant)
- Using Corporate portal regularly (insignificant)
- Using Document repository regularly - unclear (insignificant)
- Reward experience sharing (insignificant)
- Share ideas informally (insignificant)

Correlation analysis:

- Share best practices (-.326*)
- Share mistakes (-.334*)
- Ideas library (-.309*)
- Use Advanced search system regularly (-.302*)

Project planning Q17_4: Establish the budget and schedule (MM2)

CBR analysis:

- Using Document repository regularly (insignificant)
- Ask colleague for recommendation (insignificant)

- Keep information about the previous projects (paper docs, PC or in a dedicated system) – unclear (insignificant)
- Using Project Management Tools regularly (insignificant)
- Using chats regularly – unclear (insignificant) or
- Have professional communities (insignificant) or
- Lessons learnt (-.314*)

Correlation analysis:

- Share best practices (-.364*)
- Use Knowledge repository regularly (-.324*)
- Use Advanced search system regularly (-.390**)

Project planning Q17_5: Plan and allocate resources required for the project (MM2)

CBR analysis:

- Using Project Management Tools regularly (insignificant)
- Using Document repository regularly (insignificant)
- Have CSN (insignificant)
- Using chats regularly – unclear (insignificant) or
- Have professional communities (insignificant) or
- Lessons learnt (-.495**)

Correlation analysis:

- Keep information about previous projects (-.311*)
- Share best practices (-.356*)
- Share mistakes (-.511**)
- We-based trainings (-.333*)

Project Monitor and Risks Q17_7: Identify, evaluate and prioritise project risks (MM2)

CBR analysis:

- Using chats regularly – unclear (insignificant)
- Using Document repository regularly (insignificant)
- Have blogs – unclear (insignificant)
- Corporate portal (insignificant)
- Have Corporate portal – unclear (insignificant)

Identifying and attracting relevant expertise Q17_12: Assign responsibilities to the project members who have relevant knowledge and skills (MM2)

CBR analysis:

- Using chats regularly (insignificant)
- Using Corporate portal regularly (insignificant)
- Using Project Management Tools regularly (insignificant)
- Invest in knowledge sharing events (-.481**)
- Keep information about the previous projects (paper docs, PC or in a dedicated system) – unclear (insignificant)

Correlation analysis:

- Share mistakes (-.477**)

Identifying and attracting relevant expertise Q17_14: Involve external experts, who have relevant knowledge, but don't have direct interest in this project (MM2)

CBR analysis:

- Using Project Management Tools regularly (insignificant)
- Using Document repository regularly (insignificant) or
- Using chats regularly (insignificant) or
- Have corporate portal
- Have We-based trainings - unclear (insignificant)

Correlation analysis:

- Share best practices (-.490**)
- Lessons learnt (-.434**)
- Share mistakes (-.305*)

Identifying and attracting relevant expertise Q17_11: Identify needed knowledge and skills for the project (MM2)

CBR analysis:

- Using Document repository regularly (insignificant)
- Using Project Management Tools regularly (insignificant)
- Using chats regularly – unclear (insignificant) or
- Have professional communities (insignificant) or
- Lessons learnt (insignificant)

Correlation analysis:

- Share best practices (-.396**)
- Share mistakes (-.343*)

Stakeholders engagement Q17_13: Collaborate with all the parties that have interest in the project, to ensure that their interests are met (MM2)

CBR analysis:

- Using chats regularly (insignificant) or
- Using Corporate portal regularly (insignificant)
- Using Document repository regularly (insignificant)
- Using Project Management Tools regularly (insignificant)
- Lessons learnt (insignificant)

Correlation analysis:

- Share mistakes (-.493**)

Maturity level 3

Product specification Q4_5: Product development process is formalised in the company (MM3)

CBR analysis:

- Using Corporate portal regularly (insignificant) (-.307*) have
- Using Project Management Tools regularly (insignificant)
- Using Document repository regularly (insignificant)
- Ask to recommend a relevant person (insignificant)

Correlation analysis:

- Department meetings (-.326*)
- Share best practices (-.432**)
- Forum (-.462**)
- Use Profile Library regularly (.315*)

PDP performance Q4_6: Product development process is formalised in the company (MM3)

CBR analysis:

- Using chats regularly (insignificant) (-.295*) have chats
- Using Document repository regularly (insignificant)
- Using Project Management Tools regularly (insignificant)
- Keep information about the previous projects (paper docs, PC or in a dedicated system) unclear (insignificant)
- Share best practices unclear (-.359*)

Correlation analysis:

- Forum (-.437**)
- Patent library (-.302*)
- Ideas library (-.329*)
- Use blogs regularly (.286*)

Lessons Learnt Q17_10: Analyse the results of lessons learned sessions and implement key take-aways (MM3)

CBR analysis:

- Using Project Management Tools regularly (insignificant)
- Using Document repository regularly (insignificant)
- Using Corporate portal regularly (insignificant)
- Lessons learnt (-.378*)
- Ideas contest (insignificant)
- Have CSN (insignificant)

Correlation analysis:

- Share best practices (-.533**)
- Share mistakes (-.306*)
- Use profile library regularly (.302*)

PMP performance Q16_1: Project management process is formalised in the company (MM3)

CBR analysis:

- Using Project Management Tools regularly (insignificant)
- Using Document repository regularly (insignificant)
- Share best practices (-.520**)
- We-based trainings (insignificant)
- Have Knowledge repository – unclear (insignificant)
- Have Advanced search system (insignificant)

Correlation analysis:

- Keep information about previous projects (-.352*)
- Use forum regularly (.302*)
- Blogs (-.292*)
- Ideas library (-.323*)

Project Monitor and Risks Q17_8: Develop a mitigation plan for the identified risks (MM3)

CBR analysis:

- Using chats regularly (insignificant)
- Using Document repository regularly (insignificant)
- Corporate portal (insignificant)
- Invest in knowledge sharing events (insignificant)
- Share ideas informally (insignificant)

Maturity level 4

PDP performance Q4_7: The progress of the product development is evaluated against the quantified targets (MM4)

CBR analysis:

- Using chats regularly (insignificant) (-.305*)
- Using Document repository regularly (insignificant)
- Using Project Management Tools regularly (insignificant)
- Keep information about the previous projects (paper docs, PC or in a dedicated system) (insignificant)

Correlation analysis:

- Share best practices
- Forum (-.284*)
- Use Advanced search system regularly (-.312*)

PDP performance Q4_8: The phases of the product development process progress consistently well across different projects (MM4)

CBR analysis:

- Using chats regularly (insignificant) (-.297*)
- Using Document repository regularly (insignificant)
- Using Project Management Tools regularly (insignificant)
- Share best practices (-.349*)

Correlation analysis:

- Forum (-.416**)
- Profile library (-.411**)

PMP performance Q16_2: Each project has well defined objectives and quantified targets (MM4)

CBR analysis:

- Using Project Management Tools regularly (insignificant)
- Using chats regularly (insignificant)
- Have CSN (insignificant)
- Keep information about the previous projects (paper docs, PC or in a dedicated system) (-.324*)
- Using Document repository regularly - unclear (insignificant)

Correlation analysis:

- Share best practices (-.335*)
- Wikis (.292*)

Maturity level 5

Process improvement, Q7: Are there any process improvement activities taking place in your company? (MM5)

CBR analysis:

- Using chats regularly (insignificant)
- Using Document repository regularly (insignificant)
- Using Project Management Tools regularly (insignificant)
- Invest in knowledge sharing events (insignificant)

Correlation analysis:

- Address problem to professional community (-.313*)
- CSN (-.322*)

Process improvement, Q8: Is there a system at place to promote process improvement? (MM5)

CBR analysis:

- Address problems to professional communities (.429**)
- Using Document repository regularly (insignificant)
- Share best practices (insignificant)
- Have chats (insignificant)

Correlation analysis:

- Advanced search system (.363*)

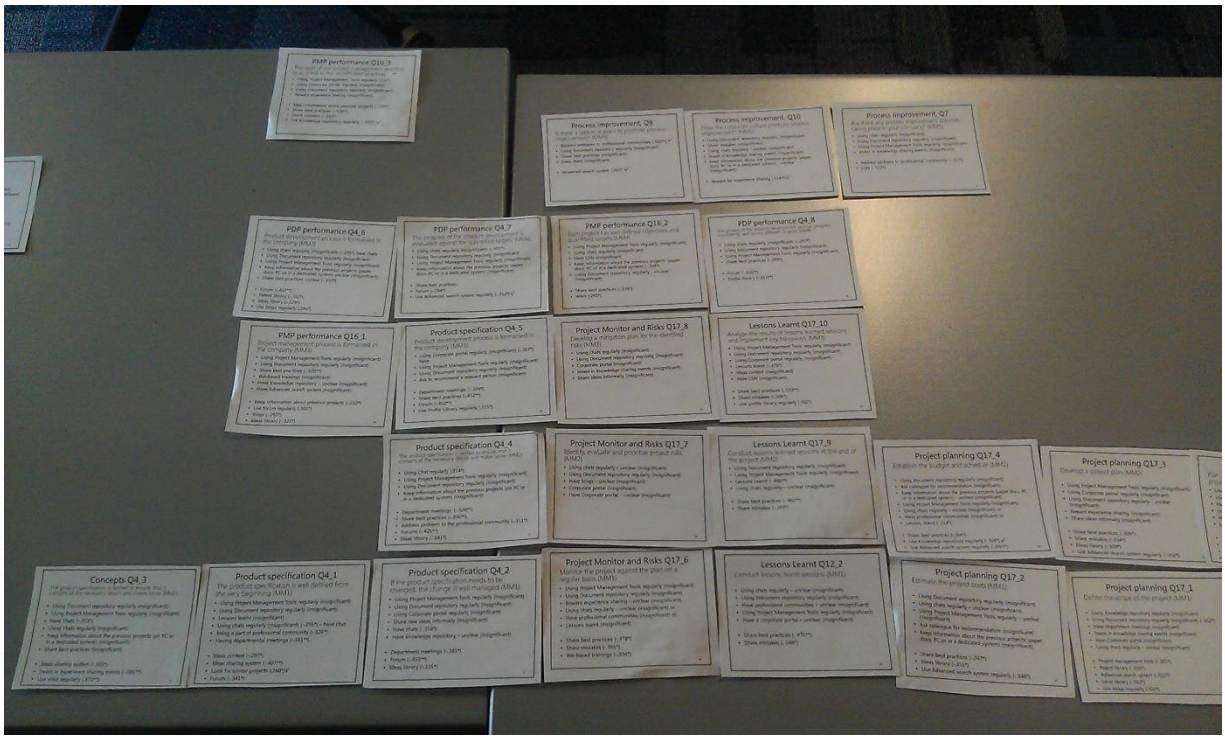
Process improvement, Q10: Does the corporate culture promote process improvement? (MM5)

CBR analysis:

- Using Document repository regularly (insignificant)
- Share mistakes (insignificant)
- Using chats regularly – unclear (insignificant)
- Invest in knowledge sharing events (insignificant)
- Keep information about the previous projects (paper docs, PC or in a dedicated system) - unclear (insignificant)

Correlation analysis:

- Reward for experience sharing (.514**)



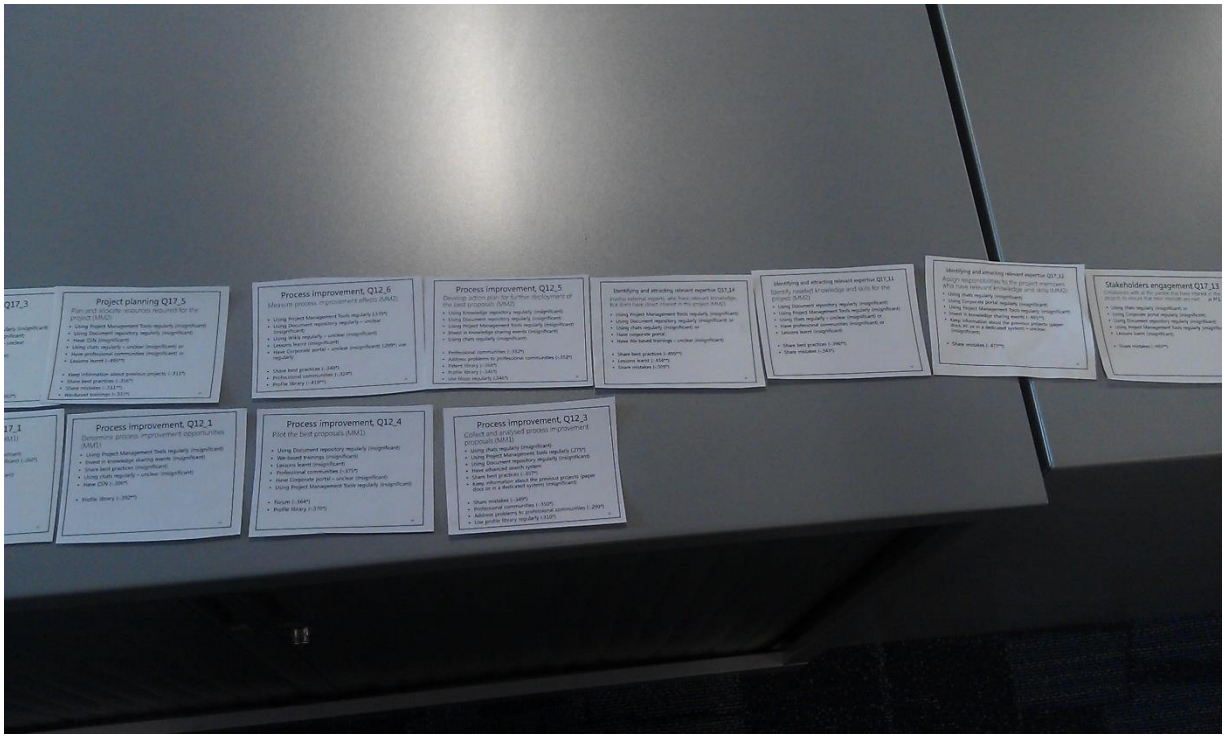


Figure 45. CBR & correlation analysis grouping by maturity levels for KM maturity.

11.5. Appendix 5. Analysis of the MM parameters through all the parameters

Each question is characterised by analysis obtained from machine learning parameters and indicated the correlation index for them in the brackets, and by correlation analysis parameters that were not shown in CBR and that are related to MM maturity only, since KM parameters have already been included in the previous analysis.

Maturity level 1

Product specification Q4_1: The product specification is well defined from the very beginning (MM1)

CBR analysis:

- Q4_2 Product specification (MM1) (.521**)
- Q17_7 Project Monitor and Risks (MM2)
- Q12_1 Process improvement (MM1) - unclear
- Q12_4 Process improvement (MM1) (.267*)
- Q12_6 Process improvement (MM2) – unclear
- Q4_3 Concepts (MM1) (.377**)

Correlation analysis:

- PDP Q4_4 (MM2), Q4_5-6 (MM3), Q4_7-8 (MM4)

Product specification Q4_2: If the product specification needs to be changed, the change is well managed (MM1)

CBR analysis:

- Q4_4 Product specification (MM2) (.521**)
- Q4_3 Concepts (MM1) (.417**)
- Q12_1 Process improvement (MM1) – unclear
- Q4_6 PDP performance (MM3) (.664**)
- Q4_7 PDP performance (MM4) – unclear (.450**)
- Q4_5 Product specification (MM3) – unclear (.369**)

Correlation analysis:

- PDP Q4_1 (MM1), Q4_8 (MM4)
- Project management Q16_1 (MM3), Q17_3 (MM2)

Concepts Q4_3: The product specification is verified to ensure, that it contains all the necessary details and makes sense (MM1)

CBR analysis:

- Q4_8 PDP performance (MM4) (.444**)
- Q17_7 Project Monitor and Risks (MM2) – unclear
- Q12_4 Process improvement (MM1) (.354**)
- Q17_12 Identifying and attracting relevant expertise (MM2)
- Q12_2 – Lessons learnt (MM1)

Correlation analysis:

- PDP Q4_1-2 (MM1), Q4_5-6 (MM3), Q4_7 (MM4)
- Process improvement Q10 (MM5), Q12_1 (MM1), Q12_3 (MM1), Q12_5-6 (MM2)

Process improvement, Q12_1: Determine process improvement opportunities (MM1)

CBR analysis:

- Q12_6 Process improvement (MM2) (.616**)
- Q16_1 PMP performance (MM3) – unclear (.333*)
- Q4_7 PDP performance (MM4) (.348*)
- Q4_6 PDP performance (MM3) (.278*)

Correlation analysis:

- PDP Q4_3 (MM1), Q4_8 (MM4)
- Process improvement Q7 (MM5), Q12_2-3-4 (MM1), Q12_5 (MM2)
- Project management Q17_3 (MM2), Q17_6 (MM1)

Process improvement, Q12_3: Collect and analysed process improvement proposals (MM1)

CBR analysis:

- Q12_5 Process improvement (MM2) (.783**)
- Q4_1 Product specification (MM1) – unclear
- Q17_4 Project planning (MM2)
- Q17_9 Lessons learnt (MM2) (.372**)

Correlation analysis:

- PDP Q4_3 (MM1)
- Process improvement Q7 (MM5), Q12_1-2 (MM1), Q12_4 (MM1), Q12_6 (MM2)
- Project management Q16_1 (MM3), Q16_2 (MM4), Q17_3 (MM2), Q17_6 (MM1), Q17_10 (MM3)

Process improvement, Q12_4: Pilot the best proposals (MM1)

CBR analysis:

- Q12_6 Process improvement (MM2) (.598**)
- Using document repository regularly
- Q17_7 Project Monitor and Risks (MM2) – unclear
- Q16_1 PMP performance (MM3) – unclear (.326*)

Correlation analysis:

- PDP Q4_1 (MM1), Q4_3 (MM1), Q4_8 (MM4)
- Process improvement Q7 (MM5), Q12_1-2-3 (MM1), Q12_5 (MM2)
- Project management Q17_3 (MM2), Q17_6 (MM1)

Lessons Learnt Q12_2: Conduct lessons learnt sessions (MM1)

CBR analysis:

- Q12_3 Process improvement (MM1) (.712**)
- Using document repository – unclear
- Q16_3 PMP performance (no MM) (.439**)
- Q4_1 Product specification (MM1) – unclear
- Q17_5 Project planning (MM2) – unclear (.315*)

Correlation analysis:

- Process improvement Q7 (MM5), Q12_1 (MM1), Q12_4 (MM1), Q12_5-6 (MM2)
- Project management Q16_1 (MM3), Q16_2 (MM4), Q17_3 (MM2), Q17_6 (MM1), Q17_7 (MM2), Q17_8 (MM3), Q17_9 (MM2), Q17_10 (MM3)

Project planning Q17_1: Define the scope of the project (MM1)

- Q12_2 Lessons learnt (MM1)
- Q12_4 Process improvement (MM1)
- Q17_9 Lessons learnt (MM2) – unclear
- Q4_5 Product specification (MM3)
- Q4_8 PDP performance (MM4)
- Q4_1 Product specification (MM1) – unclear

Correlation analysis:

- Project management Q16_1 (MM3), Q16_2 (MM4), Q17_2 (MM1), Q17_3-4-5 (MM2), Q17_6 (MM1), Q17_7 (MM2), Q17_8 (MM3), Q17_14 (MM2)

Project planning Q17_2: Estimate the project costs (MM1)

CBR analysis:

- Q17_4 Project planning (MM2) (.686**)
- Q17_14 Identifying and attracting relevant expertise (MM2)
- Q4_3 Concepts (MM1) – unclear
- Q4_1 Product specification (MM1)
- Q4_5 Product specification (MM3)

Correlation analysis:

- Project management Q16_1 (MM3), Q16_2 (MM4), Q17_1 (MM1), Q17_3 (MM2), Q17_5 (MM2), Q17_6 (MM1)

Project Monitor and Risks Q17_6: Monitor the project against the plan on a regular basis (MM1)

CBR analysis:

- Q17_5 Project planning (MM2) (.705**)
- Q4_7 PDP performance (MM4) – unclear
- Q12_1 Process improvement (MM1) (.334*)
- Q4_6 PDP performance (MM3) (.323*)
- Q12_6 Process improvement (MM2) – unclear
- Q4_2 Product specification (MM1) – unclear

Correlation analysis:

- PDP Q4_4 (MM2), Q4_8 (MM4)
- Process improvement Q7 (MM5), Q10 (MM5), Q12_2-3-4 (MM1), Q12_5 (MM2)
- Project management Q16_1 (MM3), Q16_2 (MM4), Q17_1-2 (MM1), Q17_3-4 (MM2), Q17_7 (MM2), Q17_8 (MM3), Q17_11-13-14 (MM2), Q17_9 (MM2), Q17_10 (MM3)

Maturity level 2

Product specification Q4_4: The product specification is verified to ensure, that it contains all the necessary details and makes sense (MM2)

CBR analysis:

- Q4_8 PDP performance (MM4)
- Q17_7 Project Monitor and Risks (MM2) – unclear
- Q12_2 – Lessons learnt (MM1)
- Q12_4 Process improvement (MM1)
- Q17_12 Identifying and attracting relevant expertise (MM2)

Correlation analysis:

- PDP Q4_1-2 (MM1), Q4_5-6 (MM3), Q4_7-8 (MM4)
- Project management Q16_1 (MM3), Q17_3 (MM2), Q17_6 (MM1)

Process improvement, Q12_5: Develop action plan for further deployment of the best proposals (MM2)

CBR analysis:

- Q12_3 Process improvement (MM1) (.783**)
- Using wikis regularly – unclear
- Q12_4 Process improvement (MM1) (.639**)
- Q12_2 – Lessons learnt (MM1) – unclear (.570**)
- Q4_6 PDP performance (MM3) – unclear (.309*)
- Q4_5 Product specification (MM3)

Correlation analysis:

- PDP Q4_3 (MM1), Q4_7-8 (MM4)
- Process improvement Q7 (MM5), Q12_1 (MM1), Q12_6 (MM2)
- Project management Q17_3 (MM2), Q17_6 (MM1), Q17_9 (MM2)

Process improvement, Q12_6: Measure process improvement effects (MM2)

CBR analysis:

- Q12_4 Process improvement (MM1) (.598**)
- Q12_3 Process improvement (MM1) (.598**)
- Q12_5 Process improvement (MM2) (.703**)
- Q4_5 Product specification (MM3) – unclear
- Q4_4 Product specification (MM2)
- Q17_5 Project planning (MM2)

Correlation analysis:

- PDP Q4_3 (MM1), Q4_7-8 (MM4)
- Process improvement Q7 (MM5), Q12_1-2 (MM1)
- Project management Q17_9 (MM2)

Lessons Learnt Q17_9: Conduct lessons learned sessions at the end of the project (MM2)

CBR analysis:

- Q17_10 Lessons learnt (MM3) (.801**)
- Using document repository regularly
- Using chats regularly – unclear
- Q4_1 Product specification (MM1) – unclear
- Q17_4 Project planning (MM2) – unclear

Correlation analysis:

- PDP Q4_5 (MM3)
- Process improvement Q10 (MM5), Q12_2-3 (MM1), Q12_6 (MM2)
- Project management Q16_1 (MM3), Q17_5 (MM2), Q17_6 (MM1), Q17_12-14 (MM2)

Project planning Q17_3: Develop a project plan (MM2)

CBR analysis:

- Q17_6 Project Monitor and risks (MM1) (.655**)
- Q4_3 Concepts (MM1) – unclear
- Q17_12 Identifying and attracting relevant expertise (MM2) (.360*)
- Q12_4 Process improvement (MM1) (.352*)

Correlation analysis:

- PDP Q4_2 (MM1), Q4_4 (MM2), Q4_6 (MM3)
- Process improvement Q7 (MM5), Q10 (MM5), Q12_1-2-3 (MM1), Q12_5 (MM2)
- Project management Q16_1 (MM3), Q16_2 (MM4), Q17_1-2 (MM1), Q17_4-5 (MM2), Q17_7 (MM2), Q17_8 (MM3), Q17_13 (MM2)

Project planning Q17_4: Establish the budget and schedule (MM2)

CBR analysis:

- Q4_5 Product specification (MM3)
- Q17_5 Project planning (MM2) (.597**)
- Q7 Process improvement (MM5)
- Using Document repository regularly – unclear
- Q12_3 Process improvement (MM1) – unclear

Correlation analysis:

- Project management Q16_1 (MM3), Q16_2 (MM4), Q17_1-2 (MM1), Q17_3-4 (MM2), Q17_6 (MM1), Q17_8 (MM3), Q17_11-12-13-14 (MM2)

Project planning Q17_5: Plan and allocate resources required for the project (MM2)

CBR analysis:

- Q17_4 Project planning (MM2) (.597**)
- Q17_9 Lessons learnt (MM2) (.520**)
- Q17_10 Lessons learnt (MM3) – unclear (.506**)
- Q17_14 Identifying and attracting relevant expertise (MM2) (.492**)

Correlation analysis:

- Process improvement Q10 (MM5), Q12_2 (MM1)
- Project management Q16_1 (MM3), Q16_2 (MM4), Q17_1-2 (MM1), Q17_3 (MM2), Q17_6 (MM1), Q17_7 (MM2), Q17_8 (MM3), Q17_11-12-13 (MM2)

Project Monitor and Risks Q17_7: Identify, evaluate and prioritise project risks (MM2)

CBR analysis:

- Q17_8 Project Monitor and risks (MM3) (.863**)
- Q12_1 Process improvement (MM1)
- Q12_5 Process improvement (MM2) – unclear
- Q17_10 Lessons learnt (MM3) (.277*)

Correlation analysis:

- Process improvement Q10 (MM5), Q12_2 (MM1)
- Project management Q16_2 (MM4), Q17_1 (MM1), Q17_3-5 (MM2), Q17_6 (MM1), Q17_13-14 (MM2)

Identifying and attracting relevant expertise Q17_12: Assign responsibilities to the project members who have relevant knowledge and skills (MM2)

CBR analysis:

- Q17_3 Project planning (MM2) (.360*)
- Q12_2 – Lessons learnt (MM1)
- Q17_5 Project planning (MM2) (.419**)
- Q4_3 Concepts (MM1) – unclear
- Q4_4 Product specification (MM2) – unclear

Correlation analysis:

- Project management Q16_1 (MM3), Q16_2 (MM4), Q17_4 (MM2), Q17_8 (MM3), Q17_11-13 (MM2), Q17_9 (MM2), Q17_10 (MM3)

Identifying and attracting relevant expertise Q17_14: Involve external experts, who have relevant knowledge, but don't have direct interest in this project (MM2)

CBR analysis:

- Q17_13 Stakeholders engagement (MM2) (.486**)
- Using document repository regularly
- Q12_4 Process improvement (MM1) – unclear
- Q16_1 PMP performance (MM3) (.392**)
- Q4_8 PDP performance (MM4) – unclear
- Q17_3 Project planning (MM2) – unclear

Correlation analysis:

- Process improvement Q10 (MM5)
- Project management Q16_2 (MM4), Q17_1-2 (MM1), Q17_4-5 (MM2), Q17_6 (MM1), Q17_7 (MM2), Q17_8 (MM3), Q17_11 (MM2), Q17_9 (MM2), Q17_10 (MM3)

Identifying and attracting relevant expertise Q17_11: Identify needed knowledge and skills for the project (MM2)

CBR analysis:

- Q17_14 Identifying and attracting relevant expertise (MM2) (.285*)
- Q12_3 Process improvement (MM1) – unclear
- Q16_1 PMP performance (MM3)
- Keep information about previous projects – unclear
- Q4_2 Product specification (MM1)

Correlation analysis:

- PDP Q4_5 (MM3)
- Project management Q17_4-5 (MM2), Q17_6 (MM1), Q17_8 (MM3), Q17_12-13 (MM2)

Stakeholders engagement Q17_13: Collaborate with all the parties that have interest in the project, to ensure that their interests are met (MM2)

CBR analysis:

- Q17_14 Identifying and attracting relevant expertise (MM2) (.486**)
- Q12_4 Process improvement (MM1) – unclear
- Q17_8 Project Monitor and risks (MM3) – unclear

- Keep information about previous projects – unclear
- Q4_1 Product specification (MM1) – unclear

Correlation analysis:

- Project management Q16_2 (MM4), Q17_3-4-5 (MM2), Q17_6 (MM1), Q17_7 (MM2), Q17_8 (MM3), Q17_11-12 (MM2)

Maturity level 3

Product specification Q4_5: Product development process is formalised in the company (MM3)

CBR analysis:

- Q4_6 PDP performance (MM3) (.667**)
- Q4_1 Product specification (MM1) (.369**)
- Q17_4 Project planning (MM2)
- Q12_2 – Lessons learnt (MM1) - unclear
- Q16_1 PMP performance (MM3) – unclear (.472**)

Correlation analysis:

- PDP Q4_2-3 (MM1), Q4_4 (MM2), Q4_7-8 (MM4)
- Process improvement Q8 (MM5)
- Project management Q17_9 (MM2), Q17_10 (MM3), Q17_11 (MM2)

PDP performance Q4_6: Product development process is formalised in the company (MM3)

CBR analysis:

- Q4_4 Product specification (MM2) (.618**)
- Q17_6 Project monitor and risks (MM1) (.323*)
- Q12_2 – Lessons learnt (MM1)
- Q12_6 Process improvement (MM2)
- Q4_7 PDP performance (MM4) (.667**)
- Q4_3 Concepts (MM1) (.478**)

Correlation analysis:

- PDP Q4_1-2 (MM1), Q4_5 (MM3), Q4_8 (MM4)
- Process improvement Q12_1 (MM1), Q12_5 (MM2)
- Project management Q16_1 (MM3), Q17_3 (MM2)

Lessons Learnt Q17_10: Analyse the results of lessons learned sessions and implement key take-aways (MM3)

CBR analysis:

- Q17_9 Lessons learnt (MM2) (.801**)
- Q16_1 PMP performance (MM3) (.398**)
- Q17_3 Project planning (MM2) – unclear
- Q17_13 Stakeholders engagement (MM2) – unclear
- Q7 Process improvement (MM5) – unclear

Correlation analysis:

- PDP Q4_5 (MM3)
- Process improvement Q12_2-3 (MM1)
- Project management Q17_5 (MM2), Q17_6 (MM1), Q17_7 (MM2), Q17_12-14 (MM2)

PMP performance Q16_1: Project management process is formalised in the company (MM3)

CBR analysis:

- Q12_4 Process improvement (MM1) (.326*)
- Q4_3 Concepts (MM1)
- Using Project management tools regularly
- Q17_2 Project planning (MM1) (.464**)
- Q4_4 Product specification (MM2) – unclear (.323*)
- Q16_3 PMP performance (no MM) (.389**)

Correlation analysis:

- PDP Q4_2 (MM1), Q4_5-6 (MM3), Q4_7-8 (MM4)
- Process improvement Q12_1-2-3 (MM1)
- Project management Q16_2 (MM4), Q17_1 (MM1), Q17_3-4-5 (MM2), Q17_6 (MM1), Q17_12 (MM2), Q17_14 (MM2), Q17_9 (MM2), Q17_10 (MM3)

Project Monitor and Risks Q17_8: Develop a mitigation plan for the identified risks (MM3)

CBR analysis:

- Q17_7 Project Monitor and risks (MM2) (.863**)
- Q4_2 Product specification (MM1)
- Q17_5 Project planning (MM2) (.552**)
- Q4_3 Concepts (MM1) – unclear

Correlation analysis:

- Process improvement Q10 (MM5), Q12_2 (MM1)
- Project management Q16_2 (MM4), Q17_1 (MM1), Q17_3-4 (MM2), Q17_6 (MM1), Q17_11-12-13-14 (MM2)

Maturity level 4

PDP performance Q4_7: The progress of the product development is evaluated against the quantified targets (MM4)

CBR analysis:

- Q4_6 PDP performance (MM3) (.682**)
- Q12_6 Process improvement (MM2) (.361**)
- Using document repository regularly – unclear or
- Blogs
- Q12_1 Process improvement (MM1) (.348*)
- Q4_1 Product specification (MM1) (.413**)

Correlation analysis:

- PDP Q4_2-3 (MM1), Q4_4 (MM2), Q4_5-6 (MM3), Q4_7-8 (MM4)
- Process improvement Q12_5 (MM2)
- Project management Q16_1 (MM3)

PDP performance Q4_8: The phases of the product development process progress consistently well across different projects (MM4)

CBR analysis:

- Q4_7 PDP performance (MM4) (.636**)
- Q4_4 Product specification (MM2) (.503**)
- Q17_14 Identifying and attracting relevant expertise (MM2)
- Q4_5 Product specification (MM3) – unclear (.528**)
- Q4_1 Product specification (MM1) (.331*)
- Q16_2 PMP performance (MM4)

Correlation analysis:

- PDP Q4_2-3 (MM1), Q4_6 (MM3)
- Process improvement Q7 (MM5), Q12_1 (MM1), Q12_4 (MM1), Q12_5-6 (MM2)
- Project management Q16_1 (MM3), Q17_6 (MM1)

PMP performance Q16_2: Each project has well defined objectives and quantified targets (MM4)

CBR analysis:

- Q16_3 PMP performance (no MM) (.586**)
- Q16_1 PMP performance (MM3) – unclear (.498**)
- Q4_1 Product specification (MM1) – unclear
- Q17_13 Stakeholders engagement (MM2) (.301*)
- Q4_3 Concepts (MM1) – unclear

Correlation analysis:

- Process improvement Q12_2-3 (MM1)
- Project management Q17_1-2 (MM1), Q17_3-4-5 (MM2), Q17_6 (MM1), Q17_7 (MM2), Q17_8 (MM3), Q17_12 (MM2), Q17_14 (MM2)

Maturity level 5

Process improvement, Q7: Are there any process improvement activities taking place in your company? (MM5)

CBR analysis:

- Q12_1 Process improvement (MM1) (.747**)
- Q17_8 (Project monitor and risks (MM3) – unclear
- Using chats regularly

Correlation analysis:

- PDP Q4_8 (MM4)
- Process improvement Q12_2-3-4 (MM1), Q12_5-6 (MM2)
- Project management Q17_3 (MM2), Q17_6 (MM1)

Process improvement, Q8: Is there a system at place to promote process improvement? (MM5)

CBR analysis:

- Q4_5 Product specification (MM3) (-.369*)
- Q4_1 Product specification (MM1) – unclear
- Q17_14 Identifying and attracting relevant expertise (MM2) – unclear
- Q12_3 Process improvement (MM1)

Process improvement, Q10: Does the corporate culture promote process improvement? (MM5)

CBR analysis:

- Q17_3 Project planning (MM2) (-.325*)
- Looking for similar projects in the past
- Q17_8 Project monitor and risks (MM3) – unclear (-.447**)

- Q4_3 Concepts (MM1) – unclear
- Q4_2 Product specification (MM1) – unclear

Correlation analysis:

- PDP Q4_3 (MM1), Q4_4 (MM2),
- Project management Q17_5 (MM2), Q17_6 (MM1), Q17_7 (MM2), Q17_9 (MM2), Q17_14 (MM2)

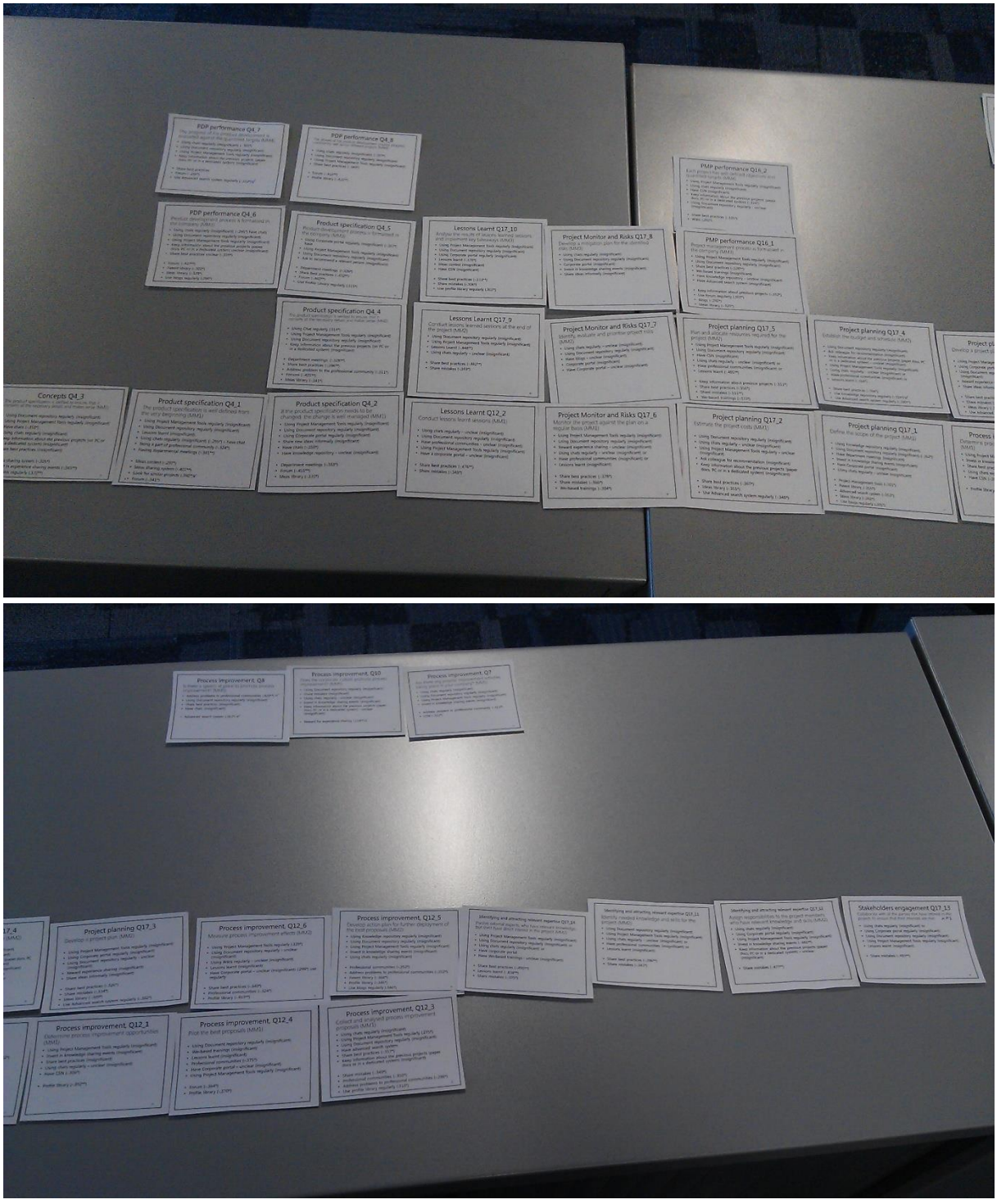


Figure 46. CBR & correlation analysis grouping by maturity levels for process maturity.

11.6. Appendix 6. Analysis of all the MM parameters through the parameters of the same theme and KM parameters

Each question is characterised by analysis obtained from machine learning parameters and indicated the correlation index for them in the brackets. The correlation analysis parameters that were not shown in CBR, are irrelevant in this analysis.

Product specification Q4_1: The product specification is well defined from the very beginning (MM1)

CBR analysis:

- Q4_2 Product specification (MM1) (.521**)
- Q12_1 Process improvement (MM1) - unclear
- Q12_4 Process improvement (MM1) (.267*)
- Q4_3 Concepts (MM1) (.377**)
- Using Document repository regularly
- Q4_5 Product specification (MM3)

Product specification Q4_2: If the product specification needs to be changed, the change is well managed (MM1)

CBR analysis:

- Q4_4 Product specification (MM2) (.521**)
- Q4_3 Concepts (MM1) (.417**)
- Q12_1 Process improvement (MM1) – unclear
- Q4_6 PDP performance (MM3) (.664**)
- Q4_7 PDP performance (MM4) – unclear (.450**)
- Q4_5 Product specification (MM3) – unclear (.369**)

Concepts Q4_3: The product specification is verified to ensure, that it contains all the necessary details and makes sense (MM1)

CBR analysis:

- Q4_8 PDP performance (MM4) (.444**)
- Q4_2 Product specification (MM1) – unclear
- Q12_4 Process improvement (MM1) (.354**)
- Q12_2 – Lessons learnt (MM1)
- Q4_1 Product specification (MM1) – unclear
- Invest in knowledge sharing activities

Product specification Q4_4: The product specification is verified to ensure, that it contains all the necessary details and makes sense (MM2)

CBR analysis:

- Q4_6 PDP performance (MM3)
- Q4_8 PDP performance (MM4) – unclear (was clear)
- Q12_6 Process improvement (MM2)
- Q4_7 PDP performance (MM4) – unclear
- Q4_1 Product specification (MM1)

Product specification Q4_5: Product development process is formalised in the company (MM3)

CBR analysis:

- Q4_6 PDP performance (MM3) (.667**)
- Q4_1 Product specification (MM1) (.369**)
- Q4_2 Product specification (MM1)
- Q12_2 – Lessons learnt (MM1) - unclear
- Q12_1 Process improvement (MM1) - unclear
- Using Document repository regularly – unclear
- Analysing lessons learnt

PDP performance Q4_6: Product development process is formalised in the company (MM3)

CBR analysis:

- Q4_4 Product specification (MM2) (.618**)
- Q12_6 Process improvement (MM2)
- Q4_7 PDP performance (MM4) (.667**)
- Q4_3 Concepts (MM1) – unclear (.478**)
- Using Document repository regularly – unclear

PDP performance Q4_7: The progress of the product development is evaluated against the quantified targets (MM4)

CBR analysis:

- Q4_6 PDP performance (MM3) (.682**)
- Q12_6 Process improvement (MM2) (.361**)
- Using document repository regularly – unclear or
- Using Blogs regularly - unclear
- Q12_1 Process improvement (MM1) (.348*)
- Q4_1 Product specification (MM1) (.413**)

PDP performance Q4_8: The phases of the product development process progress consistently well across different projects (MM4)

CBR analysis:

- Q4_7 PDP performance (MM4) (.636**)
- Q4_4 Product specification (MM2) (.503**)
- Q4_5 Product specification (MM3) – unclear (.528**)
- Q4_1 Product specification (MM1) (.331*)
- Using Project management tools regularly or
- Using document repository regularly – unclear

PMP performance Q16_1: Project management process is formalised in the company (MM3)

CBR analysis:

- Q12_4 Process improvement (MM1) (.326*)
- Using Project management tools regularly - unclear
- Q17_2 Project planning (MM1) (.464**)
- Q16_3 PMP performance (no MM) (.389**)
- Q17_14 Identifying and attracting relevant expertise (MM2) - unclear
- Q12_3 Process improvement (MM1) - unclear

PMP performance Q16_2: Each project has well defined objectives and quantified targets (MM4)

CBR analysis:

- Q16_3 PMP performance (no MM) (.586**)
- Q16_1 PMP performance (MM3) – unclear (.498**)
- Q17_13 Stakeholders engagement (MM2) (.301*)
- Have Corporate portal
- Q7 Process improvement (MM5)
- Q17_8 Project Monitor and risks (MM3) - unclear

Project planning Q17_1: Define the scope of the project (MM1)

CBR analysis:

- Q17_4 Project planning (MM2) (.686**)
- Q17_14 Identifying and attracting relevant expertise (MM2)
- Have corporate portal – unclear
- Q12_1 Process improvement (MM1) – unclear
- Q10 Process improvement (MM5) – unclear
- Q7 Process improvement (MM5) – unclear

Project planning Q17_2: Estimate the project costs (MM1)

CBR analysis:

- Q17_4 Project planning (MM2) (.686**)
- Q17_14 Identifying and attracting relevant expertise (MM2)
- Have corporate portal – unclear
- Q12_1 Process improvement (MM1) – unclear
- Q10 Process improvement (MM5) – unclear
- Q7 Process improvement (MM5) – unclear

Project planning Q17_3: Develop a project plan (MM2)

CBR analysis:

- Q17_6 Project Monitor and risks (MM1) (.655**)
- Q17_12 Identifying and attracting relevant expertise (MM2) (.360*)
- Q12_4 Process improvement (MM1) (.352*)
- Q17_8 Project Monitor and risks (MM3)

Project planning Q17_4: Establish the budget and schedule (MM2)

CBR analysis:

- Q17_2 Project planning (MM1)
- Q17_5 Project planning (MM2) (.597**)
- Q17_8 Project Monitor and risks (MM3)
- Q7 Process improvement (MM5)
- Advanced Search system
- Q12_3 Process improvement (MM1) – unclear

Project planning Q17_5: Plan and allocate resources required for the project (MM2)

CBR analysis:

- Q17_4 Project planning (MM2) (.597**)
- Q17_9 Lessons learnt (MM2) (.520**)
- Q17_10 Lessons learnt (MM3) – unclear (.506**)
- Q17_14 Identifying and attracting relevant expertise (MM2) (.492**)

Project Monitor and Risks Q17_6: Monitor the project against the plan on a regular basis (MM1)

CBR analysis:

- Q17_5 Project planning (MM2) (.705**)

- Q12_1 Process improvement (MM1) (.334*)
- Q12_6 Process improvement (MM2)
- Using CSN regularly - unclear

Project Monitor and Risks Q17_7: Identify, evaluate and prioritise project risks (MM2)

CBR analysis:

- Q17_8 Project Monitor and risks (MM3) (.863**)
- Q12_1 Process improvement (MM1)
- Q12_5 Process improvement (MM2) – unclear
- Q17_10 Lessons learnt (MM3) (.277*)

Project Monitor and Risks Q17_8: Develop a mitigation plan for the identified risks (MM3)

CBR analysis:

- Q17_7 Project Monitor and risks (MM2) (.863**)
- Q17_5 Project planning (MM2) (.552**)
- Q7 Process improvement (MM5)
- Q12_1 Process improvement (MM1) - unclear

Lessons Learnt Q17_9: Conduct lessons learned sessions at the end of the project (MM2)

CBR analysis:

- Q17_10 Lessons learnt (MM3) (.801**)
- Using document repository regularly
- Using chats regularly – unclear
- Q17_4 Project planning (MM2) – unclear
- Q12_1 Process improvement (MM1) – unclear

Lessons Learnt Q17_10: Analyse the results of lessons learned sessions and implement key take-aways (MM3)

CBR analysis:

- Q17_9 Lessons learnt (MM2) (.801**)
- Q16_1 PMP performance (MM3) (.398**)
- Q17_3 Project planning (MM2) – unclear
- Q17_13 Stakeholders engagement (MM2) – unclear
- Q7 Process improvement (MM5)

Identifying and attracting relevant expertise Q17_11: Identify needed knowledge and skills for the project (MM2)

CBR analysis:

- Q17_14 Identifying and attracting relevant expertise (MM2) (.285*)
- Q12_3 Process improvement (MM1) – unclear
- Q16_1 PMP performance (MM3)
- Keep information about previous projects – unclear
- Q7 Process improvement (MM5)
- Q17_6 Project Monitor and risks (MM1) - unclear

Identifying and attracting relevant expertise Q17_12: Assign responsibilities to the project members who have relevant knowledge and skills (MM2)

CBR analysis:

- Q17_3 Project planning (MM2) (.360*)
- Q12_2 – Lessons learnt (MM1)
- Q17_5 Project planning (MM2) (.419**)
- Q12_5 Process improvement (MM2) – unclear
- Q17_10 Lessons learnt (MM3) – unclear

Stakeholders engagement Q17_13: Collaborate with all the parties that have interest in the project, to ensure that their interests are met (MM2)

CBR analysis:

- Q17_14 Identifying and attracting relevant expertise (MM2)
- Q12_4 Process improvement (MM1) – unclear
- Q17_8 Project Monitor and risks (MM3)
- Q12_6 Process improvement (MM2) - unclear

Identifying and attracting relevant expertise Q17_14: Involve external experts, who have relevant knowledge, but don't have direct interest in this project (MM2)

CBR analysis:

- Q17_13 Stakeholders engagement (MM2)
- Using Document repository regularly
- Q12_4 Process improvement (MM1) – unclear
- Q16_1 PMP performance (MM3)
- Q17_3 Project planning (MM2) – unclear

11.7. Appendix 7. Multiple Case study. Codified results of the interviews.

Parent Node	Node	Coded Text
patents	patents	the first we try to do is we patent it.
patents	patents	But from the innovation side sometimes we do patent our ideas, sometimes we don't, because it opens the secret: if we patent it, everybody will know about it.
process improvement	process improvement	It's the around the table discussion.
process improvement	process improvement	I review their work and try to improve the way we do things, procedures, and I try to streamline it as well, because we've got lots of international offices as well, which will do different things.
process improvement	process improvement	I think they've got to do a bit of clearing up as well. But at the moment a couple of team leaders are trying to think about the optimisation processes.
process improvement	process improvement	I thought, I'd better put something like a QA process to make sure that all the losses or all out assumptions have been followed as it is.
process improvement	process improvement	it's quite good for improving, because if you have everyone agree, then you don't really have a progress road map. If people are arguing and fighting for their views, then you have to find the way which work both
process improvement	process improvement	Those types of initiatives usually appear ad-hoc, if there is a need? 36:38 Yes, and it's also headed by one person, who will say: hey, I see this need, let's think about it, get some suggestions.
process improvement	process improvement	we are doing some work on our stage-gate process, because for some of the elements it's a different timeline, it's much faster than hardware development, so we are trying to make sure that the requirements for coming to say that you are going to develop this are so stringent, that it takes you half a year of development time to get ready to go
process improvement	process improvement	I might make polite suggestions to how we might do things in the future, and then also on the projects I generally produce a report with recommendations for improvements.
process improvement	process improvement	Customer satisfaction surveys with your customers and the things come up there that show that we've got some areas that we need to improve. We work with the customer to try and improve those. And we work with our teams within Silver Spring to try and make improvements as well.
process improvement	process improvement	the management team are constantly looking at making small improvements and getting it to be a lot better, and then they document that and then go and show that information for people.
process improvement	process improvement	Typically it gets documented and presented to some of the execs, but it's really up to you as an individual to take it and implement them.
process improvement	process improvement	to create a template for this, cause it will speed up. I just do that, I just talk to my manager and do it
process improvement	process improvement	In every Weir site there is a scoreboard with process efficiency maps and KPIs for manufacturing.
process improvement	process improvement	competitions for employees to improve processes and then reward them accordingly
process improvement	process improvement	Sometimes external expertise will come to our factory and try to explore some of the things that we can improve on.
process improvement	process improvement	sometimes the managers are going around, what we call a gamble walk, they start look around the factory and try to see what places need to be improved.
Communities	grassroot CoP	we kind of like to push each other a little bit and provoke each other saying: are you sure that it should be considered that way. So it's quite good for improving, because if you have everyone agree, then you don't really have a progress road map. If people are arguing and fighting for their views, then you have to find the way which work both
Communities	grassroot CoP	It's very informal, we don't have agenda or a plan or anything like that. Between 3 of us we have a big portion of company's accounts, we just want to stay connected on what each other is doing.

Communities	grassroot CoP	There is group of us that informally share information about our job, there is 3 of us, who get on involved just on our own, just to share information among each other.
Communities	grassroot CoP	I am informally linked into a community group within the services part of organisation, to a certain extend for a bit of moral boosting. When things are going wrong on this side of the Atlantic, it's nice to have people to talk to over there and to explain them the problems that I've got and help them help me.
Communities	grassroot CoP	Gradually we've built up a network of key GIS interested people and we keep in touch with what we are doing, but because we are providing ad-hoc GIS support across the business, and somebody has got a project and then he finds out that he needs GIS based data, he comes to something like ourselves or other GIS experts.
Communities	grassroot CoP	identified the need to GIS data analyst in the business, we've created our own team, we've got a couple of guys in to do that for us.
Communities	grassroot CoP	There is not enough GIS support. So we had to build this adhoc support community that we want to enhance the need for GIS. That was grass-roots organisation.
Communities	grassroot CoP	We are constantly trying to maintain this community because I see it fundamentally as the basis for improving the business innovation.
Communities	grassroot CoP	It was just posing questions to different experts about a particular subject and then through introduction we have to see this and that. The number of people who are now getting involved into the discussion is increasing and we decided to formalise it through the teleconference, exchanging documents and things like that. It has become a forum at which we discuss almost regularly
Communities	grassroot CoP	everyone would feel like a group unit. And then people would still offer advice, when we are having problems, because sometimes even if it's not your project, you can offer advice for it
Communities	networking	Because of the way we have to share knowledge we tend to know a lot of people, and people with experience tend to know a lot of people in different organisations, I don't have those relationships, I don't really know whom to speak to, who to pick up the phone to to try and gain that knowledge.
Communities	networking	We also did sports match, we had a badminton competition, and some people started to know each other through these activities, quite informal activities sometimes.
Communities	networking	We have some training programs and sharing programs, which allow people to move around to attend a training in a specific site. And that is the change when you can start to know people around.
Communities	professional community	there is a Glasgow due diligence group and then there is a due diligence group which is the wider, people from Vancouver, Paris, Hamburg mainly
Communities	professional community	I put them together, I tried to get 1 person from every group within the company and then 1 person from every international office. It's about a dozen people. But I asked every group director or international office manager to suggest someone who would be good.
Communities	professional community	Most of the people who are in that team, have been reasonably good at responding on my requests with their views on things.
Communities	professional community	The advisory services group have tried to pull together these virtual knowledge groups, just because they've been asked to trial the system.
Communities	professional community	We've also got virtual solar team email address, one for Glasgow team and one for all the other people that are involved in solar in all the international other offices, and if you've got any questions, e.g. if anyone has ever worked on a rooftop project before, just send an email. And lots of people reply generally.
Communities	professional community	You can email other project managers in our company, if there is something that you are stuck with and you can't figure it out, you can email to them: hey guys, has anyone done this in the past? What did you do about it? And that's really useful.

Communities	professional community	On the Yammer there are these groups, self-defined communities, you can just join them. They have different topics, they cover different areas.
Communities	professional community	There is a number of them through Yammer that've been set up.
Communities	professional community	It tends to be industry wide communities and various things, so there is a cable conference. I, so I've set up an HVDC conference, that I hold on to see everyone involved in HVDC project, but that's across the UK.
Communities	professional community	we don't happen to have communities of interest internally at all.
Communities	professional community	because there is a new change that causes this subject to become topical, he suggested that we need to create a forum which can start looking at strategy in this area,
Communities	professional community	Usually we get them created around a subject matter depending on need and the time.
Communities	professional community	we had a project which was going to deal with the subject of North structures over lines, so when the project was registered, a working group was created taking into account different people expertise.
Communities	professional community	Everyone who had interest in our program is now a part of our online community in our Confluence anyway, because they've either been involved in it, or we needed to educate them about it, so we invited them in our wiki area to show them this.
Communities	professional community	I'll consider an online community to be our wiki community
Communities	professional community	Some of them are open? Most of them will go to an administrator, and that is mainly for commercial reasons
Communities	professional community	We've got the intranet page, that has communities based on different things: safety.
Communities	professional community activity	if they have questions, there is quite a lot of I would say almost daily dialogue with the other offices, where someone might say, if anyone has got experience with such and such, and I'll email that to the whole due diligence group. And you might get answers back from different locations.
Communities	professional community activity	for our ones we are trying to, so we set up a website that has a message of what we are trying to do, and ask questions. We send newsletters and bits of information to that group. So we are trying to encourage them, but we only had our first meeting 3 months ago, so it's not been much communication within that.
Communities	professional community activity	probably fundamentally it was just getting everyone to know each other
Communities	professional community activity	This working group attended every single meeting which reviewed the project progress, so it was able to bring around people who are experts in over lines, in setting standards for drafting specification of over lines.
Communities	professional community activity	I've never used one where anyone has come up with a new idea. It's more for sharing knowledge.
Communities	professional community activity	It's like community group, where you can share ideas, information, but it only reaches those that are in that community.
Communities	professional community activity	it's sharing brochures, market materials for commercialisation.
Communities	professional community activity	We have ones for graduates, where new opportunities are put into that.
Communities	professional community activity	You can have people comment on it, but most of it comes down to file sharing
Communities	professional community problem	First of all, to access an online community, you need to sign to a VPN and then you have to go through the whole bunch of different steps, it's not very easy.

Communities	professional community problem	They do have online communities for Weir. I found that it doesn't get used that well unfortunately.
Communities	professional community visibility problem	There is pages and pages of them. You can search for them, although I've tried to search for the one I'm in charge of and it didn't come up. The search function is not great, you have to know that they exist in the first place.
Formalisation	consistency improvement	Most of us have similar knowledge and experience, nearly everybody can do nearly all the work.
Formalisation	consistency improvement	nearly everything will involve the manager of the team, he plays a role in reviewing and checking
Formalisation	consistency improvement	here is my proposal, like a drawing, a very high level, and we need to send to another department, who need to cost it up, but at the same time now we would send it to our manager as well
Formalisation	consistency improvement	Now our manager at the start when we do a design, we send a copy to him, because he wants to see everything right at the beginning.
Formalisation	consistency problem	we have arguments already in our team. If her work is reviewed by someone else in the team, who has different opinions or decides to go away from the current methodology, then it creates difference between us.
Formalisation	consistency problem	it's not normal. But it works, because the project managers they have, at least the ones that I worked with are competent.
Formalisation	consistency problem	Some people do everything in email, some do meeting minutes in word, some people use spreadsheets, some people use database, some people have SharePoint. I do think, that's an issue,
Formalisation	consistency problem	you'll see project managers, that manage things totally differently
Formalisation	consistency problem	They used to do it in the past, and then they brought them all together, because what you end up finding is that if there is a design team in Edinburgh, they do it different than the design team in Glasgow.
Formalisation	consistency problem	you don't have consistency, although there is the approval, but you find it that sometimes you can be sitting beside someone and you don't know exactly what they are working on, but they are doing something that's not the way that you would do.
Formalisation	consistency trade-off	then they found that when you centralise it, you lose the local knowledge, so there is advantages and disadvantages.
Formalisation	need for flexibility	Lloyds, Google. These are modern working areas, they seem to be very much the case of younger people centred around it. It's this sort of open working hours and things like that. I'm to work from 8:30 to 4:30 every day, those are my set hours every day, but on this project I work later on in the evenings, so that I can come later on in the morning. That's the way a love to work, and that's the way a lot of people would like to work.
Formalisation	need for formalisation	last week I set objectives for my team, everybody want to come up with 5 new ideas by the end of this year, and everybody has agreed, because nobody wants to comment.
Formalisation	need for formalisation	it's something we've been talking about recently, that we need to do a kind of a formal close out and kind of debrief of the project, particularly with the client, which we are not really doing at the moment.
Formalisation	need for formalisation	some other people from the team I think have got on their objectives to put stuff on the blog.
Formalisation	need for formalisation	The standard procedure now is to send an email to everyone to see, if someone has already done that, or to check on the servers or KM system.
Formalisation	need for formalisation	There is no clear process for managing information that goes on each platform, that's what's really lacking.
Formalisation	need for formalisation	If they scheduled it like every 2 months on Thursday we are gonna have something from 4 to 6, and it's mandatory for you to attend, then we could probably do something about it.
Formalisation	need for formalisation	I've offered a part of this to my colleagues, but I'm pretty sure that it was not taken on board, not because they ignore me, but because there is no formal way of doing that.

Formalisation	need for formalisation	It's much easier to encourage people to do something because they've been ranked on it every day and it's part of their actual job – to make sure that things have been run efficiently.
Formalisation	need for formalisation	There needs to be methods in place, and everyone should be given time to look at those things, have group discussions about it.
Formalisation	need for standardisation	I would find going through these proposals over and over again and I would see that they were missing valuable bits of information that they didn't quite understand, what our role was or what the clients' role was in relationship to the project, or what the actual scope was.
Formalisation	need for standardisation	It's a project plan and it's quite detailed, but it's not a template that you can use. It's specific for that particular customer implementation. Without having the knowledge of that project you have a really hard time of readjusting that, and at then you just end up doing it from scratch on your own.
Formalisation	need for standardisation	there is certain methodology that standardises the engagement, and there is an order of priority to share those resource, there are some tasks that should be done the same way, no matter who the project manager is.
Formalisation	need for standardisation	I would love to see project management teams that have quite well developed standard templates, project plan, delivery processes, contract tracker.
Formalisation	need for standardisation	In most projects some things are very similar, all that documentation is pretty similar
Formalisation	need for standardisation	There are a lot of standard things that you could do. Then it makes it easier to feed lessons learnt into those templates or documents
Formalisation	outdated information problem	a lot of this information is outdated as well
Formalisation	outdated information problem	The network we deal with is constantly changing and individuals don't always make the effort to update those systems.
Formalisation	product development process	we do have a process internally with stage-gates, and I think they are fairly standard
Formalisation	product development process	we have a process for pricing product, we have a process even for doing a new release
Formalisation	redundancy avoidance	We would talk to other companies and see if they were looking into it or considering a project in that particular area. There may be a variation on the theme.
Formalisation	redundancy avoidance	one of the steps to take before the registration is approved is to say – yes, I can demonstrate that the idea is completely new and nobody else is doing it.
Formalisation	redundancy problems	UnionSquare might come back with a very long list of projects with a lot of duplicates, because the way the things are handles is since projects internally are done by different offices from the same project, we have multiple entries in the UnionSquare, that actually represent the same project, the same physical power plant.
Formalisation	redundancy problems	I was trying to delete all the information that wasn't useful, and go through whatever was useful and transfer it to UnionSquare, and I barely did 1% of all the information that's out there.
Formalisation	redundancy problems	There is so much information that needs deleting mostly.
Formalisation	redundancy problems	Anyone can create a page and sometimes you end up with 5 pages that have similar names
Formalisation	redundancy problems	Because no matter what we use monthly, we have a monthly meeting form, that's probably more detailed than the minutes.
Formalisation	redundancy problems	I have already experienced that where I've been confused because we have 3-4 different people in the team all looking at monitoring evaluation of overhead lines, using different technologies and apparently for different reasons. I mean the technology I was working on in my project is to monitor vibration, and I'm thinking, why are we investing in another technology when this one can do, and why are we not.

Formalisation	redundancy problems	So do you think, that it's redundant and it could be replaced just with these meeting minutes or monthly updates? 34:40 probably, yes.
Formalisation	redundancy problems	you have a project, where there is a project manager, but there is no project engineer working with it. And you have a project engineers are doing the project management role as well.
Formalisation	redundancy problems	I have an example of when we actually spent quite a significant time developing an idea only to realise that it was about to get implemented elsewhere as business as usual in our organisation.
Formalisation	redundancy problems	Not within our department, it's impossible, but in the rest of the business it's very possible that sometimes different parts of the business can be looking at the same thing at the same time.
Formalisation	standardisation	we might use a template, trying to recreate part of it for a new project.
Formalisation	standardisation	I put together last night a list for proposals. It's that I found a lot of the graduates were attempting to write a proposal, and when I came to review it, I couldn't see that they really didn't have much idea of what they were trying to build the proposal around. And so I made a check list to say: right, before you start writing a proposal, make sure, you know this, this, this, what's the relationship with the supplier, what the project states
Formalisation	standardisation	I've also done that with the operation monitoring report, because I found, I kept reviewing people's reports and there is no maps, there is no diagram, there is no health and safety section, that sorts of things, that should be standard, so I've done the other check list
Formalisation	standardisation	I've tried to create guidance documents and templates within our team
Formalisation	standardisation	single project, that's fairly standard, we've been working to standardise a proposal for that
Formalisation	standardisation	The basis is replicable and the user templates are very good.
Formalisation	standardisation	I'm focussing at the moment is quality, and a lot of that is about the way we review the report and proposals and things that we prepare for our clients, and also about the templates that we use for those report and making sure that everything is consistent across the company.
Formalisation	standardisation	trying to make sure that all our report and deliverables look similar, and that's where templates come in, but also that they are written in a similar style, and we have a style guide just to make sure that everyone rights in a similar way
Formalisation	standardisation	since it's very standard in the UK, it's almost the same all the time.
Formalisation	standardisation	One of the things was how to capture documentation for new employees and PMs. So the documentation was put together and it's actually great. I just hired somebody and handed it at them, they went through it and it was just perfect.
Formalisation	standardisation	I've got templates that are used for a project, which set up my scope: who is involved, what we are trying to accomplish.
Formalisation	standardisation	He did a design manual, we've got his manual,
Formalisation	standardisation	We have a design manual, that's how to design a transmission network, what connections are allowed, what's not allowed, what sizes of cables you can use.
Formalisation	standardisation	I've spoken with Fraser about before is potentially trying to make a like a golden sample, where you know exactly what the standard should be, a really good example of how to complete one.
Formalisation	standardisation	It's open to interpretation all the time, and you get a different answer, you get a different answer from me from one day to the next.
Formalisation	standardisation	To give you an example, we are doing a project risk register, we will start, not start from scratch, but we would only start from a base of the existing projects and start populating and say, this is a risk, this is a risk, this is a risk. A lot of them are standard, and then it's all subjective,

Formalisation	standardisation	We are talking about standardisation with risk registers, etc. When I've gone to do my second project, I did have a look at my first project and copied that and used that as a base, but again I think, it would be potentially useful.
Formalisation	standardisation	Why, it shouldn't, it should be the same. There are things that are unique to a project, because the projects are unique, but there is a lot of standardisation I think, that we could carry across and make up jobs easier, more effective and more accurate.
Formalisation	standardisation	perhaps procedures and policies – do this, do that, don't do this, don't do that, that's captured quite well
Formalisation	standardisation	we are now standardising wording that would be clearer, but certainly for this project, because it was done 4 years ago, the wording is so ambiguous, sometimes you don't really know, what they meant, what was intended originally.
Formalisation	standardisation	We had a group of people trying to make templates for project management, to help new people who haven't had the training on how to do that
Formalisation	standartisation trade-off	I can set the project up as I see, fit as I see it is appropriate for the particular project, that I'm working on.
Formalisation	standartisation trade-off	we've got 50 lights that we need to roll out, it's often very difficult to drive those processes and frustrating, because you have to carry out steps which really don't make much sense for the project of that size
Formalisation	standartisation trade-off	there has to be some acknowledgement of that in terms of how much they can actually work towards standardising and putting time into there.
Gamification	game elements	If you get an answer and you think it's a good answer, you'll give it a tick, rate it. And then experts can naturally flow to the top, because it's gamified.
Gamification	game elements	So the more answers you get, the more points you get.
Gamification	game elements	in India, when I was there, they had challenges, they were doing some presentations, they had an engineers week and different events, treasure hunt type thing, different charity events, different team-building type events.
Gamification	game elements	It's very award-based, and I think it would work well in the UK, if we were less (not giving it for everything), and also we are quite modest, nobody likes to be in the centre of attention.
Gamification	game elements	sociable atmosphere and getting people praised for what they do in terms of in someone has done a really good job, they have star-awards schemes, which works well, until when I was there pretty much everyone had a star award
Gamification	game elements	We had 2 guys in India who've worked in Hallow, and when they went back they were awarded.
Gamification	rating	The way it works I think is someone asks question, someone provides the answer and you get 5 points. If someone then gives that answer a tick or something, they approve and say, that's a good answer, that's useful. And they get 10 points. And if another person approves it, they get another 5-10.
Ideas management	Ideas collection	And then you learn from the application how to improve the product for that application plus by engaging with the client you learn more about what their real problems are.
Ideas management	Ideas collection	we see things happening in the companies and we get ideas how to deploy technology to make a solution for that.
Ideas management	Ideas collection	Every month or so I get everybody in the room and I say: this is the problem we have, and I would like everybody to have a go, how can you do things differently, which will be more cost-effective or efficient. Then everybody puts their idea and I put my idea and they try to prove whether I'm right or wrong.
Ideas management	Ideas collection	I'm gonna push every 2 weeks now, that everyone should put some ideas to the table.
Ideas management	Ideas collection	we have occasional meetings to discuss product development or new ideas.
Ideas management	Ideas collection	We do have some idea inquiries, but we are not a big company, so we just share them

Ideas management	Ideas collection	If you identify a company, you think has got something that could add to SgurrEnergy or Wood group, you suggest the name, and they'll do investigation and buying.
Ideas management	Ideas collection	We have business development, all of them go to the conference, they'll go and sit and meet some clients.
Ideas management	Ideas collection	Wood group has a seed fund – if you have an idea, you can send to them, and then if it's a good idea, they'll progress it.
Ideas management	Ideas collection	Hackathon is where you prepare and present product ideas and if there is some incentive around, if your idea gets supported within the company, there is some monetary benefit to you around that idea getting it accepted in the company and adopting it, moving it forward.
Ideas management	Ideas collection	it's a group of people that will come together and pitch their ideas, their plans
Ideas management	Ideas collection	I sent a request: guys, I want to pull back a temperature on a meter and put it into a cube. And they'll tell you, don't put it there, there is another way to get this data, and they'll tell you how.
Ideas management	Ideas collection	the company collects new ideas and tracks new requirements and PM requests through Jira.
Ideas management	Ideas collection	They have a little process saying: you pick a product, tell us things you like and things what this product should be. And they will actually award money for doing that for people to improve the product.
Ideas management	Ideas collection	We have challenges and doing our quarterly reviews and monthly updates.
Ideas management	Ideas collection	You can work with product management and give them your ideas.
Ideas management	Ideas collection	A lot of the times they will come to us because the customer says, that this product is good, I wish it could do these other things.
Ideas management	Ideas collection	it really came out from just talking to existing customers about the networking effectiveness, this is where you are getting stuck in taking the next step.
Ideas management	Ideas collection	on the early stages we do work with our project management team a lot, a lot of the times they really know their customers
Ideas management	Ideas collection	We'll talk to customer support engineering and sales, they are tuned to a lot of customers.
Ideas management	Ideas collection	they quite often say: if you've got ideas on new projects, then speak to us. They collect ideas from the business, but it's just an informal way.
Ideas management	Ideas collection	we've got a lot of stuff to do from academics and universities, approaching us and saying: we are working on this; do you have any interest in being involved? So we get ideas from quite a range of places.
Ideas management	Ideas collection	you come up with the smallish idea, then you could do a licence to innovate, if it's slightly large and needs more help, then you come to my team, the future networks, and we develop it into a large solution
Ideas management	Ideas collection	I think, if someone comes up with an idea, we'll say, wow, that's interesting, we'll look into it. And then we help develop that into what project it could be, then we decide whether to do it or not. So there is not like a big pool of projects we pick up from.
Ideas management	Ideas collection	it's two completely separate processes, both for innovation and there is a little bit of an overlap there.
Ideas management	Ideas collection	something called license to innovate. So that is the process that has got all the businesses. If you come up with the good idea, you capture it and you manage to validate it, and then they give you the time to develop that.
Ideas management	Ideas collection	We try to hold at least once a year a workshop with the transmission business and ask them what are their problems, what are they concerned about that we could do something about, or have they got any ideas
Ideas management	Ideas collection	I'm involved in a lot of conferences, essentially what we do, we've just had one, a really-really big one in November, and from that we took something like 60 ideas

Ideas management	Ideas collection	each group would have a theme, so it could be environmental concerns or reducing losses on the transmission network
Ideas management	Ideas collection	I can click, and do the rating
Ideas management	Ideas collection	I'm sending them out an email, and I say: "what did you see that we should be copying essentially?"
Ideas management	Ideas collection	it was just 1 A4 page, just what your idea was, and if they thought it sounded good, they give you a licence to innovate, which basically meant, you could take 2 days to develop that idea and if you needed some budget, there was some budget available
Ideas management	Ideas collection	There is a License to Innovate scheme
Ideas management	Ideas collection	there is no shortage
Ideas management	Ideas collection	we had a workshop day, where we invited basically like operational stuff and managers from transmission and distribution into like a day-long workshop and basically asked high level questions, we split them into groups
Ideas management	Ideas collection	we had policy of different expertise in each group. And they brainstormed for ideas. So that data also created a list of I guess fresh ideas that we were just approaching from other angles
Ideas management	Ideas collection	You also can comment
Ideas management	Ideas collection	In transmission we were doing a workshop every year, like a brainstorming session to try and extract ideas out of people in the business, that's the period when we also go to the rejected ideas and look at them and see whether we can revive them.
Ideas management	Ideas collection	There's been a couple of brainstorming sessions.
Ideas management	Ideas collection	They (managers) go to an MBA course, which is run by the University of Strathclyde and as a part of it, they do a session on innovation, which is hosted by Weir and Strathclyde. We normally get involved in that and put forward challenges that try to keep people open.
Ideas management	Ideas collection	an opinion box. The continuous improvement team will collect information from the box, which all the employees can write on the suggestion card and place it there.
Ideas management	Ideas collection platform	other one is called the innovation centre, it's an innovation spot, where people can post up ideas and other people can go and comment on those ideas.
Ideas management	Ideas collection platform	that was on our intraweb, our internal website. There was a little link to click for innovation and then just a form
Ideas management	Ideas collection platform	that (internal competition) will be our own through the intranet site, maybe using another software, we have to make a decision.
Ideas management	Ideas collection platform	We are using the company called 9sigma, who have developed a network of solvers.
Ideas management	Ideas collection platform	Anthony is looking to develop right now, more formal process of the open innovation and to share ideas
Ideas management	Ideas collection platform	He is developing an open innovation platform to share ideas internally and also set challenges that anyone can come along, based on around the problems as a business, where people can come and drop emails to him, say: look I've got these issues, can we look it up?
Ideas management	Ideas collection platform	that's what Anthony is doing with 9sigma, looking at different ways to bring the whole group into there and share ideas.
Ideas management	Ideas collection problem	the team will go, walk away in the field you know every now and then, you know, speaking to customers, that kind of thing, but 90% of the time we are in an office at a desk
Ideas management	Ideas collection problem	we are not on ground every day to see things that could be changed, that could be improved
Ideas management	ideas collection results	my understanding is that some of the products that we are coming out with came from previous Hackathons.

Ideas management	ideas collection results	It seems to me, that it worked quite well, and they seemed to add up the savings over the year into hundreds or millions of pounds of saving from lots of small ideas.
Ideas management	ideas collection results	One of the winning ideas was like a thing that you could carry 6 cups on, so that you like could carry 6 cups when you are going downstairs, because they noticed that in Perth a lot of people were carrying like 2 or even 3 and trying to balance their coffee-cups.
Ideas management	ideas collection results	competitions for employees to improve processes and then reward them accordingly, they found great financial rewards from those practices.
Ideas management	ideas collection results	that would be quite a proud thing for the employee, because they could say: yes, my idea contributed to so much more sales, and as a result, I got this reward.
Ideas management	ideas collection results	They would have a suggestion box and have a reward – a holiday or a car, for the best suggestion that gains the greatest financial reward. And they'd measure it when they release these results
Ideas management	ideas collection visibility	I used it for Hackathon updates just to share their ideas with people
Ideas management	ideas collection visibility	once we've done something which gives a difference, they will update results on the meeting, like a quarterly meeting for the company. They will show, what it was like before, and how it became after.
Ideas management	ideas collection visibility problems	they seem to not publicise much about what the outcomes are. So it'd be interesting to have more visibility about what comes out of it.
Ideas management	ideas competition	We have challenges and doing our quarterly reviews and monthly updates. They have a little process saying: you pick a product, tell us things you like and things what this product should be. And they will actually award money for doing that for people to improve the product.
Ideas management	ideas competition	for external one I think it will be much more limited, because we don't expect people to have that basic knowledge
Ideas management	ideas competition	just getting them think outside the box was really good.
Ideas management	ideas competition	Then it's really valuable, we do test out a Beta-product instead of just watching it without more testing. And it's better testing, more creative, more fun than just trying to write some key test cases.
Ideas management	ideas competition	We did an internal Hackathon. That was more around our core products, because it was easier for people to play with something tangible, but that was fun, a lot of people did come up with lots of good ideas, including ones that were completely different from what the company does.
Ideas management	ideas competition	We try to do internal ones once a year. But if there is a new product coming out, that we actually want people to test, we might wait a few extra months, so that it's a better version and is ready to use as part of a Hackathon.
Ideas management	ideas competition	We try to keep it fairly open for internal, because within the company we know that our employees understand the product pretty well, we don't want to constrain them too much
Ideas management	ideas competition	we will be doing more Hackathon that involves outside parties.
Ideas management	ideas competition	And that was to take the people and all the teams to pick up the ideas on what they could do with the products in developing them and various other things.
Ideas management	ideas competition	my understanding is that some of the products that we are coming out with came from previous Hackathons.
Ideas management	ideas competition	that was put out there by the executive team to encourage that people work in teams, they don't necessarily even have to sit in the same office. And what they are trying to do is come up with new uses.
Ideas management	ideas competition	We are looking at use of Yammer, and we were exploring the idea within Yammer of actually trying to capture ideas and have some sort of incentive mechanism there for people to come forward with ideas.

Ideas management	ideas competition	one of my objectives as a project manager, I have to go and find fast followers, which is basically one of these NIA projects that another operator has completed, that they then went out and installed in the network, or that they are going to install in the network and gain a million pounds benefit. I should be able to pick up from their knowledge and see, if we could save 2 mln pounds or half a mln pounds, and prepare a business case and submit that.
Ideas management	ideas competition	one of them was about getting our safety
Ideas management	ideas competition	the challenge in whole sales is a 1.1 bln profit in the next 5 years
Ideas management	ideas competition	they used to do these challenges
Ideas management	ideas competition	A lot of the challenges are varying processes, some in manufacturing, some in communication. We are trying to move them into groups and see, which ones we can take out, because they are almost the same with each other, because one part of the company has got almost the same problem as another.
Ideas management	ideas competition	about 5 challenges at time is a good number, there is enough variety, but there is also not too much information.
Ideas management	ideas competition	So we are looking for broad challenges, that we can actually find out solutions to, not just what we can do
Ideas management	ideas competition	We are also able to invite people in Weir to join that community and to look at challenges themselves.
Ideas management	ideas competition	we are also planning to launch some non-technical challenges in Weir, the challenges to do with process efficiency, marketing strategies or around employee engagement.
Ideas management	ideas competition	We have a group strategy, which has 4 themes, we are addressing each of the 4 themes in each of the challenges (top-down strategic challenges), and we are also picking up a bottom-up challenge for anyone in the Weir group to put forward a challenge that they see in their day-to-day life, maybe something that they see coming in the future.
Ideas management	ideas competition	We've got 2 million solvers, who we can just post a challenge to. And then 2 million people will be able to see that challenge immediately. And if it's of interest, they can post a solution.
Ideas management	ideas competition	I used to work with another company and it was fairly well managed, these types of initiatives. They used to hold competitions for employees to improve processes and then reward them accordingly, they found great financial rewards from those practices.
Ideas management	ideas competition	set challenges that anyone can come along, based on around the problems as a business
Ideas management	ideas competition	setting challenges for people internally and externally to solve problems, hopefully will push them more towards it. I think it would be a really good platform outside the older generation.
Ideas management	ideas competition problem	The company has thought about launching it a couple of years ago and it got turned down by the IP lawyer.
Ideas management	ideas competition problem	these initiatives are looking in the future, but if you go to our engineering team, guys in their 40-50s, and try to encourage them do things like this, they just won't do it.
Ideas management	ideas filtering	Some of the ideas you have to try them to see if there is any value in it, any demand for it in the market, how this idea will differentiate us from other competitors, will it generate any revenue for us and for the client, how this idea can be turned into a ready product, if it's a product driven idea. What is the time limit to do it, do we need to do any labwork, and how long it takes to do it.
Ideas management	ideas filtering	we see, which ones we can follow, which ones we are allowed to follow.
Ideas management	ideas filtering	A lot of the times you'll find small things that we might want to be implemented, what they do is they look at what is the contract requirement, is there a financial loss that we don't meet the requirement?

Ideas management	ideas filtering	Then we look at: hey, this request is coming in from 50 customers, it might be not violating the contract, but if 50 customers are asking for it, then that should really be implemented.
Ideas management	ideas filtering	They do do an evaluation of contract requirements, financial impact, customer impact and things that are nice to have, but we can't afford it.
Ideas management	ideas filtering	first we look at what's the core purpose of this product, what other things we need to do to achieve that, and there will be a list of features and the list of things that people see as well as the formats for software.
Ideas management	ideas filtering	I will then ask our internal consulting teams how we can work with market pricing and value preposition, because we want to make sure that there will be some market for it, and have an idea what people would actually pay for it. A lot of the times our customer will be interested in something, but they actually don't want to spend any money on it.
Ideas management	ideas filtering	we'll look at them depending on where we want to be in the market, whether we want it to be a complementary product, which we may want to give away for free as a part of promotional sales.
Ideas management	ideas filtering	last year we bid 3 project and successfully secured 2 of them. That was more funding than anyone else.
Ideas management	ideas filtering	a relatively short 2 page business case for it, and then there is someone in transmission that is responsible for assessing that
Ideas management	ideas filtering	once we've got the idea, it's bit more of a process to then capture, what that idea is and then go through I think, that's a kind of basic scoring of that, and then go through a gate 0 and a gate 1 to decide, whether it's worthwhile pursuing it
Ideas management	ideas filtering	we've always got enough funding to cover everything we want to do. So it's not that we have to make comparative choices, that we do, that both are good projects, but we can only do one of them.
Ideas management	ideas filtering	I suspect, a few of those may have made on to that kind of potential project index, and some of them would have just been nonsense
Ideas management	ideas filtering	I think, we are quite good at looking at something and saying, you know, whether we should implement it
Ideas management	ideas filtering	then we start to categorise them. So my role is categorising, allocated to relevant areas, so high voltage, low voltage, but then you put it against TRL (technology readiness level) and then we start with quite a large list, that then goes above my edge to the innovation steering board, and they do a sense check on it and filter it, I suppose, they've got more knowledge of things, that we've tried before or things, because our network is quite different, all networks are different from each other, so there might be just something that won't make sense in our areas, so they pick a couple they see as being a good idea at a very high level. It comes back to me then and it goes
Ideas management	ideas filtering	if 2 ideas are probably of the same magnitude of business case, then we'll do them concurrently.
Ideas management	ideas filtering	If I get an idea, the first thing I would do is to create a synopsis of the ideas and within that synopsis one very important thing is the outline business case for the idea, because everything we do has to have a business case, and it has to be one for our business and for the energy industry
Ideas management	ideas filtering	Once that synopsis is taken a reasonable structure, someone has to read it and makes sense of what you are actually trying to achieve. Then it goes to the Future Networks Responsible manager, this is the person who has got an initial view of the idea and who gives gate 0 approval. He could also say that the outlined business case doesn't stand up with the business objectives that could happen as well.
Ideas management	ideas filtering	We have a group within Weir Group, formed by executive level people, some are doing technology, some are doing business. They form a committee that will review that report, and then it will go to the directors.
Ideas management	ideas filtering problem	We are not very systematic, and I wish we were, I wish we had a stage here and there, we tried it, but it takes so much time in a small company, that we can't do it
Ideas management	ideas filtering problem	It should be strategy, road maps, evaluation. There should be an evaluation of all the ideas based on criteria.

Ideas management	ideas filtering problem	Somebody comes with an idea here and he goes all the way, there is loads of them. How do they fit in within the overall data management and data analytical strategy? Nobody has got a clue. Nobody has built a metric's to integrate all the potential into one area.
Ideas management	ideas filtering problem	There is a possibility to do this evaluation, but it's not done currently. There are little bubbles of projects within the business that don't talk to each other. They are stuck in their own bubble, because they've got to deliver that as their goal.
Ideas management	ideas filtering problem	Was there any matrix of criteria, based on which they were making the decisions? 54:50 No, I don't think so
Ideas management	ideas implementation	they pull all those requests and then they look at them, does this make sense, is there something that we can implement now. Our product team does have a formal process to do that.
Ideas management	ideas implementation	the ideas that people have come up with might be a part of their MBA, they then do a project on implementing their idea into the business
Ideas management	ideas implementation problem	I've got the greenlight from my leader to do any improvements to this sort of templates to develop tools of my own if I want as long as it's useful and as long as I still do my work, which means unfortunately that there is no time allocated for you to do this, you do it in your spare time, in your spare hours or if we are relatively quiet, which hasn't happened for 2 years.
Ideas management	ideas implementation problem	They come with project, and within the project they've got a data analytical requirement. So they go away and they need this pilot data: ooo, I can't get it. They do all the work around, and then mainly create the data, because they are only within a proof of concept area. They manually get the data they need and go away and do the project. But that's not enduring solution.
Ideas management	ideas implementation problem	the big problem with that scheme was, if your idea was a good one, and they said: "yes, go for it!" The person assigned to lead that innovation was the person who had come up with an idea
Ideas management	ideas implementation problem	You ended up with sort of a lot of ideas which I think never progressed, just because somebody had a great idea, but they weren't the best to bring it on
Ideas management	ideas implementation problem	if you are trained to do things in a certain way, with the new way you need to learn something completely new, and it will cause problems, that's why change is quite a problematic thing for us, getting people to accept change and accept people to use more innovative things.
Ideas management	ideas implementation problem	the bigger challenge has been us developing a technology or an idea to something that can be used by the business and finding it difficult to get it accepted by the business because of issues with change.
Ideas management	ideas implementation problem	what then happens is that the person that accepts an idea or says, yes we want this technology might not be the same person who actually uses it physically on sight.
Ideas management	ideas implementation problem	a lot of people (MBA) have come up with the solution, e.g. condition monitoring, putting sensors on equipment. But this is something that we already do in some parts of the business that are leading
Ideas management	ideas implementation problem	a lot of the times it falls flat in its face (MBA ideas), people have implemented it to a certain extend or they found a barrier and can't overcome it
Ideas management	ideas implementation problem	There is a lot of ideas and not a lot of room for implementing them.
Ideas management	ideas sharing	I would talk with the technical manager that the company has.
Ideas management	ideas sharing	you put a 1 page business case of why it's a good idea and how much time you need to develop it, maybe what other resources you might need. And that can go straight to one of the founders of Sgurr, and he will decide, if it's worth pursuing and if it's worth investing you at the time to develop that.
Ideas management	ideas sharing	I would usually speak to my line manager first and few other managers in Glasgow, put everyone in the loop in a form of email.

Ideas management	ideas sharing	that's a kind of what we are trying to do a little bit with Yammer. That's happening in a few places independently. I have a group of people called Technical Excellence Champions from around the company. And when we set up Yammer, that was focus on that group, trying to share ideas and me trying to get input from them on things that I was trying to do. That is happening but it's limited.
Ideas management	ideas sharing	we talk to clients all the time and know what they are interested in. And typically between the two of us we'll run it past the people in the Australian team and then we would get the idea where to take that.
Ideas management	ideas sharing	If I had an idea, which I have not, I would probably just suggest it to my line manager and then if she thought it was worthwhile I guess she would probably ask to put it on the list, so on the potential project matrix, but without, I suppose before you get on to the potential project matrix
Ideas management	ideas sharing	People do share ideas, but it's very much a personal thing.
Ideas management	ideas source	software products should be pretty solid, customers report to us a lot of the bugs, and we have to deal with them, and we end up creating a lot of work around.
Ideas management	ideas source	They just look across the business at different topics and try and identify pieces of work that they think have an innovation element, that then they can make the excuse, that you could fund it as innovation funding, rather than just doing the work anyway
Ideas management	ideas source	they will listen to researchers or vendors of new products or services, people will come to our company like SPEN and say: we have this idea, would you like to try it in an innovation funded project
Ideas management	ideas source	They will look at what other people are doing and trying to say whether they are trying to do something related to that,
Ideas management	ideas source	they come back with what potential companies out there could offer and then that goes to the forum and various companies would comment on what's been offered, whether they think it's good or any reservations that they have, and they would then come back to the company and try to address those concerns.
Ideas management	ideas source	We work with Energy Innovation Centre and we identify problem statements – issues that we have. Then EIC goes to the market looking at who might be out there, particularly around SME to see what they could potentially offer.
Ideas management	ideas source	Within the business: a business need, from operational engineers; or from outside of the industry.
Ideas management	ideas source	an idea can come from anywhere: it can come from the university, suggesting something or supplier, or just someone who has been to the conference and seen something interesting. It can be somebody internally, just identifying that there was a problem with something, can we come with some sort of solutions.
Ideas management	ideas source	the guys that are on the substations 24/7, I'm sure, they have ideas
Ideas management	ideas source	we always look at what we did well, what we didn't do so well, what we could improve. In some cases we probably end up registering follow on projects simply to try and address some of the challenges identified within the initial project, that's why we end up with phase 2 of the projects and maybe improve on the learning that would have got in the 1st phase
Ideas management	ideas source	we have a process of gates, which (1) idea being stumbled upon, being suggested at the meeting, and idea could come from anywhere, it could be through looking on the internet and seeing an interesting story, which talks about the technology, or as what happened just a couple of days ago, when I was in the South of Glasgow on a sight activity. Someone mentioned something: we've just built a line for this particular organisation and this has got this particular feature in it.
Ideas management	ideas source	the plan of how we launch a program with a number of different streams, all focused around collaborative innovation within the company, but also with suppliers, customers and entrepreneurs, inventors, academics and SMEs.

Ideas management	ideas source	We've got 2 million solvers, who we can just post a challenge to. And then 2 million people will be able to see that challenge immediately. And if it's of interest, they can post a solution.
Ideas management	ideas source	It was reverse engineering.
Ideas management	ideas source	the guys in Oil&Gas wanted to expand it further, so I've been working with a couple of them on the project I'm doing, and they've approached me, and I took it to Anthony, who is putting it now to the open innovation global scale.
Ideas management	ideas source	at the beginning of the technology scouting phase. I'm collecting information across this market: looking at technology and opportunities or threats.
Ideas management	ideas source	I'm trying to look at different resources; websites, journals, magazines, conference, to see what might be relevant.
Ideas management	ideas source	Sometimes external expertise will come to our factory and try to explore some of the things that we can improve on.
Ideas management	ideas source	sometimes the managers are going around, what we call a gamble walk, they start look around the factory and try to see what places need to be improved.
Ideas management	ideas storing	we are working of excel sheets
Ideas management	ideas storing	We have a massive repository of these things from all the projects that are registered, the live projects, the close projects, the rejected projects and the ideas. We have a structure.
Ideas management	ideas storing	we will be going into the SharePoint very soon, but it's like an internal network drive, which everyone within the department has access to.
Ideas management	ideas storing	we had a project hopper: some of the ideas were just thrown out and forgotten. Some ideas were put on hold for a certain amount of time.
Ideas management	innovation barriers	it also brings competition into others, because when we created some opportunities, our client might say: we can ask somebody else to do the same thing for us. It can destroy that part.
Ideas management	innovation barriers	Do you think that the focus on process improvement damages the innovation potential of the company? 12:18 I think it did.
Ideas management	innovation barriers	In the last 2-3 years we are moving into the innovative mindset, but it's a big change. Probably the fact the process efficiency is so ingrained in the culture, it makes it difficult.
Ideas management	innovation barriers	Probably because if someone has got an accountability for lean and process efficiency, they've got to justify the salary by reducing costs by the amount, whereas in innovation it can take 4-5 years before an idea comes to creation.
Ideas management	innovation barriers	Weir Group is pushing very much into innovation, but if you speak to the majority of people across the group, they won't have any knowledge of what's actually going on.
Ideas management	innovation integration problem	people do not change that easily, especially in the oil&gas industry. For example, certain design that was designed 50 years ago, is still the same.
Ideas management	innovation integration problem	So where we started as a project we were too ahead, too outside of the business as usual norm.
Ideas management	innovation integration problem	They come up with business learnings and they just make a glossy brochure and send it to people, but then what? There is no enduring solution coming up about innovations.
Ideas management	innovative thinking	I look at the innovation side, why we are doing this thing and why can't we do others. It creates opportunities to sell our product

Ideas management	innovative thinking	we are trying to educate next generation to take our ideas and expand them and improve them, and this is how it works: if no one gives an idea, it becomes stagnant, and that's it.
Ideas management	innovative thinking	We are trying to push the way of thinking
Ideas management	innovative thinking	What is a challenge for us is a 3T solution: we have teach, we have to tailor (adjust to your own environment) and we have to take control.
Ideas management	rejected ideas	So sometimes we damp the ideas. Sometimes we record the ideas, sometimes I get the scratch and put somewhere in the presentation, and then every now and then we just go back and say: these are the ideas, is the time right to look at it?
Ideas management	rejected ideas	It can be so, if it's modified, we keep it in mind, try to improve it.
Ideas management	rejected ideas	If there is anything that we think is worth considering, we'll just leave under considerations until we decide that it's either happening or not.
Ideas management	rejected ideas	sometimes if it's a brand-new thing, you don't always know the answer and it can be worth trying at least going down the initial steps.
Ideas management	rejected ideas	usually features that you reject, we usually don't revisit those, because usually the reason is: we'll reject it because it just won't work, because it's not worth the time or it's something that we think is gonna be stale.
Ideas management	rejected ideas	We started doing a process where we track product feature requests and that is usually for features that you come across mostly from the project managers. Otherwise I keep a log roadmap for my product.
Ideas management	rejected ideas	there is a pile of "no" projects, we kind of keep, we might look into them in the future
Ideas management	rejected ideas	things just disappear off the excel sheet and if it were something that you'd keep an eye on, you could then go back, we have like basically another folder, which is, you know, rejected ideas
Ideas management	rejected ideas	Some ideas were put on hold for a certain amount of time. Maybe it would be because we couldn't find a partner or maybe it would be a specific technology that we were developing, sometimes we just didn't have enough budget to do all the projects, sometimes we just didn't understand the application well enough.
Ideas management	revisiting rejected ideas	we might revisit it later on or it might give us valuable learning into another project.
Ideas management	revisiting rejected ideas	they are all documented in case something changes, yes. But more or less we are not.
Ideas management	revisiting rejected ideas	it mostly happens, that an idea that we've rejected before, gets back on the list
Ideas management	revisiting rejected ideas	one of our current projects that is very interesting was rejected initially, and it was lying in the rejected status for almost a year before we revisited it.
Ideas management	revisiting rejected ideas	that's the period when we also go to the rejected ideas and look at them and see whether we can revive them. We do it almost as a routine exercise, but it also happens that sometimes we review an idea just because something happened.
Ideas management	revisiting rejected ideas	There are several reasons why the idea might be revisited: it may be due to the change in knowledge about the subject matter or change in circumstances in terms of business case or change in regulations… If something unforeseen happens, which forces to address that particular challenge, your innovation strategy changes.
KM	intrinsic knowledge	how to build a car, so that you can train someone to do that task, whereas it's a lot harder for an engineering consulatancy, because there is so much about what skills you need to write a proposal. What type of proposal is it, doing task A. The only way to know that is through experience.
KM	intrinsic knowledge	It's to some extend inside the head of our manager and ourselves
KM	intrinsic knowledge	whom you would identify with particular topics. It's not written down
KM	intrinsic knowledge	A lot of it comes down to experience.

KM	intrinsic knowledge	it's not like there is a document that says that him or her does this, for some reason we just know.
KM	KM barrier	that's something that we need try and work out, how we assess people performance so that it's not just on the project work, but it's something that we need to do and try and get everyone involved in that. Because at the moment, I don't think that it's really valued and people are worried about spending too much time on stuff that isn't chargeable because they think, that it will be seen as just wasting time.
KM	KM evaluation	If we feel that this is improving, it will probably be implemented, it will probably be considered success.
KM	KM evaluation	it's gonna be on a subjective basis, seeing if it proves useful, easy to access.
KM	KM evaluation	no measure going on so far
KMS	document repository	So wikis and forums is something that we'll do, but I think, what it is at the moment, is we really want them just to engage in the SharePoint library to upload the knowledge and learning and documentation before we start pushing other tools at them.
KM	KM problems	We do get lots of nice speeches about how we should always try to strive for better, discover new ways of doing things, keep on pushing on new things. But at the end of the day nobody is giving any budget or time to do it. If something gets done, it's because people are trying to push it their own way, and eventually it gets through.
KM	KM problems	I always find it frustrating doing the same thing over and over again.
KM	KM problems	We seem to have a lot of issues completing them in the right level of details with the right wording and having actually the right information in there.
KM	KM problems	We seem to have a lot of issues with our knowledge and capture, learning plans,
KM	KM problems	the moment the main knowledge is captured at the end of a project is in a close-down research, which is first of all too high level, because it goes externally. So we sanitise everything, that will go out. We don't provide enough information in my view in that output report.
KM	knowledge themes	But what we do is really catalogues and categorise all our knowledge and learning by this innovation themes.
KM	knowledge themes	we're pulling all that central, we've got a central repository about that particular innovation topic, so that's where we are using, we are hoping, well, we are gonna use SharePoint for.
KM	KPI	some other people from the team I think have got on their objectives to put stuff on the blog.
KM	KPI	Generally people have objectives when we are evaluating their performance for appraisal, and it's very much based on chargeable work and not focused enough on: you need to do this piece of research or contribute that much knowledge to the knowledge pool.
KM	apprentiseship	the senior engineers should be feeding information down to technicians and engineers, because everyone should be able to do everyone else's job.
KM	need for KM	When we provide advice, it's good to keep the underlying data to organise the analysis etc. It's really the core, it should be at the centre of the business of KM.
KM	need for KM	also to be able to communicate between the group, so that when they are asking a question, e.g. about a capital cost of an offshore wind project, the person that actually knows about that and has all the data to hand is here, but there is a tendency for people just to ask people around.
KM	need for KM	certainly it has taken us a lot of time as a company to appreciate the importance of KM and setting up those systems. Once they are set up and everyone sits in, they'll save everyone a lot of time, because they'll stop people from searching for the same information again and again. Because if it's all just there hopefully and much easier for everyone to access.
KM	need for KM	it's also on the content side, trying to make sure that everyone has access to the same information, so that if we are benchmarking it comparing with other projects, then everyone in the company has the same info to compare to.

KM	need for KM	I would love if just once in a while I just got a free week to do as much research as I can. I think, it's important as well, because it pushes the employees into doing something new and exciting,
KM	need for KM	it relies a lot on people's knowledge and expertise and their ability to do things in a smart way.
KM	need for KM	it's really important that we are demonstrating to folks from Ofgem and other DNOs, we are producing the knowledge and learning
KM	need for KM	And in that one then we show, that we are getting a really big return on the investments that are Ofgem made
KM	need for KM	to come along to our stand, see something and say: "wow, that's brilliant, we could do that."
KM	need for KM	you must show all your learning
KM	need for KM	you must show-case all the projects which have closed down since the previous projects, since the previous conference
KM	purpose of KM	to try and collect what's in people's heads as much as possible and make that available and findable for the people.
KM	purpose of KM	KM is all about facilitating training and capturing skills and making them available to other people. I guess, the way the engineering consultancies work is you acquire someone who already has the skills.
KM	purpose of KM	If knowledge is retained, so we have a growing knowledge base, for example, when senior staff quit the company or move on, the knowledge stays within the company
KM	purpose of KM	to be able to access an organised information, so that people who are the staff of the company can access it easily, can make sense of it, analyse it and then improve the quality of the reports
KM	purpose of KM	to improve business development, e.g. keep a good knowledge of track record and achievements of the company; then it is easier to present this track record to the potential client with specific geographic criteria or assignment criteria
KM	purpose of KM	making sure that information that is useful to everyone within your team is shared in the place where you can all easily access it, that it's well organised, that the people who contribute to it don't put unnecessary information.
KM	purpose of KM	KM I think is important to delivering our business in the best way, doing it more cost-effectively and more efficiently
KM	purpose of KM	couching in terms of people to actually understand. I think that's key, because you are not going to get buying from people unless they understand what the message is.
KM	purpose of KM	How you present things is very important, getting feedback from people as well to see actually: do you understand what we are trying to achieve here.
KM	purpose of KM	It's also about getting the information across correctly
KM	purpose of KM	learning and listening to others , what their concerns might be, it's dissemination of information, it's storing information as well, maintaining and reporting on information.
KM	purpose of KM	trying to consider a range of use, because it's difficult to please everyone.
KM	purpose of KM	What could make the difference? What could give us the best return on our effort? We could find our resource, but where should we focus our activity on.
KM	purpose of KM	Capture and disseminate.
KM	purpose of KM	Dissemination and reuse
KM	purpose of KM	Learning capture plans and that stuff across all the project. I sensor the work instruction. And also to do with discretionary work for.
KM	purpose of KM	Sort of knowledge management strategy and putting together employees.
KM	purpose of KM	we are trying to identify subject matter experts for each innovation theme, producing stakeholder engagement plan, customer engagement, if required, and then reviewing the outputs and that sort of stuff through to dissemination, signing off with subject matter experts.

KM	purpose of KM	successfully capture, retain and share the learning from something
KM	purpose of KM	capturing and disseminating, and probably storing for future.
KM	purpose of KM	capturing what that knowledge is and getting it to the right people.
KM	purpose of KM	how to best store and index and final thing, you can easily access to bits of knowledge in the future
KM	purpose of KM	the first thing is being better at capturing knowledge in something that is useful and meaningful
KM	purpose of KM	The whole point of everything we do in innovation is basically to create knowledge, that's the output of everything. So I completely agree, that knowledge management is, is key to everything that we do,
KM	purpose of KM	Then it's being more proactive about sharing it. So spending time identifying who that knowledge needs to get too, both internally and externally, and how to communicate that
KM	purpose of KM	knowledge management, so for making sure that we have a plan for dissemination
KM	purpose of KM	how you can keep that knowledge and understanding that we shouldn't do this, how do you make known to others who might be affected trying to do the same thing, and how do you make it easily accessible to any interested parties
KM	purpose of KM	it's about making sure that knowledge is captured, retained, passed on and is retrievable
KM	SME KM	because we were small enough and we could just go and talk to other people.
KM	SME KM	When we were almost all in Glasgow, then if you didn't know about something you just wandered across the desk to a person.
KM	top-down push	We found a few new people at senior level coming to the business. Maybe when these new people have come in, they started asking, if you are working with valve business, why are you not working together?
KMS	blog	Sometimes if we have something, we just use a twitter account
KMS	blog	Petrofac do have 2 types of internet: open to public and internal. They have blogs
KMS	blog	some other people from the team I think have got on their objectives to put stuff on the blog.
KMS	blog	In Wood group I have access to their internal SharePoint system. It's more about improving methodologies for some of the stuff they did, and they have various pages that people post up on, just doing some subsea cable work and found out that this is a better way of doing it.
KMS	blog	Presumably every now and then somebody puts something new on that blog and marketing team presumably go out and ask if anyone has something interesting to write on that blog.
KMS	blog	This is something that marketing team run I think. I'm aware of it, but I couldn't tell you what was on there or very much about it, and it doesn't surprise me that no one has heard about it.
KMS	blog	about whatever meetings they've been too or new developments in the company
KMS	blog	little news
KMS	blog	the thing that I like the most is actually this blog. And this is basically our CEO, he has a blog
KMS	blog	safety blog, the only difference is that there are only certain people who can post on the blog, the rest of the company can comment on blog posting, that's another thing that I know, but it's all corporately managed.
KMS	blog	for a new website that we've developed, we are getting about 15 000 people viewing it externally.
KMS	blog	have access to the information about what we are trying to develop, so that when it comes time, they will know: oh, actually we could do with this system in our place.
KMS	blog	I tend to find people commenting are based in India and Dubai, they are much more happy to comment, whereas in UK we just don't want to show that we are interested.
KMS	blog	I'm trying to get people excited about what we are doing and where it is going before we have to go and approach them.
KMS	blog	I've written some blogs as well for this project
KMS	blog	Most blogs that are viewed are video blogs.

KMS	blog	Once it's announced it will be on the webpage, Facebook, everywhere.
KMS	blog	The blogs, I'm trying to use them in a more of a sociable way than what you get from CEOs, knowledge sharing rather than CEO giving motivation speech.
KMS	blog	They might understand that we are doing mechatronics, but they don't know what we are trying to use it for. I've encouraged people from the team to use it now, let everybody know, let everyone across the globe
KMS	blog	up until now they are very much blogs from the CEO, CFO, MDs from different divisions, giving the ideas what's happening at the quarters
KMS	blog	We have various different Weir accounts (LinkedIn), where you can access and get more information.
KMS	blog	What I'm doing at the moment will be internal, because we are not publicly announcing it yet, because we are pilot test.
KMS	blog problems	we found that people we deal with, they are not very much into that, they are more into serious kind of information thereafter.
KMS	blog problems	But what I noticed was that actually I don't know how often people read it, but they only got posts only once every 3 months, and it was the same people all the time, it was only used by a very small number of people.
KMS	blog problems	And it could be used a lot more for: here is the project that I'm working on, really interested in it.
KMS	blog problems	But most of the comments are just: what a great idea…
KMS	blog problems	We have internal blogs, I don't agree how they are used particularly
KMS	chat	using Skype for Business as a second layer of escalation
KMS	chat	Yes (they use a lot)
KMS	chat	We also have a messenger thing Link. People use that quite a bit, and you can video chat if you want to.
KMS	chat	It's just the messenger that we use for communicating something, rather than using emails or phone calls.
KMS	chat	We've started using Skype for Business
KMS	chat	I used LinkedIn to contact people, but that tends to be the younger guys. If it's senior staff, I email them or use chat.
KMS	communication technology	we are looking a global technology base to work of, whereas before you had to have specialists across the table from you, we can now bring specialists all over the world.
KMS	CRM	CRM, I think, that's for managing stakeholder relationships, that's just been rolled out
KMS	CRM	We've worked with company that the previous business unit fell out with it, and we have started working with the same company, but we've just found ways around that by coordinating their resources
KMS	CRM system	We have our own database which includes contact database, we retain the contact details of the people that we engage with or meet them, that are worth adding into the database.
KMS	CRM system	you can actually add: I spoke to the client of Thursday, he wasn't very happy bla bla bla. In a month time you can look back, because otherwise you are searching your emails and the client goes – I never said that. So it's like Customer Relationship Management database.
KMS	CRM system	we do have a customer relationship management system (CRM), but that's not yet populated with stakeholder information.
KMS	CRM system	This system is used to store the information about customers involved in projects and their properties and the equipment that we installed, but it doesn't practically capture all the stakeholders that we engage with.
KMS	CRM system	you specifically have an expert sheet where we have the stakeholders that are in, and then we would identify what types of outputs they would be most interested in, then try and share these findings with them.

KMS	CRM system problem	it's broken down by offices, so you might have a big company like Siemens, and you might have the Netherlands office and the German office, and the London office and the other London office, and the New York office, and you need to review each one of those separately in order to see the history.
KMS	CRM system problem	That tends to be mainly done through people's email or through individual excel files. So there is a plan to try and bring it together so that we can have a central stakeholder database.
KMS	CRM system problem	it would be useful to follow that list, but list wouldn't actually tell it all.
KMS	CRM system problem	That (partners' database) could be useful, but that could be also quite confidential, because if that list had to get out with all the contractors that we are working with, you can imagine that there is a bit of an IP issue over there.
KMS	CSN	it's much more flexible for things like forums and suggestions and ideas, than UnionSquare or just emailing.
KMS	CSN	Confluence is very flexible. There are lots of different types of page, one of them is meeting minutes page, and you just type in notes and actions, as you go along in a meeting, and if you've got actions, you've got names associated with that. If someone just clicks on their actions, it will take all the actions from all the different meeting minutes across the system and list them with the date, and it'll also become bigger and more orange, the close the date is.
KMS	CSN	In Confluence people can add and design their own pages, it's very flexible
KMS	CSN	the good thing about Confluence is that it's not hosted on our server
KMS	CSN	We are currently trialling Confluence platform, that allows you to identify subject matter experts,
KMS	CSN problem	but the risk is that everyone puts in different stuff, and they'll do it differently, and you'll end up with mess.
KMS	CSN problem	It should be easy to get things out, but it should be also easy to put things in, otherwise it won't grow and capture the K with the system like that, it needs to be all the users who can contribute and add things into it. You can't just have 1-2 people who goes through, because I think it's too difficult.
KMS	document repository	We maintain a database to track the project, frequency isn't that high at the moment, it's not a huge task to maintain. We are only talking in terms of 5-10 projects a year.
KMS	document repository	it's merely excel-based.
KMS	document repository	it's all stored on the networks drives, projects folder or an archive.
KMS	document repository	SharePoint, it's useful. We store everything there, from correspondence to project documents and clients documents.
KMS	document repository	For specific project documents, like the reports, the proposals, forecasting toolkits, specific documents it's useful
KMS	document repository	on UnionSquare there is a very good version tracking.
KMS	document repository	There is people who put things in the yellow Microsoft folders, and it makes me very nervous that our project documents are in that format, because I think it's, it's not auditable, it's very easily lost, there is no back up, so you ca
KMS	document repository	We have another system, which is our content management system, which is the UnionSquare. It's more focused on management of internal content that we create.
KMS	document repository	SilverNet was introduced recently, and it's taking over right now. We are uploading documents there so that people could see what we've done, completion reports, project plans
KMS	document repository	we put all the documents on SharePoint, which we are trying to put into anyway.
KMS	document repository	We use SpringBoard for marketing activities. And Confluence primarily.

KMS	document repository	At the moment those get stored on my local drive. Which is backed up to the main server every night.
KMS	document repository	just for file sharing, really just use it the same as you would use shared pace on a server. It does a little bit of version control but we are not sophisticated users of SharePoint.
KMS	document repository	we have shared space on the servers. We use SharePoint
KMS	document repository	We used to work with ShareDrive, but the trouble was that when in particular there is a lot of graphs and photographs, it takes a lot of capacity. The good thing about SharePoint is that you've got a history of different versions. There is visibility.
KMS	document repository	We have a document library on it, which is good, any of our specifications or network diagrams, it's all kept in a document library, so you would always go onto that and onto the document library and to get the latest drawing.
KMS	document repository	we've got a document library on our intranet, where we can pull documents from and upload them there.
KMS	document repository	we have a lot of shared folders that Future Networks team has access to
KMS	document repository	the document library, it has a lot of formal processes and procedures. And I can usually find. So it works on key words and searches or documents will have code, words, numbers, references that look something like you know
KMS	document repository	we also use it for our repository. If we have very large files that we need to put online and everyone needs access to them, we can do that. Obviously email is not very good for that.
KMS	document repository	It's just a hard drive storing system.
KMS	document repository	People have different systems in different places.
KMS	document repository	Some people will use different systems because what's is commercially sensitive, we won't store it there.
KMS	document repository	We also use software for sharing drawings, Product Centre. We use Product Centre for keeping track on drawings, where anyone can have access it, as long as they have the right training.
KMS	document repository	We have internally for each of the businesses our own storage facility. If you access, you can see all the files according to your access level.
KMS	document repository	What we actually do now is having a public desk, and you just save it yourself. Each department will have their own structure sometimes, they decide how the structure will help them to look up things and tag them.
KMS	document repository adoption	you have to get a training to use it, which is provided by software suppliers.
KMS	document repository problems	We try to minimise the paper copies, and we find that one of the challenges is they get outdated, especially when you get into the parents system, and all of a sudden data becomes hard to find.
KMS	document repository problems	We had a very professional one, which is used by Petrofac for large projects. Our projects are not that large. We use that for simple document area tracking and that sort of things.
KMS	document repository problems	for other things like the data rooms, that we need to download and review the information for projects, it's too clunky to take that format of different data that might be different for every project
KMS	document repository problems	Microsoft folders, and it makes me very nervous that our project documents are in that format, because I think it's, it's not auditable, it's very easily lost, there is no back up, so you can over-write one version with something else.
KMS	document repository problems	the pools are not specific enough and it's not easily searchable, the key word search

KMS	document repository problems	There is no clear process for managing information that goes on each platform, that's what's really lacking.
KMS	document repository problems	Everyone in all the offices can get access in UnionSquare, but that's not really that easy to access, that doesn't really help with the knowledge side of the things. And also a lot of the people find access to it quite slow from where they are, every time you click something, you have to wait for 5-10 seconds until it actually appears, which doesn't sound like a big problem, but actually it's really annoying
KMS	document repository problems	UnionSquare is not very easy to search, it's fairly basic. You might know what you are looking for, when you type in the key words or template or something. And you end up getting a list of 200 things, and what you are looking for is somewhere in the bottom.
KMS	document repository problems	The problem is that if you go to the documents pool, it doesn't make a difference between the work stage 1 and 2, so all the documents from the previous part of the project are here and ideally you'd want to put them under another work station, so it's nice and clean and you can instantly see what's there.
KMS	document repository problems	I used to look at SharePoint, but there was so little information, that it was useless.
KMS	document repository problems	the problem with SharePoint is that the rules for sharing information are so restricted, that it's very limited. E.g. there is a page for expert delivery executives and none of the project managers can upload or download or share information from those pages.
KMS	document repository problems	Other PMs in our company use this tool as well, but we don't necessarily have access to each other systems. We should, but we don't
KMS	document repository problems	It's not easy to find information in many of them
KMS	document repository problems	Some people might say what that is, but if there are clear guidelines I'm not sure what they are.
KMS	document repository problems	Somewhere, but it's not always obvious.
KMS	document repository problems	there has not been an integration. Now it's just difficult to know what is going on groupwide.
KMS	external portal	They have a network portal, so it's basically a website, where when we register any project, we submit the information. We have to submit an annual report, I think, yes, an annual report, and update reports, and close down reports, finding reports on that project.
KMS	external portal	those are real projects, that got registered at some point or getting registered or still ongoing in total.
KMS	external portal	We have a portal called ENA Smart Energy Portal and the last time I looked was with 1150 projects registered
KMS	forum	we all have general discussions in Facebook.
KMS	forum	The idea with Yammer was that it was just a better way of communicating and having everything go through emails, which how companies traditionally communicate and how we mostly communicate. But the problem with the emails is that they get lost, and the knowledge that is in them is lost.
KMS	forum	There is also a Q&A facility, which means that anyone who is looking for answer on a particular subject, can post a question and hopefully, when they post a question, they'll find that similar questions had been asked before and are already in there, and they'll get the answer.
KMS	forum	they post the question, they tag them with different labels, and then the relevant experts will get notified, if that's the labels that are relevant to them. And they can then answer the question
KMS	forum	In Confluence you can post a question and make a suggestion within a page, one of our teams uses it on the operational side, and it does a really good job of making sure that the information is up to date

KMS	forum	Sometimes people will have conversations in the comment on a page, but I don't think there is a company forum or even big team forum on Confluence.
KMS	forum	I know in the engineering teams that is definitely in place. I think in the project teams that's one of the outcomes of a summit that we are having in April.
KMS	forum	he was talking about the conference and letting people know
KMS	forum	They use it for posting news mainly, something like: I attended this event and it was quite interesting, or there was a power outage somewhere, we had to work really hard to restore supplies, well done to the team there.
KMS	forum	to see what's happening, if there is anything interesting. I don't really contribute anything, just read stuff.
KMS	forum	Yammer, it's like a forum system, then there are different topics, so you can register to different topics, and some of these are technical areas. You could ask a question on the Yammer forum and anybody could respond.
KMS	forum	they come back with what potential companies out there could offer and then that goes to the forum and various companies would comment on what's been offered, whether they think it's good or any reservations that they have, and they would then come back to the company and try to address those concerns.
KMS	forum	That works well for us. We are sharing thoughts and comments.
KMS	forum	they do project synopsis – a couple of pages about the project benefits, where it is on technology readiness level, and then there is a base camp – an online arrangement, where all the utility companies are connected in – these proposals are posted on that and then people can make comments.
KMS	forum	I think it probably will be quite helpful
KMS	forum	sometimes someone might put an article on it, the managers tend to try and use it and say: we have installed a new piece of equipment here, this will do this.
KMS	forum	They are trying to encourage people to use every morning, when I get to my computer, the window pops up: welcome this person to Yammer.
KMS	forum	we talked about this at discussion forums. I think, that is something that we'll pursue
KMS	forum	a lot of people in IT use it
KMS	forum	I like it because I get a lot of articles through Yammer, some of them which actually help me make some decisions about some of my projects as well.
KMS	forum	if you have new ideas or a question that has already been asked, you post it and get an answer. I used to use that tool when I used to work in our measure projects department
KMS	forum	Within the group I'm working in just now we share different articles through LinkedIn and just get people interested.
KMS	forum implementation	in the engineering side of the business we had that, and for the first month it was great, everybody was on it, and everyone kind of starts forgetting and so suddenly people aren't logging on, so if somebody asks the question, the chance of anybody seeing it or responding to it was nothing. So it very quickly died on the engineering site.
KMS	forum implementation	I've just naturally joined it, I know the benefits
KMS	forum implementation problem	I think, the challenge is that you view it as a social network, the idea of social network is not everyone's cup of tea.
KMS	forum problems	But I think the problem with Yammer for us was that it wasn't quite structured enough in terms of trying to set up expert groups and links, files, Q&A, meeting minutes.

KMS	forum problems	we use the website called Yammer. But it's not really used that often, most of the time we wait for Richard to come provoke us with some questions and push us to tell us what we think about the processes in the company as a whole and things like that
KMS	forum problems	I don't have time to sit and read emails or chats from other individuals within the business to try and understand what's going on.
KMS	forum problems	I didn't see there was enough penetration of it Yammer to get use of it. If it was more mature, if I thought everybody was looking at Yammer, reading Yammer, I would maybe use it more.
KMS	forum problems	I just don't think, the audience was there. So I didn't want to waste my time. Until it's mature system and I recognise the benefit of it, I'll maybe hand fire of spending any of my valuable time using it.
KMS	forum problems	But I don't really bother with it.
KMS	forum problems	it was at a time when it wasn't really seen of most value.
KMS	group chat problems	then we said, that you then run into the issue, instead of disrupting one person you disrupt everybody in the team, because everybody was going to read the message and you get somebody that goes, what about this guy, and then somebody else, no this guy is better, and you know, then everybody is getting in all these messages rather than just one person that you might have disrupted.
KMS	implementation	but people still need to understand what it can and can't do, what our rules for using it are, what for. People won't necessarily do it, but at least you've got a guidance and there will be a conscious decision to do something differently.
KMS	implementation	It needs to be even an hour session once a month with whoever started that month to help them understand what it's all about.
KMS	implementation	some other people from the team I think have got on their objectives to put stuff on the blog.
KMS	implementation	there should be structure there to start with for people to hang things on, and there still needs to be training about what people should and shouldn't do with it, rather than just giving people a piece of software and telling them: go for it. Otherwise it will make a huge mess.
KMS	implementation	One of the things with Confluence is that when we get to roll it out, one of the big challenges is making sure that everyone has got enough training
KMS	implementation	The key thing is to make sure that the benefits of it are obvious to everybody.
KMS	implementation	we are going to need to put some guidelines to make sure that doesn't happen, make sure that we are not storing them in 2 different places. UnionSquare is very much focused on document management and version control of the reports, with Confluence we can probably have a guidelines, like no uploading of documents into confluence, because you can just put a link to the document in UnionSquare.
KMS	implementation	before we start pushing other tools at them
KMS	implementation problem	I think that's a shame that they've invested so much in this software in the first place, but there doesn't seem to be any responsibility for someone to twick the last bits that will make it useful for people, e.g. key words search bit.
KMS	implementation problem	if you are sitting next to someone who is resilient for not being trained in the first place, then they are hardly gonna be an ambassador of the product.
KMS	implementation problem	every change we have in UnionSquare, we have to pay the UnionSquare people to code the change.
KMS	implementation problem	I get told, the time-sheets, the leave booking or you know a really day-to-day functional stuff, but not the concept of UnionSquare and what it's good at and what it's not good at. It's just those basic functional aspects.
KMS	implementation problem	some people choose not to use it at all.

KMS	implementation problem	there is a problem with the uptake, still, it was launched in October 2013 and there is people who are still really resisting using it, and I think, part of that is because there was no or very-very-very limited investment in training, when it was launched, and there is still no training or very-very-very limited training for new starters
KMS	implementation problem	They approached it with a lot of trepidation, because they didn't know why they were forced to move Yellow Folders, which are really easy to understand to something that just didn't make any sense. And new starters need to be trained in UnionSquare properly, because pinpointing people to 10 000 videos is not training.
KMS	implementation problem	I think that's one of the big problems that we are gonna have. There is a bit of overlap between what Confluence does and what UnionSquare does.
KMS	implementation problem	One of the big problems with UnionSquare is that when it was rolled out, no one has got any training. There were some training videos, but as a result, still 2 years later a lot of people don't know how to use UnionSquare probably.
KMS	implementation problem	I'm not sure that any of our project managers know how to update the pages of Confluence. We do have some upcoming trainings to get everybody a little more educated on how to use Confluence.
KMS	implementation problem	I've never received any training on Confluence, I just figured out how to use it. It's a fairly simple software, it's not that hard to use, but it takes some trial and error to figure it out
KMS	implementation problem	in most of the companies that I've worked for the biggest challenge was maintaining it and adopting it.
KMS	implementation problem	You can develop a great system, but if nobody uses it, then it's not gonna go anywhere
KMS	knowledge repository	we do have our own document pools on UnionSquare, just drives. There is an equipment one and a general one. I'm trying to stimulate a culture of putting useful things there.
KMS	knowledge repository	to have data and knowledge stored mainly on for example databases, e.g. UnionSquare,
KMS	knowledge repository	And then since UnionSquare started, I've been trying to create some new pools on the knowledge management area.
KMS	knowledge repository	My director is a little bit involved with this and he is the one with whom we built different pools in the UnionSquare in the KM area.
KMS	knowledge repository	we had yellow folders in which we put lots of articles about different bits of research, and also one for different solar manufacturers
KMS	knowledge repository	target and catalogue and all of our knowledge and learning content, and having that in a central repository
KMS	knowledge repository	We are looking at using SharePoint to build a knowledge library. A lot of our projects are dealing with different technologies. There is not a lot of overlap between project.
KMS	knowledge repository	we're pulling all that central, we've got a central repository about that particular innovation topic, so that's where we are using, we are hoping, well, we are gonna use SharePoint for.
KMS	knowledge repository implementation	So the plan is that the project managers will have to upload all the information about their past projects. 23:15 Yes, I think, what we would do is some retrospectfully and then a lot of it will be just going forward, I don't think, we'll go retrospectively on project, but more on topics.
KMS	knowledge repository implementation	either somebody is gonna spend a lot of time putting all of that, all the material down there and cataloguing it or realistically what's gonna happen is, you know, we'll ask the project managers to do it, and everything is just gonna get dumped.
KMS	knowledge repository problem	It was very badly organised though, very messy
KMS	knowledge repository problem	navigating, there is so much information between our document repository reports and Confluence, where we share information, and different resources you get from different peers,

KMS	knowledge repository problem	There is such a volume of information, that navigating it, what was relevant, was really challenging.
KMS	need for CSN	once it's been emailed, it just gets lost and you can't find it again, and different people certain people weren't on the email list. Then they don't ever hear about the idea. So it's much more limiting
KMS	need for CSN	I think we need to look for more sociable things: having the meetings, discussing the ideas, having online platforms to use them, where things can come in from.
KMS	need for KMS	But now that we are trying to streamline a little bit more, maybe it's something we could think of.
KMS	need for KMS	it would be good for everyone as well to send everyone an email with a few links, so that we can all have a set of email stored somewhere, so that we could just get back to it.
KMS	need for profile library	You only put in that CV the things that are directly relevant to the renewable energy industry, because the CV is not really used as an internal tool, it's used for proposals.
KMS	need for profile library	I think that would be quite hard to put all the different things that people do.
KMS	need for wikis	an internal wiki would be quite good. I worked with companies before where we had a wiki, like a project wiki.
KMS	need for wikis	There is no other way to memorialise as well as share information not only for now.
KMS	newsletter	It's sent electronically, but usually they print it out as well and leave it in the kitchen for everyone to have a read.
KMS	newsletter	We get a newspaper, which is called "What's Sgurring on" and in there we do a fair bit of information that's interesting
KMS	newsletter	we have our own internal newsletter as well
KMS	portal	we have our own website, which is more like a news thing.
KMS	portal	I use it mostly for the network drives.
KMS	portal	we use it mostly for getting formal updates and getting access to the IT services.
KMS	portal	Just for things like IT tickets, if I have a problem with my computer, or to look up organisational charts. It's more administrative
KMS	portal	The SilverNet? Yes, that's where all my reports go, that's where our action items, closing documents or purchase order are.
KMS	portal	The ENA (energy network association) hosts a portal on behalf of Ofgem, any new projects will be registered on that.
KMS	portal	it's relatively high level information. It doesn't go down to the details of projects to actually provide any detailed information
KMS	profile library	in that system everyone has a profile that you can go and see a bit about them.
KMS	profile library	CV for everyone, which everyone is meant to be updating at least once a year.
KMS	profile library	. Within engineering we'll track stuff on our internal wiki, where you can look at past projects and who was involved in them
KMS	profile library	we have 500-600 people, and we all know what different teams do, none of the teams are actually that big. But I could definitely see it if it was a couple of times the size.
KMS	profile library	team page with the profile of everybody, because then, especially if that was tagged, if you had a question, you could find somebody and ask.
KMS	profile library	we should have that
KMS	profile library	But if they had a couple of lines that actually told you what they are specialised in and that was accurate, that could be fairly useful.

KMS	profile library	I use it before I go to the meeting with someone on the phone, I'll look them up in LinkedIn and see their past history, what they've been involved in.
KMS	profile library	The reason I have it ILinkedIn) in the first place is to try and make contacts, so that people can put a face and senior ranks in the company.
KMS	profile library	We don't have a set in stone database, where I can go and find out where Zi and Chris and what projects they've worked for years. I'm gonna do that using LinkedIn.
KMS	profile library	We'll have a contact book, email them and try to seek for help. We don't use it very much.
KMS	profile library problem	but ultimately they don't necesserally tell you that much about what person can actually do, when you come back to their work.
KMS	profile library problem	Maybe as you are saying, when you've got new people coming in and you want to know, whether or not they can do the work, but even then it's not really us, who decide, where the work goes.
KMS	profile library problem	I don't think the company is big enough for that. I could definitely see for a much bigger company, I think we have 500-600 people,
KMS	profile library problem	there would be so many literal things that people do on the day to day basis, that you'd need to contact them for that. I don't think that would always be easily documented.
KMS	profile library problem	If I was looking for someone like that, I'd imagine it could be useful to find out who is the specialist in what area, but it's like looking through people's CV, you never really know until you meet the person.
KMS	profile library problem	we've got guys here, who've been with the company for 40 years, they are classed as senior engineers, you've got guys in India, who've been with the company for 2 years and went through the basic training and therefore they are classed as senior engineers over there.
KMS	profile library problem	we still use Lotus Notes in China, which is an older version. You need to update it yourself, and a lot of people's background is not complete. Normally you can only find the position and then email address and the phone number. And if you don't update that, no one can find you.
KMS	project management software	you can publish emails to UnionSquare.
KMS	project management software	because any project management related tasks should be in a project management sheet, this is where you have a free form text will, you can actually add: I spoke to the client of Thursday, he wasn't very happy. In a month time you can look back, because otherwise you are searching your emails and the client goes – I never said that.
KMS	project management software	ProductEve, which is a task management software. It's more for adhoc – a bit of a grey line between what should be captured in ProductEve and what should be captured in the project management sheet.
KMS	project management software	I maintain Confluence status around my projects, any relevant information around my projects that I feel I need to document for future reference as well as share with people in Silver Spring: project schedule, any specific architectural design or unique thing for link, to other cases, that are relevant to my project by creating typically a project page for each project.
KMS	project management software	everybody has access to it. I'm able to use to interact with the customer as well. It's got a lot of features, you can make it whatever you make it, I can customise it for our project.
KMS	project management software	I primarily live in Quickbase, which is like Access online. I use MS Project for some of the key deliverables, like putting things on the map. And the other application is Excel.
KMS	project management software	It's all done in Word, Excel, Microsoft Project.
KMS	project management software	We have MS Office, we have Microsoft Project, other than that we have SharePoint,

KMS	project management software	I use Microsoft project for pulling Gantt charts together, other than that no, it's done by MS Office type products.
KMS	project management software	I typically will use Microsoft project, which we are all given, and we manage our financials and forecast in Team 1
KMS	project management software	Projectwise, that's another system that we use for projects.
KMS	project management software	For ourselves we just tend to use the spreadsheet. It's the most convenient, and we just update ourselves.
KMS	project management software	The most we use is spreadsheets
KMS	project management software	There is a more formal program – a project web access because once the developer signs the project, it needs to go to the construction and needs to be financially approved
KMS	project management software	We use just a spreadsheet tracker.
KMS	project management software	We use Microsoft project and maintain it. Basically if each of the tasks has been completed, It'll be agreed, that not so much at gate 0 meeting, but at gate 1 we'll certainly look back at the details, and what we do is we line up with for example other roles that I've mentioned, the what we call an NIA registration document, which is submitted as a portal.
KMS	project management software	we use Microsoft Project at the moment, but are developing SharePoint to include other tools where we can actually collaborate a lot more from a project management perspective.
KMS	project management software	I know some people use Microsoft Project, but we don't really use that unless you are making Gantt Charts.
KMS	project management software	We use WebX, which is the key for setting a meetings, that's just for communication
KMS	project management software	I've got one (online community) setting it up about the project that we are doing just now, where we can share. You can have people comment on it, but most of it comes down to file sharing.
KMS	project management software problem	(1) it's not adapted to handling large amounts of information, that are handled better in standard Windows Explorer system on server, (2) lack of criteria for some projects.
KMS	project management software problem	the system is an absolute nightmare when it comes to working with the international offices, because it's very complicated to open a PO for an international office to work for us on a project.
KMS	purpose of KMS	A well-controlled place, where you can put information but not too much and try to condence in the information rather than putting thousands of PDFs about specific type of information.
KMS	search engine	already I've been using Confluence to access documents in UnionSquare, because I've put you know for 4 proposals
KMS	search engine	It's like Google, you just type in what you want and it brings up any question, any documents, anything associated with that.
KMS	search engine	On one page in the Confluence there is all the useful stuff that you need for a proposal, whereas on UnionSquare you'd have to go looking for template here, looking for template there
KMS	search engine	Confluence helping you to navigate through the different databases to find the one that is most relevant to you

KMS	search engine	it will be an easy way to find something in UnionSquare rather than trying to find something through UnionSquare.
KMS	search engine problems	the complecation is that UnionSquare, you have to know, what the document is called and where it is in order to find it, which means that people looking for guidance, if they've just assumed that it's not there, then they won't have a look and so even if it's there and I've sent emails, repeating and saying, we've got guidance on this and this and this, then they'll still not use or not remember it or not find it
KMS	search engine problems	There are some really important search functions that are missing, which makes it challenging for some things.
KMS	search engine problems	UnionSquare doesn't have a key-words search
KMS	search engine problems	You don't have all the criteria for the projects that you need for search, like track record on specific technologies, countries.
KMS	security issue	I do wonder if it gets bigger and once we roll out and then it starts to become a big important bit, they say: alright, we want to bring it onto out server, which we can do, but it might slow it down for everyone else.
KMS	system integration	already I've been using Confluence to access documents in UnionSquare, because I've put you know for 4 proposals
KMS	system integration	UnionSquare could be the document control area, where the versions are held. And then you can put a link to that document in Confluence.
KMS	team page	we should have a team page first
KMS	team page	another community on LinkedIn, our KM base. It's called SSEPD knowledge sharing group.
KMS	technical issues	a lot of the people find access to it quite slow from where they are, every time you click something, you have to wait for 5-10 seconds until it actually appears, which doesn't sound like a big problem, but actually it's really annoying
KMS	technical issues	SharePoint, and theoretically everyone in the business here has access to their SharePoint system, but there is a really simple problem, which is people who don't use it very often, every month you have to change your password, and if you don't change your password, it just locks you out, and you have to ring at Huston to get a new password.
KMS	technical issues	And also once you've put it there, it's a nightmare because it deletes everything that is under it, you have to create a new one
KMS	technical issues	everybody has got an email always open on your desktop, where as on the website that means that you have to click on
KMS	technical issues	under the methodology one you can't add more folders to say: Solar resource methodology, energy yield methodology, financial methodology.
KMS	technical issues	I said, I'll just look it up, and the project plan wouldn't load, and then I'm like, I'll open this document, and that wouldn't load.
KMS	technical issues	As soon as anything becomes too complicated, people will not use it, and I found that worldwide
KMS	technical issues	BigBucket and Jira have some issues. It's not immediately intuitive, you can't immediately figure out how to use it.
KMS	wikis	Confluence has a thing that you could have random ideas, page or something like that.
KMS	wikis	interface as such means that you can maintain the document control aspects, while also using the functionality and the ease of using. If that's not a very good way then you just change it, whereas UnionSquare is very rigid in its structure.
KMS	wikis	these are the 5 documents you might need to prepare a proposal, so I have now brought that together in Confluence, so that means that for me I can go straight to confluence and I know that there are links to exactly what I need.

KMS	wikis	those useful things will already be in there for people to very easily find, because it's a much easier structure to UnionSquare.
KMS	wikis	I've tried to set up virtual knowledge teams on different pages of Confluence, which is like wiki
KMS	wikis	I use Confluence mostly for documentation as well as the research.
KMS	wikis	I use it a lot to search for information
KMS	wikis	We as PM started using it a lot to document issues, best practices, lessons learnt. In the future we are planning to use it the same way as other teams, which is document and share things
KMS	wikis	You could also subscribe to specific pages, e.g. when you want to know about any change in the process or useful recommendation. And when there is an update and I have a question about it, I can email them and just go to that page, and then they go on and reply what there is.
KMS	wikis	I use it to look up software, what's currently being released, technical information, things like that.
KMS	wikis	. Within engineering we'll track stuff on our internal wiki, where you can look at past projects and who was involved in them
KMS	wikis	I don't want to email people every time there was an update. For that I'd just ask them to follow the page and we'll put everything there. Some people use it to put requirements in the form, because it's an easy way for my engineering director to look at it, and we don't have to worry about both of us accidentally changing the same document.
KMS	wikis	We use it to track various things, high level project plans when we want everyone to see it in the company.
KMS	wikis	Wikis are fine for engineering type of activities, where you want guys to provide details of how they've done stuff, tracking individual detail points.
KMS	wikis	I have looked at it and used some of the information the other day.
KMS	wikis	we also talked about using wikis, as well and having wikis about different innovation themes, you know, maybe Simon did a project in a HVDC, and Peter has done something as well, and instead of having to go to that project, they could go to HVDC and see our knowledge and learning related to that topic.
KMS	wikis	And if we conduct a similar trial, we'll read through that and see: our customers are probably gonna have the same issues. Let's make sure that we rectify that beforehand.
KMS	wikis	Everyone who had interest in our program is now a part of our online community in our Confluence anyway
KMS	wikis	I'll consider an online community to be our wiki community
KMS	wikis	If we are going to do training materials. I've been doing it a lot with my team. Everyone can update wikis, comment on wikis, like the pages if they need to.
KMS	wikis	if you put it up on Confluence, you can watch pages and you can immediately be notified if something gets changed. That's an important thing, because people are constantly changing.
KMS	wikis	It really helps to distribute the information. There are quite a lot of restrictions on the emails: (1) you can quite easily skip an address or add by mistake, and people were not kept in a loop. And often you have emails going to people who are not interested in it at the time, and you forget to cc them.
KMS	wikis	Technically we can treat it as our trials, and we do write about it in our wikis for everyone to read.
KMS	wikis	There will be something written in the wiki, and they'll look it up, when they need to look at it, but it's not something that is conducted at the end of the project.
KMS	wikis	we can control access to that information. E.g. when you want business units to see their information and you don't want them to see other business units' information, which might be considered confidential, then we can block their own app, we can use the controls.

KMS	wikis	We use the program Aracia, it's primarily design for software engineers, but it can be utilised for a bunch of different things. We use it for wikis, for Gira, which is task setting, and you can monitor the progress on that task,
KMS	wikis	We'll write up about the projects
KMS	wikis	We've branched out of the normal Weir group tasks and done this because we needed to have some form of collaboration with all the business units and sub-contractors. There was no way for us to do it with the current system that's in place.
KMS	wikis	you need to have links to other information, and that's really a restriction on the email.
KMS	wikis origins	It's was driven from the top, by my boss's boss getting it implemented in our region, so that we can spread it over to other regions. We were trying to find a tool that would be used by everyone, and have been trying to find the needs through survey internally, what do you use, what do you need.
KMS	wikis origins	This is something that was used by one of our team members before, and it was particularly successful, so they brought it in.
KMS	wikis problem	not everybody proactively looks at it. I will, but especially on sales, I think it gets a better reach with just emails.
KMS	wikis problem	because these people have different disciplines, quite often you go and try to find out something, and then you see that this page has been updated in 2 year.
KMS	wikis problem	in my personal opinion we need to produce more formal, baselined and maintained documentation.
KMS	wikis problem	My concern, and this has already happened in Silver Spring, is that existence of wiki means that people think that they don't need to formally issue documentation on products and keep that documentation up to date.
KMS	wikis problem	on the Copenhagen project I was doing some testing with the customer-partner, and things weren't working as we thought they should work, and we then found out that they were not supposed to work, because detailed conversations were held between the engineers, which may or may not be maintaining wiki
KMS	wikis problem	The challenge that we might have, is that you can never be sure which data is correct or not.
KMS	wikis problem	I would use, it's just we haven't got a common for the team yet
Knowledge application	information retreaval	it's also on the content side, trying to make sure that everyone has access to the same information, so that if we are benchmarking it comparing with other projects, then everyone in the company has the same info to compare to.
Knowledge application	information retreaval problem	Defining what a project actually tells us is probably a little bit more difficult. We have acronyms for everything, so everything has got a strange name that means nothing to you, you don't know what project entails.
Knowledge application	information retreaval problem	Trying to dig through some of that information and finding out the details has proven to be a little bit difficult.
Knowledge application	information search	it's quite easy, it's all stored on the networks drives, projects folder or an archive.
Knowledge application	information search	I just do a quick google search on Confluence for relevant information on that subject.
Knowledge application	information search	But if you are looking for something that you've never seen before, we do have fractions broken down by engineering, different topics of engineering.
Knowledge application	information search	it's pretty easy to find stuff if you know what you are searching for
Knowledge application	information search	Do you find it useful? 24:04 yes, sometimes, as long as you know what you are searching for.

Knowledge application	information search	we are thinking of a kind of launching into another a kind of big project, and you know, you need to start doing your research and figuring out, what's going on before, and it's, there is nothing, you know, all you can do, so you can do google search and try to find what you've made public, but for some of the kind of smaller projects all we have is folder with the name, which might not be very representative
Knowledge application	information search problems	Finding relevant information, like documents, it was quite challenging
Knowledge application	information search problems	The biggest problem with confluence is finding things
Knowledge application	information search problems	at the moment that is really a matter of what you know, if we looked at a particular piece of technology or on a previous project, we didn't know what that project was called and who the documentation is for and who the PM was on it
Knowledge application	information search problems	from certainly I've see, it's very difficult to browse; you have to actually search that library. So it's quite difficult to find that information.
Knowledge application	knowledge reuse	When they start a new project, they do as well
Knowledge application	knowledge reuse	Yes, we do quite a bit, especially in terms of performance
Knowledge application	knowledge reuse	it's always based on the past applications, what worked, what didn't work.
Knowledge application	knowledge reuse	I think most people would try and have some awareness, but UnionSquare has a function, where you can look any organisation and look up the history of this organisation.
Knowledge application	knowledge reuse	people keep going back to the proposals that I made for those purposes in order to go and say, right, how do you approach this portfolio transaction
Knowledge application	knowledge reuse	lot of it is replicable from one project to another, and then you will find tune-based projects seeking for information.
Knowledge application	knowledge reuse	The other part that is replicable is the analysis, and for that we use databases.
Knowledge application	knowledge reuse	The standard procedure now is to send an email to everyone to see, if someone has already done that, or to check on the servers or KM system.
Knowledge application	knowledge reuse	we don't have that much experience in it, because we only work in the megawatt scales, and there aren't that many megawatt roof tops in the UK at all. I have to try to use as many previous experience as possible
Knowledge application	knowledge reuse	there is a little bit of that going on, but that's not to any great extent
Knowledge application	knowledge reuse	when you start a project, you don't have a plan, and the information around it goes to asking someone: Have you ever implemented this particular product? Yes, I've done that. Do you have a project plan around it? Sure.
Knowledge application	knowledge reuse	A lot of what I did for this particular project was taken from another project we have at another customer. So I looked at their best practices, what they were doing and tried to take as much of their stuff into my process
Knowledge application	knowledge reuse	Curt whom I'm working with, he ran that project and found about all that stuff, He came over to our team and became pretty much a manager for it. He said: hey, I've done this before, you should look into this
Knowledge application	knowledge reuse	We reach out all the PMs in the company usually and try to get historical information and lessons learnt that way
Knowledge application	knowledge reuse	in Silver Spring PMs put a call out to other PMs and say: has anybody worked in the same area and done this? People will get is and say: try this, I've got this.

Knowledge application	knowledge reuse	I do personally, because I know, that's a good way to start.
Knowledge application	knowledge reuse	E.g. one of the considerations we have is around the uptake of electric vehicles and the impact that they might have on the network. It's useful to look at some earlier studies and maybe we could refresh that with up to date figures. What might happen that it might be changed with government incentives. You might find that it accelerates in the future, and then we need to know how that scenario may play out.
Knowledge application	knowledge reuse	PM should do knowledge management, stakeholder engagement and responsibility, responsible manager. So project inception, reviewing previous projects,
Knowledge application	knowledge reuse	probably not. We probably should, but what we are trying to do is get the right people and then assume that the right people will know, what has happened in the past.
Knowledge application	knowledge reuse	a lot of them build on each other
Knowledge application	knowledge reuse	At the same time you might find that some of the things like techniques or technologies can actually have an impact on another project manager's project, but maybe at the time they would not have realised how the two could impact each other, this is the chance to actually say: you are dealing with radio communication at the moment, I'll do that in a few months time, is there any learning that you've got from interfacing with the people who are supplying that, which I need to know about and prepare for
Knowledge application	knowledge reuse	If we discuss a new project, someone will say: something that we've learnt in the last project was these issues and we should think about it now.
Knowledge application	knowledge reuse	we do use or past experience from the past projects. We'll just take all the best aspects of this
Knowledge application	knowledge reuse problems	It's a project plan and it's quite detailed, but it's not a template that you can use. It's specific for that particular customer implementation. Without having the knowledge of that project you have a really hard time of readjusting that, and at then you just end up doing it from scratch on your own.
Knowledge application	knowledge reuse problems	but it's difficult, because most of the PMs don't even have time to document their own stuff, most of us work 50-60 hours a week
Knowledge application	knowledge reuse problems	I think it's quite difficult actually. Eventually you can find some stuff but sometimes you have to find the right person to ask and then they've got it buried in their email somewhere.
Knowledge application	knowledge reuse problems	I think, that's a bit of a gap, that we are trying to plug with SharePoint and whether it will work or not
Knowledge application	knowledge reuse problems	we are falling down a little bit on the reuse
Knowledge application	knowledge reuse problems	we do to an extent, but it's all dependent of people remembering, people knowing what's going on. So there is now mechanism or process for doing that.
Knowledge application	knowledge reuse problems	We don't know, because probably primarily because we don't have access to those projects.
Knowledge application	knowledge seeking	if we do have questions like that, we will ask them during the general discussion.
Knowledge application	knowledge seeking	they send an email and ask one of the team-leaders that can then say, what should I look at to get a good basis of this
Knowledge application	knowledge seeking	I go to UnionSquare or I ask people in my team
Knowledge application	knowledge seeking	sometimes you have to find the right person to ask and then they've got it buried in their email somewhere
Knowledge application	knowledge seeking	at the moment, what you are talking about happens at the gate 0, where the gate 0 will be a meeting with the responsibility manager, PM, the KM, to see whether it's worth pursuing the project to gate 1 and then really you are relying on the people in that room, on the people who have a knowledge of the previous projects in order to point the project manager in the right direction to go and talk to another PM or look at another documentation from a certain project.
Knowledge application	knowledge seeking	we also talk to National Grid and Scottish Power and ask for their advice and if they've done anything similar.

Knowledge application	knowledge seeking	we do ask a lot of questions of who is the right people and get them all in and try to work out, what it's been done
Knowledge application	knowledge seeking	I use it a lot (LinkedIn) to understand what our competitors are doing as well and where industry is going.
Knowledge application	need for knowledge reuse	A lot of things could be replicated, but each project is different because the clients facilities and the processes involved are different
Knowledge application	need for knowledge reuse	The work is quite repetitive, there is not that many new things
Knowledge capture	expertise acquiring problem	I don't think the company does succession planning very well, maybe at director level of senior manager level, but at my level I don't think they handle succession planning at all. That might be an issue that's being addressed, that has a manager appointed to look at succession planning and how business as a whole moves forward with obtaining the necessary staff at technical level that need to run the business.
KMS	document repository	that's rather straight-forward, although we are always struggling with documenting and archiving.
KMS	document repository	But if you use something like SharePoint really, you have check in and check out documents, the version control, and you don't have that issue.
KMS	document repository	In terms of what we use within future networks, within our department, we have everything stored in folders.
KMS	document repository	library of all, because we've done over 200 innovation projects already
KMS	document repository	SharePoint, but we are only starting to a kind of use that as a team
KMS	document repository problems	I think that's a challenge wherever you go. Especially when it gets more than a couple of years old and starts to disappear.
KMS	document repository problems	we don't have a good repository of project plans, action lists, checklists or something like that, that are typically replicated
KMS	document repository problems	Some people do everything in email, some do meeting minutes in word, some people use spreadsheets, some people use database, some people have SharePoint. I do think, that's an issue,
KMS	document repository problems	I find in instance where I've overwritten my own document by mistake and I've had, where somebody else has overwritten my document by mistake in one of my project folders.
KMS	document repository problems	in terms of storage and accessibility in the future, we, I don't think, we are as good as we should be
KMS	document repository problems	my experience with the companies is they either get lots into a knowledge library, and if you don't know that something exists, then you can't find it. So with all best intentions you, you index all the files in their own way, but who is gonna find it and read it again?
KMS	document repository problems	Or you get huge spreadsheets with thousands of different items, and again, they just get lost in the details.
Knowledge capture	knowledge recording	to start really documenting the stuff there: important issues, customer experience, innovation.
Knowledge capture	knowledge retaining	But the problem is that people retire and a lot of their experience leaves
Knowledge capture	knowledge retaining	do you try to do any exit interviews or try to. 39:43 I think they had in the past. I vaguely remember 1-2 people, but I don't think they do now.
Knowledge capture	knowledge retaining	He did a design manual,
Knowledge capture	knowledge retaining	retaining knowledge is done well to a degree, I think, we have a lot of people who have a lot of experience

Knowledge capture	knowledge retaining	It's getting better through these things like graduate rotational programs. You get to spend a lot of time with guys, who are absolutely wizards in what they do.
Knowledge capture	knowledge retaining problem	the idea was that he would sit down and write some technical notes about specific areas of the field in which he operated. But he wasn't interested in doing that, so I had to shadow him for a few weeks before he left the company and gain any knowledge from him that I could in that short space of time.
Knowledge capture	knowledge retaining problem	In the next 5-10 years, we are going to have an interesting phase of we've got people who have been with the company for 46 years, they came from the shopfloor as apprentices and worked for the company right up to senior engineers.
Knowledge flow	communication problems	they actually submitted the proposal for that, but then we won the measurement, and they didn't know that we bid on it as well. But we generally do know, because if there is a big job, it's very rare that other parts of the company are working together
Knowledge flow	communication problems	we've just gone through the reorganisation that decentralised a lot of the background or a lot of the individuals who were involved. So engineers who were based in this office, are now transferred to outline offices, and things do slick between the cracks, it's not always possible to get in contact with people. We do have issues from time to time.
Knowledge flow	communication problems	As for the previous project, I think it didn't really take off because of the poor integration of the rest of the business. We were in a separate office, away from everybody. The only point of contact for the project was a director level.
Knowledge flow	communication problems	we never really got involved with the rest of the business or clearly integrated with the innovation side of the business.
Knowledge flow	communication problems	So I am worried, that when we get to the end, we'll end up with a report and my report
Knowledge flow	communication problems	that's one of the projects, that very few people in the north were working on it. It starts to feel very disjointed like I'm not involved
Knowledge flow	communication problems	the one in the south is also a much bigger project, so it's much more difficult, but it does sometimes feel like we've taken a chunk. I took a very obvious section of that project to do, because it meant I could do it independently, but it does mean that sometimes I feel like my part of work is forgotten.
Knowledge flow	conference	one of the engineers has seen my presentation, he contacted me and asked: we have this problem, can you do something?
Knowledge flow	conference	it was less about talking to engineers, more project managers
Knowledge flow	conference	like a university poster display
Knowledge flow	conference	this year we had more people on the stand, who we had trained
Knowledge flow	conference	This year we tried to go a bit more in the direction of what everyone else was doing, which is a bit more flashy, but also focusing on a few projects.
Knowledge flow	conference	we had lots of engineers on the stand as well to talk to people
Knowledge flow	informal interactions	solar team is from what I hear from the other teams anyway, is one of the most sociable ones, you can ask anything to anyone and it's very easy.
Knowledge flow	informal interactions	there is 15 of us, we just talk to each other most of the time, no real need to go via internet based anything.
Knowledge flow	informal interactions	I would say it's really easy to just reach out and talk to people.
Knowledge flow	informal interactions	I have because I make my business to be on top of what's happening, I stick my nose into other projects, because to me the underline of a lot of projects is the same base problems.
Knowledge flow	informal interactions	I've always kept in touch with the manager who runs us, she knew my interest in the overall technology,

Knowledge flow	informal interactions	There was a business user, the only reason why he gets involved is because he was on fringes of innovation himself, because he was involved into introducing automation system.
Knowledge flow	informal interactions	When dealing with the rest of the business, you can identify key people, who might actually help you, but you can also be told: don't talk to them, he is a dinosaur.
Knowledge flow	informal interactions	have a chat over coffee you know or things come and he says: "or, did you see this or did you?"
Knowledge flow	informal interactions	my other project is based in Aberdeen and I sit beside the project manager downstairs, so through that project I'm like much more on top
Knowledge flow	informal interactions	in the same site it's quite easy, because we normally have a size of a hundred, once you've been there for a few weeks.
Knowledge flow	informal knowledge sharing	it's really informal, definitely informal. So people just know that you did it in the past.
Knowledge flow	informal knowledge sharing	we are quite a small team. We just go over and ask, did you do that?
Knowledge flow	informal knowledge sharing	we send out useful links
Knowledge flow	informal knowledge sharing	because we like to share experience and the French office does energy yields differently than we do, so we kind of like to push each other a little bit and provoke each other saying: are you sure that it should be considered that way.
Knowledge flow	informal knowledge sharing	it's word of mouth. The team-leader will tell you: just ask him or her, and they will do it.
Knowledge flow	informal knowledge sharing	It's just ad-hoc, there isn't any sort of a formal way transferring the knowledge from one project manager to another
Knowledge flow	informal knowledge sharing	There are new project managers, that I've come to know, any anytime that I need to get something, I'll have a call with them and get some information from them
Knowledge flow	informal knowledge sharing	Hackathon was fun just to meet people across the company, across teams.
Knowledge flow	informal knowledge sharing	hey, we are thinking about this, can you ask around help us find somebody who can give us a piece of that or help us confirm or deny whether or not it's important.
Knowledge flow	informal knowledge sharing	I think the company is pretty good in trying to get people chat and present what they are working on.
Knowledge flow	informal knowledge sharing	We talk to other teams a lot. I'm in contact with other product managers and some of the PMs, people working on the other stuff, and I either worked with them on 1 project, and we'll just keep in touch.
Knowledge flow	informal knowledge sharing	we both work from home, we both meet weekly at least to have a coffee and to talk things over, just sort of catch up.
Knowledge flow	informal knowledge sharing	I could be looking at something, and I might use it for my job, but I might say it to the people around myself, but not all the time.
Knowledge flow	informal knowledge sharing	magazine that is sent to me once a month, that's called renewable news. It's all that's going on in a windfarm community and who has got a contract for this, how this project is going. I tend to just send it around the other people in the department, so that they can see more further interest.
Knowledge flow	informal knowledge sharing	The most probably really if you are not sure about something you just ask someone

Knowledge flow	informal knowledge sharing	I'll talk to other graduates, especially new ones, what I've done, what's interesting I've seen. I'll share with them and they'll do the same back for me.
Knowledge flow	informal knowledge sharing	It's a lot of word of mouth.
Knowledge flow	informal knowledge sharing	Mostly within the younger group and during the casual conversations.
Knowledge flow	informal knowledge sharing	They are very helpful and share their knowledge, trying to explain the details of their project.
Knowledge flow	interacting between offices	It's usually just email, occasional calls
Knowledge flow	interacting between offices	We started to do a little more work with the Canadian office, because they are getting more into measurement. We are trying to train people up.
Knowledge flow	interacting between offices	Very often the team comprises of people from different offices, in particular, the offices of Glasgow, Hamburg and Paris are well integrated
Knowledge flow	interacting between offices	we find that even in the same offices like people in Glasgow most of the communication is done via email to keep track of everything. There are meeting, we have good communication lines either through meeting or via skype for business.
Knowledge flow	interacting between offices	Since I'm French, I do spend a lot of time with the French offices
Knowledge flow	interacting between offices	we had one of the Beijing people coming for an assignment for a while, so once in a while we can forward work to her, but that's pretty much it.
Knowledge flow	interacting between offices	I usually go with email being a priority, and then we have internal massager, using Skype for Business as a second layer of escalation. And the third would a phone call.
Knowledge flow	interacting between offices	When I was starting my project, I was travelling to Redwood City to meet with others every month, 2 months
Knowledge flow	interacting between offices	We'll have a conference line and projector line for them. They probably can't hear pretty well sometimes, we have to remind the presenters to keep the questions for these people.
Knowledge flow	interacting between offices	however the products part and the manufacturing part of Silver Spring, then we do have quite a lot of interactions with them
Knowledge flow	interacting between offices	I have periodic project meetings. When the projects were new, that would be weekly meetings, where I would pull together groups of people that were interested in projects and the project would go on, I reduced the frequency of those meetings
Knowledge flow	interacting between offices	then obviously via email
Knowledge flow	interacting between offices	we don't collaborate much with the services side of the US operations
Knowledge flow	interacting between offices	I'll organise weekly meetings with them, and that way to talk to them long enough, that you start building the relationship.
Knowledge flow	interacting between offices	If there is a small change for my client (e.g. expiring licence), it goes through the main team in the States.
Knowledge flow	interacting between offices	My manager is based in Australia, I'm often talking to him.
Knowledge flow	interacting between offices	Our project administration, who handles all the financial information for us, they've also got some people in Taxes.
Knowledge flow	interacting between offices	There are not necessarily problems or issues, it's just slower. Instead of standing up and going over to someone's desk I need to wait for them to see my email, and if they are busy, it's fairly easy to ignore those.
Knowledge flow	interacting between offices	there is a whole bunch of technical guys that sit in their office as well, that I work a lot with.

Knowledge flow	interacting between offices	they have people in engineering business, and they talk to their colleagues in the engineering business in Spain. That international crossover happens there.
Knowledge flow	interacting between offices	we have regular team meetings, where we would maybe meet half way, we go down south or they come up here. We have teleconferences
Knowledge flow	interacting between offices	we do have to seek information from elsewhere within the business. But that has reduced over the years, because of centralised systems and documentation that we have to produce for the regulator.
Knowledge flow	interacting between offices	The collaboration is usually trying to get input from other people into innovative ideas that you want to pursue, or if you do manage to get a project up and running, trying to provide business expertise to help drive the project.
Knowledge flow	interacting between offices	it doesn't seem, it doesn't seem like the geographical location is really much of a problem.
Knowledge flow	interacting between offices	We also have online meeting centres, in which we can share screens
Knowledge flow	interacting between offices	We've got a couple of folk in the south, a couple of them are here in the north, we make quite good use of technology. We use telecalls
Knowledge flow	interacting between offices	email, phone calls, we have Microsoft Link instant messenger.
Knowledge flow	interacting between offices	Most of the time I work with Perth or Glasgow, so I tend to spend 1 day or 2 days down in Glasgow
Knowledge flow	interacting between offices	we do teleconferences and the email too
Knowledge flow	interacting between offices	between Glasgow and Perth we tend to commute quite a lot. So I'd be in Perth at least once a week
Knowledge flow	interacting between offices	Just email, yes, yes, so we have like a weekly team call
Knowledge flow	interacting between offices	It's very easy to create meetings, to chat with employees, to just share desktop with everyone in the world and immediately show them what you are doing from a collaborative point of view.
Knowledge flow	interacting between offices	our primary function is getting everyone together. And to the end we are based all around the world: my manager is in Perth, his manager is in Sydney, my team is within America, and I've got my contractors all over the world.
Knowledge flow	interacting between offices	We use the program Aracia, it's primarily designed for software engineers, but it can be utilised for a bunch of different things. We use it for wikis, for Gira, which is task setting, and you can monitor the progress on that task,
Knowledge flow	interacting between offices	There've been discussions through our engineering hub in India. They've got a lot of the equipment and a lot of the projects will go through them.
Knowledge flow	interacting between offices	Once I get the opportunity to visit other sites, it should be easier for me to talk to them.
Knowledge flow	interacting between offices problem	We are 6 hours ahead, and then the west coast 8-7 hours. So there is a limit to how much that can happen.
Knowledge flow	interacting between offices problem	So they end up just working out within their own office, and a lot of the time that's not the same way we do it here.
Knowledge flow	interacting between offices problem	As for the Lunch events, the problem is the time, when it's lunch for them, it's morning for me, so I have other commitments
Knowledge flow	interacting between offices problem	Being able to walk over to someone's desk and talk to them, they would have immediately responded, whereas with the email you get the same information 1-2 weeks later.
Knowledge flow	interacting between offices problem	Those who work remote and don't have that much access to a team, it's a little more difficult for them. I've never heard anybody remotely participating in Hackathon

Knowledge flow	interacting between offices problem	The background noise in this kind of events is really difficult.
Knowledge flow	interacting between offices problem	I'm aware of what they call groundback events, but because we are based in London city, we don't have many opportunities to go there.
Knowledge flow	interacting between offices problem	I find it quite easy to get on with people through email or text, but once it goes to a group conference call with people around the world, it start to get communication issues. People tend not to follow others very easily.
Knowledge flow	interacting between offices problem	To communicate with people not from the same site might be hard, especially in China, which is quite big
Knowledge flow	interacting with other companies	A lot of my time is spent talking to clients, which is basically international oil companies. This is the application and they should consider it, and this is how it adds value from that. And by doing that we generate potential project, and then personnel in the oil company can go and get budget for deployment.
Knowledge flow	interacting with other companies	And then you learn from the application how to improve the product for that application plus by engaging with the client you learn more about what their real problems are.
Knowledge flow	interacting with other companies	Lunch & Learns are a form of engagement where we can get people's interest, get their attention for a short time to try and generate their interest in the technology.
Knowledge flow	interacting with other companies	Sometimes we might get some third party resources for help, a lot of what we do is subcontract work out.
Knowledge flow	interacting with other companies	we are trying to educate next generation to take our ideas and expand them and improve them, and this is how it works: if no one gives an idea, it becomes stagnant, and that's it.
Knowledge flow	interacting with other companies	Sometimes we go to the third parties, if we don't have necessary skills.
Knowledge flow	interacting with other companies	we invested a bit more time in computer modelling, and then we have a research with Cranfield University, we can test it there.
Knowledge flow	interacting with other companies	I think, it's more for an early stage of exploring the market, then it makes a lot more sense to engage, because students and universities can bring a really good prospective.
Knowledge flow	interacting with other companies	It really depends on who is in that area and whether they have an interest and time to support a project like that.
Knowledge flow	interacting with other companies	We'll after interesting things in meetings and conferences, they are a good way to chat, it's not too official, and it's good to get feedback that way.
Knowledge flow	interacting with other companies	We have experts come over informally to the office in London and give us briefings on things. I went to Paris last year to talk to colleagues from Street Light Vision to have some formal training. Informally it happens.
Knowledge flow	interacting with other companies	they come back with what potential companies out there could offer and then that goes to the forum and various companies would comment on what's been offered, whether they think it's good or any reservations that they have, and they would then come back to the company and try to address those concerns.
Knowledge flow	interacting with other companies	we have constant dialogue with the smart grid designers, just the other day we were trying to input into a NIC.
Knowledge flow	interacting with other companies	April next year, Ofgem is introducing a new regime called ITPR, and that introduces competition. So when we say, we need a new line in Aberdeen and Inverness, let's say, it's not automatically us that does it, because that's competition, so Scottish Power might do that or the National Grid, or Siemence, or else GE. So suddenly from next year there might be more competition with SP,

Knowledge flow	interacting with other companies	if customers are paying for it, there is an expectation, that we share all the knowledge that comes out of it
Knowledge flow	interacting with other companies	If we wanted to keep something private that we thought was a competitive advantage, we'd fund it ourselves and then keep all the IP
Knowledge flow	interacting with other companies	in term of all the innovations that we do, we open and share things with them, and that's part of… Because this is all funded through Ofgem
Knowledge flow	interacting with other companies	if you know they haven't published a lot, we'll go and have a meeting with Scottish Power
Knowledge flow	interacting with other companies	The only time we see ideas before they are registered is through our collaboration meetings and when we are reviewing the registration forms before registration.
Knowledge flow	interacting with other companies	With other companies we have a system of collaborating, we have regular meetings with National Grid, Scottish Power, which are coordinated through the ENA, and this enables us not to duplicate any ideas
Knowledge flow	interacting with other companies	we were given a grant from Scottish Enterprise to start looking at open innovation.
Knowledge flow	interacting with other companies	In fact there is very little development of our own within these systems, although we have our own R&D, we go on and hire electronic engineers to go and do the development or software engineers to do that.
Knowledge flow	interacting with other companies	We find the ones that are quite accommodating to this concept, it's actually quite useful for them, because by assigning tasks and giving lists to them they get the idea on their side of what is important and what they need to develop.
Knowledge flow	interacting with other companies	We've branched out of the normal Weir group tasks and done this because we needed to have some form of collaboration with all the business units and sub-contractors. There was no way for us to do it with the current system that's in place.
Knowledge flow	interacting with other companies problem	We don't get any news from them and we recognise it as a weakness in our learning, and try to find better ways of engaging
Knowledge flow	interaction between BU	To be frank, the only real thing that we get from Petrofac is funding in terms of we don't have to worry about how are we gonna pay salary each month. It's really just a bank effectively.
Knowledge flow	interaction between BU	We share and transfer our technology.
Knowledge flow	interaction between BU	And there is an ongoing plan to try and make us all work more closely, because at the moment we don't share any of our systems really with Wood group.
Knowledge flow	interaction between BU	And we also need to make sure that our requirements are met. We will discuss the needs with various business units.
Knowledge flow	interaction between BU	we can control access to that information. E.g. when you want business units to see their information and you don't want them to see other business units' information, which might be considered confidential, then we can block their own app, we can use the controls.
Knowledge flow	interaction between BU	It came from senior level. I don't really know, but once this decision was made, engineers came together and started talking about what they can bring to each other.
Knowledge flow	interaction between BU	now they were pushed together and realised that would be ideal if we do it every year, we've got really good results from that.
Knowledge flow	interaction between BU	We found a few new people at senior level coming to the business. Maybe when these new people have come in, they started asking, if you are working with valve business, why are you not working together?
Knowledge flow	interaction between BU problem	Minerals are completely different, a lot of people will view them as a completely separate company, so it's quite difficult to work with them.

Knowledge flow	knowledge dissemination	began disseminating that check list. At the moment I've put it on Confluence
Knowledge flow	knowledge dissemination	We tend to hear snippets of what they are doing, but at some stage during the project they will disseminate that information in a formal setting to those who really need to know what the work is that they are doing and what the benefits are for the company as a whole.
Knowledge flow	knowledge dissemination	any other operators, for example, SP, National Grid or anybody can come in at the end of the project, that we have to be pretty much open with the findings of the project and the idea behind it is to share the knowledge.
Knowledge flow	knowledge dissemination	theoretically everybody should get access to the same information at the end.
Knowledge flow	knowledge dissemination	one of the things that did work well , was that we helped develop and test a new type of camera that see SFX escapes which is a dangerous chemical that we need to reduce escaping from switch-gear. So instead of just writing a report to say: this is quite good, it works, we did demonstrations of it, both internally and for National Grid and Scottish Power as well.
Knowledge flow	knowledge dissemination	EA Technology managed it, so when it came to closing, so they did the close-down event and everything.
Knowledge flow	knowledge dissemination	webinars or have done any presentations we want to do
Knowledge flow	knowledge dissemination	you can see, which ones have progressed to a pilot, which ones have been approved, the whole theme for the ones that did really well, what's not gone ahead
Knowledge flow	knowledge dissemination	you must show-case all the projects which have closed down since the previous projects, since the previous conference
Knowledge flow	knowledge dissemination	I'm trying to get people excited about what we are doing and where it is going before we have to go and approach them.
Knowledge flow	knowledge dissemination effectiveness	we do other conferences and we you know we publish our close-down reports online and everything, but I guess the conferences are a real chance just to show it off.
Knowledge flow	knowledge dissemination effectiveness	for a new website that we've developed, we are getting about 15 000 people viewing it externally.
Knowledge flow	knowledge dissemination effectiveness	Most blogs that are viewed are video blogs.
Knowledge flow	knowledge dissemination effectiveness	The blogs, I'm trying to use them in a more of a sociable way than what you get from CEOs, knowledge sharing rather than CEO giving motivation speech.
Knowledge flow	knowledge dissemination effectiveness	We have 2000 people accessing blogs a day, they spend about 4.5 min reading through the blogs.
Knowledge flow	knowledge dissemination evaluation	We have no way of really quantifying it. We didn't gather feedback either year, which is maybe something we should do next year,
Knowledge flow	knowledge dissemination format	A lot of companies have Lunch & Learns maybe once a month, and you can book a slot there and it's a way to bribe people to come and listen to you for some free food. Literally it's what it comes down to in some places.
Knowledge flow	knowledge dissemination format	I only do workshops for clients for a day or two at their offices, looking at the problems and explaining to them how we have done things.
Knowledge flow	knowledge dissemination format	Our projects are not obvious to the current way of thinking, even they are not taught at the universities, so I'm and my colleagues, we go to the university to guest lecture and give a talk about the idea solutions.
Knowledge flow	knowledge dissemination format	Sometimes just giving a talk, sometimes informal conversation or a paper, technical note, presentation, or just sitting in the meeting, doing workshop.

Knowledge flow	knowledge dissemination format	the best way to get everybody is they provide lunch or we provide lunch, just sandwiches and drinks, and they invite all the engineers to have sandwiches, they all sit there, have sandwiches, while we present to them for an hour. This is quite successful, people come for free lunch.
Knowledge flow	knowledge dissemination format	we sometimes sponsor events, and we are actually planning to organise an event in the British embassy in Oman in 2 months' time.
Knowledge flow	knowledge dissemination format	We just need a good way to deliver messages, or do videos that we are allowed to watch.
Knowledge flow	knowledge dissemination format	I used it for Hackathon updates just to share their ideas with people
Knowledge flow	knowledge dissemination format	We have some Lunch & Learn, so people can go present their products to others.
Knowledge flow	knowledge dissemination format	I think the best way of dessiminating is presenting because then you get people asking questions.
Knowledge flow	knowledge dissemination format	In addition to that we had Ipads with presentations and voiceover of what we were doing.
Knowledge flow	knowledge dissemination format	Last year we hosted a networks event in London with ENA. There was quite a few of us who have presented and we had a stand with drop in sessions for people to come along with people who presented on the project.
Knowledge flow	knowledge dissemination format	We also videoed the conference as well. That's quite useful because you could circle this video around the company. And then people can revisit things on the video to learn.
Knowledge flow	knowledge dissemination format	We've got half day sessions where we have invited people.
Knowledge flow	knowledge dissemination format	we are looking to publish around 16 papers at Strathclyde, we are doing 4 at the moment.
Knowledge flow	knowledge dissemination format	we'll also look to host a number of different events in order to disseminate all this knowledge and all that learning
Knowledge flow	knowledge dissemination format	if the project has some learning and it has completed, try to invite stakeholders to come to a location and we can then present the findings that we've got to the project and that requests people to attend, if they find it useful.
Knowledge flow	knowledge dissemination format	sending emails or organising events, or posting things on websites
Knowledge flow	knowledge dissemination format	We are also organising webinars and trying to present the findings.
Knowledge flow	knowledge dissemination format	doing active demonstrations and showing, getting engineers, that would actually be using it to see it working in practice worked really well.
Knowledge flow	knowledge dissemination format	this year we had 2 workshops, which are 90 minutes, and we had like think 12 presentations
Knowledge flow	knowledge dissemination format	with the Aberdeen project we are gonna try and do a video and see if that helps
Knowledge flow	knowledge dissemination format	Most blogs that are viewed are video blogs.

Knowledge flow	knowledge dissemination problem	That's a problem as well, it's whatever the marketing team has picked up on. It's not necessarily the most interesting project that's come out.
Knowledge flow	knowledge dissemination problem	my main problem with innovation though is that they are not good at spreading their information to others on what's going on, especially on operational level.
Knowledge flow	knowledge dissemination problem	But I find that when I've tried to find out the information on other operating projects, it hasn't been as clear as I hoped it to be.
Knowledge flow	knowledge dissemination problem	But there is some stuff that they won't share. As I find out, when I'm trying to find out information about other projects, other ones, that I've completed, it tend to be difficult.
Knowledge flow	knowledge dissemination problem	I haven't seen anything where we fill out plan and we say, we are gonna capture the learnings for streamlining the process or making this easier or what was difficult in the project and feeding that back, so that somebody else could learn from that. I think, we are probably lacking there a little bit.
Knowledge flow	knowledge dissemination problem	in terms of findings from the Future Networks, I don't think that's necessarily shared very well. We have a lot of reports, but I don't think they are shared in the best way.
Knowledge flow	knowledge dissemination problem	then that report is lost. It's not shared, it's not shared as widely as it should, hopefully internally and externally as well.
Knowledge flow	knowledge dissemination problem	I think, we are really bad at publicising it for people, who aren't directly involved at that
Knowledge flow	knowledge dissemination problem	people who are, when I collect all the ideas at the conference, they might think: "well, I gave her 6 ideas and they've all just disappeared into her inbox
Knowledge flow	knowledge pull	You could also subscribe to specific pages, e.g. when you want to know about any change in the process or useful recommendation. And when there is an update and I have a question about it, I can email them and just go to that page, and then they go on and reply what there is.
Knowledge flow	knowledge pull	I don't want to email people every time there was an update. For that I'd just ask them to follow the page and we'll put everything there.
Knowledge flow	knowledge pull	There will be something written in the wiki, and they'll look it up, when they need to look at it, but it's not something that is conducted at the end of the project.
Knowledge flow	knowledge sharing	We have weekly meetings on a Friday.
Knowledge flow	knowledge sharing	we've got weekly meetings, so we are very open
Knowledge flow	knowledge sharing	Confluence has a thing that you could have random ideas, page or something like that.
Knowledge flow	knowledge sharing	if they have questions, there is quite a lot of I would say almost daily dialogue with the other offices, where someone might say, if anyone has got experience with such and such, and I'll email that to the whole due diligence group. And you might get answers back from different locations.
Knowledge flow	knowledge sharing	it's separate from the debrief process, but it's a prompt for people to share something unusual that they've come across.
Knowledge flow	knowledge sharing	All the team-leaders are doing the SVQ in team-management, in the past we would all get together in the room and just discuss management.
Knowledge flow	knowledge sharing	eventually we go and idealise the world and say, what should be done in the perfect world.
Knowledge flow	knowledge sharing	new technological development in the solar. 12:07 we do share it, but mostly with the Glasgow team rather than the internationals, but it does happen.
Knowledge flow	knowledge sharing	So we decided, that every Monday we have a team meeting and try to use this meeting to share these experiences and to use them as well to present any work that could have been done, for example, if you've developed a new tool

Knowledge flow	knowledge sharing	We usually call each to discuss one project in particular, and then it evolves to a general methodological conversation.
Knowledge flow	knowledge sharing	In the past the approach was: hey, let's bring a bunch of people from headquarters, have them present what they do
Knowledge flow	knowledge sharing	It was very informal,
Knowledge flow	knowledge sharing	Now we are going to share what all of us are doing, what is working well, what is not working so well
Knowledge flow	knowledge sharing	one of the things that came out of that is trying to bring people together, and that's probably one of the drivers for this summit.
Knowledge flow	knowledge sharing	You can email other project managers in our company, if there is something that you are stuck with and you can't figure it out
Knowledge flow	knowledge sharing	most of us will get together periodically just to check in
Knowledge flow	knowledge sharing	the product teams will have periodic meetings as well, where we will chat with each other.
Knowledge flow	knowledge sharing	there is a big email chain that they can actually send emails to: look at this news, everybody should be aware of that.
Knowledge flow	knowledge sharing	We have some Lunch & Learn, so people can go present their products to others.
Knowledge flow	knowledge sharing	I personally believe that you have to take every note of the meetings that you have with the customer and internally, so that everybody can read those notes and get up to speed.
Knowledge flow	knowledge sharing	we just talk to each other, because we just sit in the same space.
Knowledge flow	knowledge sharing	a half hour meeting on weekly basis, trying to identify if there are issues that need to be resolved.
Knowledge flow	knowledge sharing	I'll send it around all the different departments in SP: to a control room, to the business people, they'll all have a chance to read this paper and then we'll set a meeting once a month and I'll do a presentation: this is what I'm planning to do, I think this is best because this is the least cost and we can build a new circuit from here to here. And then people will discuss it around the table
Knowledge flow	knowledge sharing	Sometimes we have a team meeting, once a month. And someone might talk about a project.
Knowledge flow	knowledge sharing	We have a meeting once a week, engineering people and the commercial department who do all the contracts to discuss all the projects and whether they are on target. This one is due in 2 weeks' time, who is going that, are you gonna be ready?
Knowledge flow	knowledge sharing	But once that was shared, you could really see the value in repeating the project in the future and being aware of all those things.
Knowledge flow	knowledge sharing	I got one that was running HVDC project that had to do with presentation and to see what their key lessons learnt were and key concerns were, and lots of those were similar, so we were talking about how they consolidate it together. So quite high level, but yes, it's useful to get those people together
Knowledge flow	knowledge sharing	it was mainly just getting each other, getting everyone to know each other, getting to know what they are doing and exchanging contact details and probably the main benefit
Knowledge flow	knowledge sharing	now that the Aberdeen one is going so well, the project manager is now hanging on: "oh, wait." So this is somewhere, where we will learn, because I've shown them exactly what we did
Knowledge flow	knowledge sharing	At the same time you might find that some of the things like techniques or technologies can actually have an impact on another project manager's project, but maybe at the time they would not have realised how the two could impact each other, this is the chance to actually say: you are dealing with radio communication at the moment, I'll do that in a few months time, is there any learning that you've got from interfacing with the people who are supplying that, which I need to know about and prepare for

Knowledge flow	knowledge sharing	There is a lot of internal correspondence between various departments, various experts, because we also have to share knowledge
Knowledge flow	knowledge sharing	we talk for an hour every Monday morning at 10 o'clock. We share our experiences. We are almost 20 of us, and each person discusses their project and the experience they are having, the challenges, success and not so successful elements
Knowledge flow	knowledge sharing	And then people would still offer advice, when we are having problems, because sometimes even if it's not your project, you can offer advice for it.
Knowledge flow	knowledge sharing	a lot of the people have begun to realise that if we don't collaborate better, we won't exist the same way as we do.
Knowledge flow	knowledge sharing	We have training weekend for graduates in Stirling every year for 1 week.
Knowledge flow	knowledge sharing problems	Patents are of limited value and the dilemma between generating interests and keeping things secret, but the only way we can generate interest is to share information, but when we share that information we lose power.
Knowledge flow	knowledge sharing problems	Sometimes, when you are trying to do some market research or combine track records for specific business related activities, you will find that someone has done this before.
Knowledge flow	knowledge sharing problems	I know that everyone is far too busy to do anything like that.
Knowledge flow	knowledge sharing problems	Other PMs in our company use this tool as well, but we don't necessarily have access to each other systems. We should, but we don't
Knowledge flow	knowledge sharing problems	It just happens that people keep to this separate bit and try and build up the experience, but it also means that there is not much sharing from that.
Knowledge flow	knowledge sharing problems	nobody has got time to look at everybody else's work in detail anyway
Knowledge flow	knowledge sharing problems	there is one person just now looking at South West of Scotland, using consultants to redesign the whole part of the network, but at the same time I'm doing connections into that network and I'm not that sure what his final plans are. So the danger is he has gone into one direction and I'm offering connections.
Knowledge flow	knowledge sharing problems	we gave them a connection date, let's say June 2018. And this offer was dependent on SP, I knew we were doing some substation works to take away some old equipment, but then I just found out recently, that the project to take away the old equipment has been delayed
Knowledge flow	knowledge sharing problems	we identify that we need to change some transformers, we added a cost of £2 mln, but then I discover later on that one of the departments were already planning to change those transformers because that was a part of SP own work, and we never knew about it.
Knowledge flow	knowledge sharing problems	I had a potential project with a supplier, they are working on another project, that we are trying to put into business as usual, and you hear a couple of bad things about them not being able to support the project technically the way we should be able to know how difficult is it. I don't think there is an official list of people to deal with registered as such.
Knowledge flow	knowledge sharing problems	in previous experience you have an issue with people, who start putting pressure, want lots of updates on where the project is. People would become worried about telling truth about where project is, because you are the messenger, you are the project manager and then you say, basically that this project is not working and everything is red, we've got lots of problems, what are you doing about it. Well, if I could do something about it, I wouldn't need to be telling you about it.
Knowledge flow	knowledge sharing problems	But what that means is that coming next year we might be in direct competition with Scottish Power and that might mean that we are less helpful at sharing knowledge.

Knowledge flow	knowledge sharing problems	Now it fell away a little bit. Now I primarily deal with the projects that fall into my program.
Knowledge flow	knowledge sharing problems	a lot of people still got a mind-set, that if you have someone across in America who is the equivalent of your job, at this moment, with financial difficulties people get worried whether they are still gonna be required by the company.
Knowledge flow	knowledge sharing problems	before people were not aware of it: we've come up with this idea, that's our idea, we'll keep it.
Knowledge flow	knowledge sharing problems	In China people would be normally tired by their work, and they'll have less time for communicating formally and informally.
Knowledge flow	knowledge sharing quality	I've seen some useful things coming in the past, but whether the person who comments on the blogs will read them as well, we don't know.
Knowledge flow	knowledge sharing with partners	many clients also like it, they have a lunch break normally, in some companies near the last week of month they arrange a 2 hours presentation internally or they invite somebody from the outside for the technical PMs to learn from some other experiences.
Knowledge flow	knowledge sharing with partners	Sometimes just giving a talk, sometimes informal conversation or a paper, technical note, presentation, or just sitting in the meeting, doing workshop.
Knowledge flow	knowledge sharing with partners	We learn the world problem that they have seen, and we are using their knowledge to improve our offering.
Knowledge flow	knowledge sharing with partners	synopsis of all the projects we are looking at. All the utility companies have to do that, and that gives us visibility of what everyone else is doing, and we might actually say: that's of interest to us
Knowledge flow	knowledge sharing with partners	That works well for us. We are sharing thoughts and comments. And then there is regular meetings with all the utility companies that are engaged in with the EIC about what their concerns are, what would be good project to consider
Knowledge flow	knowledge sharing with partners	another DNO in London area to share learning around customer engagement strategies, that we used in NINES, and they were moving into project, where they would be engaging directly with the customer for a housing association, which is somewhere what we did. So there was some knowledge and learning shared.
Knowledge flow	need for knowledge sharing	I think project management thing would be useful, that people talk.
Knowledge flow	need for knowledge sharing	if it's a new project and it's been interesting, that it's something that can be used in the future, as you said, then it would be interesting to share the experience.
Knowledge flow	need for knowledge sharing	With the wind industry, which is much more established, I don't think, you have that many points to discuss as you do with solar, because a lot of our losses for energy yield are so guessed, the best guess that we do.
Knowledge flow	need for knowledge sharing	But sometimes within our own department people are doing projects which might affect where I'm doing connections, and that's probably more important to us.
Knowledge flow	need for knowledge sharing	the danger is that you think that what you are doing is the best thing to do, but you don't know if someone else has done something better.
Knowledge flow	need for knowledge sharing	We also have issues like when we get a wind farm connection; we need to know about all the small connections in the background and in the distribution, because that will impact upon what we are designing.
Knowledge flow	need for knowledge sharing	across National Grid, Scottish Power and ourselves we've got hundreds of project and within those hundreds of projects each one is coming with tens or hundreds of good bits of knowledge that would want to be shared.
Knowledge flow	need for knowledge sharing	how do you get all those bits of knowledge to the right people?

Knowledge flow	need for knowledge sharing	there is lots of work going on on HVDC projects in the UK, but they don't tend to talk to each other, and we all come across the same sorts of issues.
Knowledge flow	need for knowledge sharing	how you can keep that knowledge and understanding that we shouldn't do this, how do you make known to others who might be affected trying to do the same thing, and how do you make it easily accessible to any interested parties
Knowledge flow	need for knowledge sharing	Let's say, we decided to do a particular thing, that was not there before, and we find out after starting to make it that this thing cannot be made or it can, but it's absolute rubbish in terms of what we thought it would do. That's knowledge that tells others, that in the future don't try to make this thing.
Knowledge flow	need for visibility of work	somebody, who is working with one client internationally, could see that these 5 project managers are implementing the same product that I'm implementing with my customer, and I can go and talk to them.
Knowledge flow	need for visibility of work	We are working with my manager and his manager on how to connect all of them together and how to interact with them, so that if a PM works with a customer, they could see that we are working with them as well.
Knowledge flow	need for visibility of work	we don't have a lot of access to IT systems which show the status of the report and things like that. You then find out that, or, right, I've just lost a month on top the delivery time, because it's stuck here and nobody did anything about it.
Knowledge flow	seminars	I do not participate a lot in Lunch & Learn sessions, I've got a lot of work to do. It's not high in my priorities. Most of the ones that I attend are mostly about the product prior to its launch
Knowledge flow	seminars	There is some key aspects, that are used for project management: best practices, but the summit in my opinion should be all that it should be.
Knowledge flow	seminars	a product manager says: I want to go and present my stuff, it could be an hour, and sometimes marketing will help with that. It can be a part of a product launch, if we do a product release.
Knowledge flow	seminars	We have some training programs and sharing programs, which allow people to move around to attend a training in a specific site.
Knowledge flow	specialisation	we've got one guys who is an expert in one type of measurement and the offshore guys got all that skills
Knowledge flow	specialisation	It's not that I have personal preferences, it's more because these people tend to work more on solar than others.
Knowledge flow	specialisation	it tends to be 1 person will work on the interconnectors in Scotland and England, because there is a whole set of rules about that and about designing those, 1-2 people will do windfarm connections and they'll become better at those, other people will look at another area.
Knowledge flow	visibility of work	we try to have an hourly weekly meeting which we go through everyone running projects, pros and cons, everybody agrees with that and their views, and not only the projects, but also the next steps that we need to do, how we need to do, what other inquiries are coming in.
Knowledge flow	visibility of work	Now there are business development people, who discuss and go through all the leads and recognise that at that stage
Knowledge flow	visibility of work	If it's a technical due diligence in the UK, which we do thousands of time, than we don't need to know all the aspects of it.
Knowledge flow	visibility of work	I set up a shared page, where each project manager can go in and see other project managers in Silver Spring, they need to go in and list the companies that they are supporting, and then list different products that they are implementing over 2016 with the customers
Knowledge flow	visibility of work	I'm generally aware of all the big projects that are run in the company at the very high level, what customer we have, what customers we are implementing new products at
Knowledge flow	visibility of work	We do have project meetings and catch up sessions once a month or quarter, where the company gives a brief of what we are doing

Knowledge flow	visibility of work	any new projects will be registered on that. The other utility companies will get notification of projects registered. So that gives them visibility of what other people are looking at.
Knowledge flow	visibility of work	We have to report on our project on an annual basis to Ofgem, and that report would be a synopsis of all the projects we are looking at. All the utility companies have to do that, and that gives us visibility of what everyone else is doing
Knowledge flow	visibility of work	I don't always hear that that work has kicked off, but then it's not within my limit to take a day to day interest in that type of thing.
Knowledge flow	visibility of work	within the distribution side of the business, I have visibility of all the reinforcement work that's planned for the year.
Knowledge flow	visibility of work	I have because I make my business to be on top of what's happening, I stick my nose into other projects, because to me the underline of a lot of projects is the same base problems.
Knowledge flow	visibility of work	We also have a benefits tracker of the ones to whom the project has been deployed as completed and transferred to business as usual. If we claimed that we are gonna save 10 mln pounds on a project we have a benefit tracker which should actually be tracking it to see how effective it was
Knowledge flow	visibility of work	we have effectively project register that tells you what projects have all been looked at and effectively worked on or rejected for one reason or another. We have a project manager who will be named on it. So you always have a way of going back and speaking to somebody.
Knowledge flow	visibility of work	I have an idea for some of them that are relevant to me. And some of them are just interesting. We used to have meetings where everyone would speak about their projects, and that was actually quite nice, because you understood where everyone was, even if it didn't concern you
Knowledge flow	visibility of work	They have challenges, which is let us know about what you've done, write a report on it and present to the group. So everybody is constantly in a loop of what's going on.
Knowledge flow	visibility of work	we have weekly meetings in the engineering team, where everyone will go around and talk about the projects. That's sometimes very good, because we have a lot of current themes that come up, and they can help each other that way.
Knowledge flow	visibility of work	It's easy to understand, what projects they are working on in the office I work in because we don't have a lot of people and they also encourage me to talk to them.
Knowledge flow	visibility of work problems	We do not have really
Knowledge flow	visibility of work problems	I'm just guessing, I'm not a part of that, part of that business, so I can't help you actually.
Knowledge flow	visibility of work problems	UnionSquare does have proposals, but engineering didn't know that we are doing Undershore mast and they are doing Undershore Lander's engineering services.
Knowledge flow	visibility of work problems	unless it directly affects the project, probably no one needs to know.
Knowledge flow	visibility of work problems	I thought it was a bit of a shame that already in the office we don't really know what the other teams are up to, but even within our team don't necessarily now, what my colleagues are up to.
Knowledge flow	visibility of work problems	if it's a new project and it's been interesting, that it's something that can be used in the future, as you said, then it would be interesting to share the experience.
Knowledge flow	visibility of work problems	We communicate through emails but these are mostly about procedures around the company than projects we are working on.
Knowledge flow	visibility of work problems	We get occasionally emails from the marketing team, but it's mostly about what the marketing people are doing: conferences, exhibitions rather than the projects themselves. I don't really have any idea of what's happening in the wind team, for example, unless I talk to the specific people.
Knowledge flow	visibility of work problems	If they scheduled it like every 2 months on Thursday we are gonna have something from 4 to 6, and it's mandatory for you to attend, then we could probably do something about it. But they are sometimes late in the afternoon, or sometimes in the morning.

Knowledge flow	visibility of work problems	part of it is my own fault, because I just don't have the time to attend all of the trainings that they have, because we are fully engaged with our customers.
Knowledge flow	visibility of work problems	The problem is the briefs are one time slot, they are late in the afternoon, when the project managers are working with customers.
Knowledge flow	visibility of work problems	we have product teams drafting to get the product into the market. They do that and find about it after the fact, that we are not a part of implementing it, but then we become a part of the sales.
Knowledge flow	visibility of work problems	One of the challenges that I've had however is that sales people, who were enthusiastic about pushing next derivatives of what we are delivering now, at that point I found it difficult to follow conversation, because I haven't always been in the loop. Unfortunately I have then seen the customers who were expecting me to deliver certain things, when we've never really signed up to that.
Knowledge flow	visibility of work problems	I can't think of one system where it's all kept in. It tends to be different departments that would have their own projects and programs.
Knowledge flow	visibility of work problems	they don't normally put an optical fibre in there because they don't need it and it's more expensive. But we've had some jobs, where our overhead line department has built an overhead line and we think: o, we can connect a windfarm, but because they never put an optical fibre in it, we now have to rebuild it again or do something.
Knowledge flow	visibility of work problems	I don't know, what everybody else does, and I don't know what everybody else's job should be. For example, I don't really know what Sorcha does, I know what her job title is, but I don't actually know what her role entails.
Knowledge flow	visibility of work problems	we have project engineers, who also run projects, and I don't know, why they are on them and we are on them, rather than project managers run projects and project engineers deal with the technical part of it.
Knowledge flow	visibility of work problems	we should actually have a metrics where we are saying, we will want to monitor vibrations and populate it with what technologies are meeting that, and that almost drives you to where you should invest.
Knowledge flow	visibility of work problems	he is doing some projects, I couldn't tell you, what they are
Knowledge flow	visibility of work problems	We maybe miss out on opportunities to kind of do that kind of informal dissemination and informal sort of knowledge transfer among the team.
Knowledge flow	visibility of work problems	for people who work in Inverness knowing what is happening in Portsmouth is not possible, unless there is anything valid, then we are communicating directly.
Knowledge flow	visibility of work problems	a lot of people (MBA) have come up with the solution, e.g. condition monitoring, putting sensors on equipment. But this is something that we already do in some parts of the business that are leading
Knowledge flow	visibility of work problems	A lot of the people who have come up with the idea, don't really know that it's going somewhere else, and what happens is that it just filters through the company.
Knowledge tracking	experience tracking	UnionSquare does that automatically, So in order to book timetable to a project, you need to be listed against it, which means you can go to the project and you can see a list of everybody from Sgurr who is taking part
Knowledge tracking	experience tracking	you can look up a company or you can look up a history of that company, you can look up each and every person and see the history of, that I've worked on in UnionSquare.
Knowledge tracking	experience tracking	in UnionSquare there is a search of the history of particular people to see what projects they've been involved in.
Knowledge tracking	experience tracking	I personally don't track their skills, I worked with these teams for the last 4 years and I know who does what.
Knowledge tracking	experience tracking	I think it's informal
Knowledge tracking	experience tracking	for the past, it will be project by project depending on how well each of them is documented.

Knowledge tracking	experience tracking	It wouldn't be a specific register to identify who was involved, but we could determine who had been involved through the technical authorisation process.
Knowledge tracking	experience tracking	It does, but in a smaller scale. I'm a part of technical engineering services, which includes a number of places down in England. Within that business we'll have access to that information.
Knowledge tracking	experience tracking problem	The only issue with that is you don't necessarily see the main projects or the ones that are more relevant. You really see everything, you cannot delete information.
Knowledge tracking	experience tracking problem	you get people here who've got lots of experience and don't do anything, and people who are just graduates and don't have any experience and who are so dedicated to the work that they actually produce better results at the end. Experience, is it relevant? Not necessarily as I see.
Knowledge tracking	expertise mapping	I know who has the information I need.
Knowledge tracking	expertise mapping	Each person have a list of trainings that they've got. For us for climbing certain types of mast you've got to have tickets – first aid, climbing certificates, rescue.
Knowledge tracking	expertise mapping	(1) SNE list, that is being compiled for offshore mainly, this is to help international offices know where the staff are allocated for each task
Knowledge tracking	expertise mapping	SNE initiative is probably better, tracking skills or people across different sectors, so when you need specific tasks being done, the idea is that you can see the list of people, who can carry out this task at various levels of experience.
Knowledge tracking	expertise mapping	Any particular virtual knowledge team will have a list of subject matter experts, and then it will link you to them and you'll be able to get in touch with them.
Knowledge tracking	expertise mapping	If you get an answer and you think it's a good answer, you'll give it a tick, rate it. And then experts can naturally flow to the top, because it's gamified.
Knowledge tracking	expertise mapping	We are currently trialling Confluence platform, that allows you to identify subject matter experts,
Knowledge tracking	expertise mapping	We've got 2 systems, both of which are in a process of being set up: those who will have nominated subject matter experts and Q&A things. Hopefully, people who give the best answers, naturally flow to the top of that system.
Knowledge tracking	expertise mapping	you could in theory have a look at these CVs and see who is doing what
Knowledge tracking	expertise mapping	I'll go to product management in most cases or those who supervise customer support, and if they can't help me, then I'll put a ticket inside Jira: here I've got a problem with this device, here is my issue.
Knowledge tracking	expertise mapping	Or I'll come to my boss: here is my issue, whom do I need to engage?
Knowledge tracking	expertise mapping	I think it would be the same, if we had everything documented. New things always come up and you don't always know who is the appropriate person to speak to. Sometimes you just need to talk to people who are a bit more experienced.
Knowledge tracking	expertise mapping	I've got enough people whom I can talk to and say: whom do I talk to in this instance? And then I get through. It might be one phone call more, then otherwise
Knowledge tracking	expertise mapping	I would start to ask questions of who a particular person is if I didn't know.
Knowledge tracking	expertise mapping	When dealing with the rest of the business, you can identify key people, who might actually help you, but you can also be told: don't talk to them, he is a dinosaur.
Knowledge tracking	expertise mapping	I would just tend to ask someone.
Knowledge tracking	expertise mapping	So I might say: does anyone knows who works in that region, so they might just get me an email, it's very informal.
Knowledge tracking	expertise mapping	Knowing people that know people that… There is not list of skills or anything, no easy way to find them.

Knowledge tracking	expertise mapping	the other way I think to improve knowledge just comes from the people point of view. So instead of trying to mechanistically capture all bits of knowledge you just work out, who all your experts are in the business, and sort of assume that they, they will know what to capture, they'll remember, what's been done, etc.
Knowledge tracking	expertise mapping	team page with the profile of everybody, because then, especially if that was tagged, if you had a question, you could find somebody and ask.
Knowledge tracking	expertise mapping	if you just need to talk to someone this will be through recommendation.
Knowledge tracking	expertise mapping	we went top down – from the top management to ask for who is the right people to speak to.
Knowledge tracking	expertise mapping	It's very informal
Knowledge tracking	expertise mapping	If you want to find someone whom you completely don't know at all, we normally ask for help from people who know that and stay in the company for longer.
Knowledge tracking	expertise mapping	It's easy to find technical experts.
Knowledge tracking	expertise mapping problem	it's not done particularly well, but there is an awareness that it should be.
Knowledge tracking	expertise mapping problem	I think, potentially problem with that might be that generally people are not that keen on saying: I'm great at this, I know a lot about this. People are generally quite modest and they don't want to put them down as experts in lots of things.
Knowledge tracking	expertise mapping problem	Now China and India and America, I've never been to the offices there and I have no idea who those people are and I don't know whom to ask.
Knowledge tracking	expertise mapping problem	Some people will be nominated as subject matter experts and that's fine, because that will be agreed, but I don't think people will nominate themselves as being good at things.
Knowledge tracking	expertise mapping problem	but ultimately they don't necesserally tell you that much about what person can actually do, when you come back to their work.
Knowledge tracking	expertise mapping problem	It's partly difficult, and part of it is just my own fault, that I don't go to some of the meetings that happen.
Knowledge tracking	expertise mapping problem	Sometimes it's hard to get a hold on that person, find out who it is and then get a response.
Knowledge tracking	expertise mapping problem	There is an org chart and there is a directory, but it's not always easy to understand who looks after what, when you are new to the company, even if there was a really thorough directory.
Knowledge tracking	expertise mapping problem	At times it would be useful to know where to go, but then you just ask your colleagues and they'll point you.
Knowledge tracking	expertise mapping problem	I don't think so. It's to some extend inside the head of our manager and ourselves
Knowledge tracking	expertise mapping problem	You want to find out something, but that's the case of asking the manager or other people who knows about that.
Knowledge tracking	expertise mapping problem	And then you might not speak to the right person. A lot of that comes down to individuals and their experiences.
Knowledge tracking	expertise mapping problem	in this sort of business, you could spend a lot of time you know listing up lots of people, listing up their competences or what they know, what they don't but then to be honest, that would never be obtained, and would never be as good as just talking to key people and finding out, and they probably know more about people's expertise.

Knowledge tracking	expertise mapping problem	how do you distinguish between real-time systems, national telecom centre, IT communication? If you look at those departments, there are a lot of overlaps.
Knowledge tracking	knowledge gap	with the company for 46 years, they came from the shopfloor as apprentices and worked for the company right up to senior engineers. People who come from university will never really have that standard, because they haven't seen the whole process.
Knowledge tracking	knowledge gap covering	And Apprentices as well, which is what we need more and more.
Knowledge tracking	knowledge gap covering	People who come from university will never really have that standard, because they haven't seen the whole process. Because of these graduate development programs you get a bit of hands on experience.
Knowledge tracking	expertise mapping	finding people, getting to know their respective roles in the organisation, if you are not from smart grid community, it will take you a little while to get to know what each group does, and what responsibilities each of them have, that probably took me a year to figure out, who you need to engage with on various problems.
Knowledge tracking	expertise mapping	Some people are recognised as subject matter experts by their title, if you are the manager of software engineering, there are expectations, that you are a subject matter expert around that particular task
Knowledge tracking	expertise mapping	There are a number of other people who established themselves as subject matter experts by their competency
Knowledge tracking	expertise mapping	there is a number of people who stand out in their particular job. They've enabled themselves as the go to person, not because of what they do, but also because of the broad knowledge, that is outside of what they are responsible for.
Knowledge tracking	expertise mapping	now when you need someone with the certain expertise you just go around and ask if anyone knows anyone
Knowledge tracking	expertise mapping	so at the moment the one who doesn't have the experience is picking up the one to ask the one who has the experience.
Knowledge tracking	need for expertise tracking	I can program, I can build websites, all that stuff, that's not necessary for my job, but I can do that, and it adds extra functionality to the team.
Knowledge tracking	expertise mapping problem	how do you distinguish between real-time systems, national telecom centre, IT communication? If you look at those departments, there are a lot of overlaps.
Knowledge tracking	team selection	We have a very small organisation here, the operations team is only 4 people, the roles are quite defined already.
Knowledge tracking	team selection	I find a project team and then I pull up all the ideas, and in that team there are 4 people: one person from technology, one will be from operations, one will be just looking after from the overall point of view, how things work, and one will be either a student or a very junior guy, who is gonna do all the work.
Knowledge tracking	team selection	Whoever is free, normally? So I speak to the team-leaders of the respective teams and say, you know, who is available to have a job started, and I try to give them notice
Knowledge tracking	team selection	It's their skill set and title, and experience, but then the availability.
Knowledge tracking	team selection	People are assigned. We've got an installation team, they are the people who install mass, we've got 2 offshore guys.
Knowledge tracking	team selection	what determines the composition of the team is mainly the availability of stuff, if they are already committed to projects or not, and also sometimes expertise, specific knowledge, particular tools or specific background, and of course the seniority levels if some positions require more seniority level, this will be taken into account.
Knowledge tracking	team selection	environmental team and civils team, but in this team you don't ask respective leaders, you ask people, you know within this team, if they want to take these tasks.
Knowledge tracking	team selection	If I'm the project manager, I'm going to ask my team leader who he wants to do the solar tasks within the team and then the electrical stuff is send over to the head of the electrical team

Knowledge tracking	team selection	I don't. A lot of the work that we do we rely on resources, that are already set in the company, unless you've got a really big.
Knowledge tracking	team selection	I have no influence on why I want this person, we also have specific groups in our company, that you can choose from.
Knowledge tracking	team selection	They are all tied together, but the knowledge in order to make that happen is very specific. So when I'm doing network design, I only have people who work on that. It's really not a challenge of interchanging people, it's really getting that person to do that part.
Knowledge tracking	team selection	It's a very good process actually: Here is the person in contact, there is the contract that we perform, and that group will work with the director of proposals. And that person will go through and determine: ok, I've done this before, I can ask this person in the company, who should document then what that resource is, not necessarily a person, but the resource.
Knowledge tracking	team selection	The project team is usually defined by access and our contract.
Knowledge tracking	team selection	we actually get our team managers select the members during their team review.
Knowledge tracking	team selection	involve people on ad-hoc basis based on who is available at the moment
Knowledge tracking	team selection	things are quite informal, so I will tell that I've got Steve to build the product for you, but Steve will have 10 other things to do, so the challenge is getting Steve to focus on and deliver the work for my project
Knowledge tracking	team selection	I have 1 other person who works for Silver Spring, and he is a smart grid engineer. He is whom I work with the majority of the time. And in fact I'm typically working with the Australian team, whoever is available.
Knowledge tracking	team selection	if it's people in the States, who are already in their roles, you are just working with whoever is available at the time. So far I didn't have to pick anybody, it was pretty obvious whom to work with.
Knowledge tracking	team selection	It's based on availability of people and their capability
Knowledge tracking	team selection	It comes down to primarily skills and knowledge, and then there is a question around availability
Knowledge tracking	team selection	So the engineers who are working on the innovation projects, are they also doing their regular job? Business as usual
Knowledge tracking	team selection	There is a limited pool of people who are involved in this type of work. All I'm looking for is additional support for the preparation of costs and for performing network analysis studies.
Knowledge tracking	team selection	Basically it's organically growing at the moment. There is only 4 people in the team
Knowledge tracking	team selection	It's the same for everybody else, we were picking key people, but also people who are available as well,
Knowledge tracking	team selection	For technical point of view there is one person in business that is recognised as the expert in HVDC, so I had to get him on the project, so I had to persuade.
Knowledge tracking	team selection	He probably did have a choice, but it was interesting enough that he… It was probably mainly, if his manager did not want to release him, that could have been a problem, but he did
Knowledge tracking	team selection	I was selected, because this the NIC project, so I was the person who wrote the bid for that, so I was the natural person to go and look into that
Knowledge tracking	team selection	The IT person, we did an interview, we did a recruitment process for the selection of an internal person. So that was an active selection. We've got the best person, we could find. And lastly it's a commerce person, who is just from our team.
Knowledge tracking	team selection	Pretty much get appointed
Knowledge tracking	team selection	At the time there wasn't much choice about who would do it, although it was timely that I was there because I had knowledge about it. It would have come to me anyway.

Knowledge tracking	team selection	It's basically placing people where their best strengths can be used.
Knowledge tracking	team selection	now the idea is just allocating different project manages within the department, however we then sign technical lead persons within the business who then advise those project managers for technical matters.
Knowledge tracking	team selection	we've changed that now based on the fact that business has got a lot of work to do and if you were a project manager and needed to run your daily projects and then you get another project, you'd give the priorities which one to give more time to. When you do a research project, it can last for 4 years, and the technology is too far from becoming a reality.
Knowledge tracking	team selection	when you are allocating the project you are trying to look at the background of the person to see whether they have relevant expertise. 23:23 Yes.
Knowledge tracking	team selection	With the current role that I have now sometimes I actually have to volunteer to directly manage the project rather than oversee a project. It might be based on the fact that I can add more value based on my experience.
Knowledge tracking	team selection	Assigned by higher level managers.
Knowledge tracking	team selection	Normally the GM will assign different parts of the project to different managers, and they will decide who is the person who can help with that project.
Knowledge tracking	work allocation problem	the team leader in general has all the power to decide where this work gets done, who does that work. And sometimes they choose the most technical person to do it, which is relevant to the business, but it would also be nice to encourage anyone else who would be interested in that area to do it as well.
Knowledge workers	connectors	So I'm relying on people like Tawanda, who is really helpful to say, you know, I'm trying to get someone in the national grid, who is a good person to speak to? And Tawanda does those little things like giving a bit of an introduction through an email, saying that it's one of my colleagues, looking for some information. And then I follow up.
Knowledge workers	connectors	would never be as good as just talking to key people and finding out, and they probably know more about people's expertise.
Knowledge workers	KM team	We've had our customer service director here and the girl that does stakeholder engagement, I think she comes up with all these things using yammer and advertising campaigns and all this stuff,
Knowledge workers	KM team	we have 2 knowledge analysts, one commercial, sorry, I'm commercial analyst, one communications person and one communications and stakeholder engagement person
Knowledge workers	KM team	you have knowledge management or knowledge managers, I suppose, communication people, stakeholders' engagement managers and commercial analysts.
Learning	benchmarking	I'm sending them out an email, and I say: "what did you see that we should be copying essentially?"
Learning	benchmarking	pile a list of innovations to fast follow, so innovations, that other companies have trialled
Learning	best practice	Wood group in the last few out of nowhere have suddenly come up with these 2 new things that they are doing. One is called the knowledge hub, which is mostly collecting case studies about past projects that you can use to show to clients as a part of your business development.
Learning	best practice	in the company I used to work for they had an awesome system for best practices, every project you were closing, you had to have it, you had to put it.
Learning	best practice	It was saving you a lot of time I guess. 17:20 A lot of time,
Learning	best practice	we are putting together some information, but it's not totally complete
Learning	best practice	in the intranet they do talk about success stories.
Learning	best practice	you do get emails praising up people every now and then for their work in certain areas.

Learning	best practice	Mostly within the younger group and during the casual conversations.
Learning	best practices problem	And in terms of best practices is the situation similar to lessons learnt? Nobody is trying to reflect what they did really well and trying to spread the wisdom? 25:16 That's all that come down under the same thing, no one is really doing that.
Learning	learning from projects	we might revisit it later on or it might give us valuable learning into another project.
Learning	learning from projects	we've got a potential project index, so that's project that we thought about doing, but maybe not have been, the technology has not been right or something like that, or it's not gonna produce enough learning and knowledge at this time, and there is not appetite for it within the business.
Learning	learning from projects	I like it because I get a lot of articles through Yammer, some of them which actually help me make some decisions about some of my projects as well.
Learning	learning problem	our time is broken down on hourly rates, and people's chargeability and the number of hours is a key parameter for the company. And although I suspect it might be a good idea, I don't think we'd be able to get the budget signed off here to do that, unless it's gonna contribute directly to earnings in the future.
Learning	lessons learnt	it's more or less incorporated into the system that we have on the design improvement level. That's almost always dealed with immediately.
Learning	lessons learnt	some clients have a project close out meeting and we'll try and get as much information as we can from that.
Learning	lessons learnt	We try to get the customer satisfaction from them
Learning	lessons learnt	at the end of every project, and sometimes even before the project
Learning	lessons learnt	If the project fails or it was successful, we want to see what we can learn from it, how can we avoid it in the future or how we can implement it.
Learning	lessons learnt	we produce a 1 pager sheet with the presentation which shows the highlights of this one.
Learning	lessons learnt	We have meetings, where we would talk about what things were learnt, what problems we currently have, how we can avoid things like that.
Learning	lessons learnt	I don't think there is an actual formal process, we just share informally
Learning	lessons learnt	I normally will send a feedback, just can you let us know what we did well and what we could do better in the future
Learning	lessons learnt	in our team-meeting one of the agenda items is lessons learnt, so I have people who heard about something particularly interesting or unusual on a project, then it's a prompt for them to say: oh, yes, last week I came across...
Learning	lessons learnt	it took longer than we thought, because it was just different over there. So this time we bided on a tender with the World Bank and partnered up with the South African company.
Learning	lessons learnt	When the masts break down they are taken off, and previously we would send them away, they get refurbished and calibrated, however then you put them on a new mast, and they just stop working. So we've stopped doing that. We just buy a new one.
Learning	lessons learnt	they are not as immersive as they should be, but there are lessons learnt session, where you track what is good, what is bad, and try to combine them, to do some best practice guidance, which is usually compiled by an expert to the field, senior member of the staff.
Learning	lessons learnt	you really have a tonne of them, it's really recording everything from management practices to technical details,
Learning	lessons learnt	they would identify project that are of a certain size or they've gone badly or well and just they eventually made everyone sit down and talk about it. It was a good idea but never quite implemented.
Learning	lessons learnt	At the end of my last project I had a series of meetings with all of the key participants in the project and we set down going through, filling out lessons learnt report, what lessons we have, what we should change for future projects, it was really well received.

Learning	lessons learnt	I did a small 4 months project and there were a lot of lessons learnt
Learning	lessons learnt	I documented them for myself
Learning	lessons learnt	We do discuss lessons learnt internally with managers, but we don't do it in any other place
Learning	lessons learnt	do that for every development to talk about what went well, what didn't go so well. And certainly after every release we will talk about it.
Learning	lessons learnt	for deployment you get a lot of product feedback, but there is only one product that is only going to a few customer, than it's a lot easier after each release to just talk to the project managers and get their input, what went well, what didn't.
Learning	lessons learnt	For the stage-gate process, it's only engineering and core stakeholders will show up.
Learning	lessons learnt	For those with whom we have close relationship, we either run it with their head of marketing
Learning	lessons learnt	we'll talk about achievements, risks, what could have gone better.
Learning	lessons learnt	And on all of those projects what we do at the end is write a report that will say – this is what we set out to do and this is what we actually achieved, this is what it actually costed us, this is how much longer it took us to do than it should have.
Learning	lessons learnt	And then I take the individual issues and put them on the table and say – that was that issue, understand what the root cause of that issue than I come up with the recommendation.
Learning	lessons learnt	We've done learning through competition bids, and what did for that is we got everyone together in the room before we bid again to share our experiences of previous bids, to share what went well and what didn't go so well and what we might do differently.
Learning	lessons learnt	lessons learnt within the project are transforming into other teams and needs, mainly through data analytics.
Learning	lessons learnt	The failure of the project had its own lessons – don't go too far outside the BU, build from the base, identify business benefit a lot more for directors.
Learning	lessons learnt	it was good to be able to learn kind of things that people didn't write down in their reports, because they felt that it wasn't appropriate or wasn't necessary. But once that was shared, you could really see the value in repeating the project in the future and being aware of all those things.
Learning	lessons learnt	Other projects tend to try and have a log, and the idea is that you can populate that when you need to, and then at the end of the project you have a wrap up session where you look what you've learnt.
Learning	lessons learnt	Some projects try and have lessons learnt moments at the start of each monthly meeting, they have a monthly review meeting.
Learning	lessons learnt	For me it's useful, because I can say what went well in this stage and then what will I change for the next stage. So for me during my stages it's fine,
Learning	lessons learnt	with the large projects it's a requirement, that every gate (there are 5 gates in the process), at every gate we do a lessons learnt workshop or interview
Learning	lessons learnt	we had a couple of lunch and lean sessions last year, so and that was just within our team, and we asked project managers just for 40 min over lunch time to give an update of their project and some of the lessons learnt
Learning	lessons learnt	when I was in the engineering part of business, we did, you know, we used to have lessons learnt, but with a facilitator
Learning	lessons learnt	each person discusses their project and the experience they are having, the challenges, success and not so successful elements
Learning	lessons learnt	we are still on a learning curve and every time we close a project, we always look at what we did well, what we didn't do so well, what we could improve. In some cases we probably end up registering follow on projects
Learning	lessons learnt	And if we conduct a similar trial, we'll read through that and see: our customers are probably gonna have the same issues. Let's make sure that we rectify that beforehand.

Learning	lessons learnt dissemination	Technically we can treat it as our trials, and we do write about it in our wikis for everyone to read.
Learning	lessons learnt	There will be something written in the wiki, and they'll look it up, when they need to look at it, but it's not something that is conducted at the end of the project.
Learning	lessons learnt	We'll just take all the best aspects of this, just like you saw – using confluence, that was used by one of our team-members before. We use a lot of personal experience
Learning	lessons learnt dissemination	I've put some bits in blogs for a project I've worked on: here is an issue, here is what the fault was.
Learning	lessons learnt	It's becoming more common now. We've had discussions about people using their knowledge, lessons learnt type a bit more.
Learning	lessons learnt	we have weekly meetings in the engineering team, where everyone will go around and talk about the projects. That's sometimes very good, because we have a lot of current themes that come up, and they can help each other that way.
Learning	lessons learnt dissemination	I try to diplomatically make suggestions to other colleagues in other functions
Learning	lessons learnt problems	we might find a year later, that it's still up and running, and they've forgotten about it, which is usually the case
Learning	lessons learnt problems	because we are not often involved in the actual deployment of the technology into the client's facilities, there've been many cases where client had taken the equipment and they've installed it, and we have no feedback at all.
Learning	lessons learnt problems	We don't get any news from them and we recognise it as a weakness in our learning, and try to find better ways of engaging
Learning	lessons learnt problems	it doesn't get documented, but I actually might not know about it as well.
Learning	lessons learnt problems	But it's pretty informal, just email and sometimes they reply, sometimes they don't. So I think, that's something that we, we recognise, we have to work on.
Learning	lessons learnt problems	There is a lessons learnt register and report and lots of stuff, we seldom do that. Just because we've not got enough time.
Learning	lessons learnt problems	I'm not sure if it's very well streamlined across the business
Learning	lessons learnt problems	I'm not aware that any team does it. I tried to get the engineering team at the end of one project, which was with China and they had a problem, and did try and get the project manager to write a lessons learnt note that we could share and discuss, but I don't think that they ever did it.
Learning	lessons learnt problems	that falls under the project closure and lessons learnt from projects, which is the system which we briefly set up in 2010 for big projects or projects that had gone either really well or really badly. But that only lasted a few months
Learning	lessons learnt problems	Everybody was saying that it's such a good idea. But that's where it ended. Over the things that we decided, there was no program taken from it to actually be carried out and be responsible for it.
Learning	lessons learnt problems	We really didn't follow up with tracking and holding people responsible for carrying out these things. No did we have an effective way of sharing those things with all the other PMs out there.
Learning	lessons learnt problems	I did not document them.
Learning	lessons learnt problems	we don't disseminate them as we have meetings. I don't think I've ever had a lessons learnt session.
Learning	lessons learnt problems	but my understanding is that unfortunately we have lots of stuff, and much of that capability has gone away.
Learning	lessons learnt problems	I did that for the project on UK PM about 4 years ago and I circulated that, but I'm not entirely sure that went anywhere.

Learning	lessons learnt problems	I've offered a part of this to my colleagues, but I'm pretty sure that it was not taken on board, not because they ignore me, but because there is no formal way of doing that.
Learning	lessons learnt problems	I think we would argue that we do it through discussion and in our heads, but we don't right down and record those lessons learnt.
Learning	lessons learnt problems	not in a formal way
Learning	lessons learnt problems	We are trying to do lessons learnt. It's probably on the ongoing bases, but at the end of it you probably get caught up with the next project.
Learning	lessons learnt problems	I'm not sure how frequently that happens purely because of the high volumes of connections that we are dealing with
Learning	lessons learnt problems	But it gets quite difficult because you've got several years' worth of findings and it can be quite hard trying to think about it at the end of the project.
Learning	lessons learnt problems	I guess, this is where it disconnects, when you kept the learning and the lessons learnt, then do you do with it? How do you ensure that that's taken on board by everybody?
Learning	lessons learnt problems	I don't think, anyone outside my project reads it. So it doesn't help other projects, it just helps me.
Learning	lessons learnt problems	the way we capture the learning from projects needs to be better.
Learning	lessons learnt problems	There is no such requirement for future networks, so it's very adhoc. If people or project managers do it or not
Learning	lessons learnt problems	You capture lessons learnt log, which is pretty well useless, so no one is actually going to use it again. So there is no process to actually review past lessons learnt.
Learning	lessons learnt problems	I certainly find that in a project where we had real-real difficulty with the supplier, and then you find out, that we've hired them for something else
Learning	lessons learnt problems	It's like a formality. 33:32 yes.
Learning	lessons learnt problems	it's not like you sit around brainstorming. The manager goes off and thinks themselves and writes it down
Learning	lessons learnt problems	that's something that we've been really bad at
Learning	lessons learnt problems	you lose a lot in terms of lessons learnt from the earlier days
Learning	lessons learnt problems	Unfortunately it's not formal reviews after the project. That should be something that is written up, or something that we talk about in the meeting.
Learning	lessons learnt problems	But at the end of the project that information tends to be lost.
Learning	lessons learnt problems	For a lot of the engineers lessons learnt are: has there been a wrong input, has there been a wrong material used? Which might be ok for that situation, but may not apply to anything else. Trying to get this nice middle-ground – here is really useful information and how you can apply it.
Learning	lessons learnt problems	I think people are still in this way: they are not gonna show how to use it. It's fair enough. You can put in: I worked in this project, this was the fault, this is how we solved it. I think people don't specifically know what they should cover.
Learning	lessons learnt procedure	We have a project review process as a part of our QM system. We are ISO 9001 certified.
Learning	lessons learnt procedure	it's a close out normally at each end of project, that it supposed to recap the project. I'm not sure if it's very well streamlined across the business, but it's a part of the normal procedure.
Learning	lessons learnt procedure	For some of the bigger ones it might be a lessons learnt meeting, for some of the smaller ones it can be just lessons learnt notes.

Learning	lessons learnt procedure	up until about 2 years ago we did have a more formal way of feeding back into the services part of the organisation lessons learnt and recommendations, recruitment services,
Learning	lessons learnt procedure	we would take it from design through the specification stage to the installation and then have a financial close-down and try to ensure that all the works or issues associated with that project are put in for future reference
Learning	lessons learnt procedure	framework that we are using at the moment is fairly new, it started on the 1st of April 2013
Learning	lessons learnt purpose	we try to see what went wrong in the system, and this system has been assessed by the outside examiner, we've been given clearance twice last year.
Learning	lessons learnt purpose	The other part of that is when the project is closed, is to make sure that all the key information and new knowledge is extracted on the Confluence or somewhere else, where it can be found, so that other people can find it in the future. But it's quite hard to do that.
Learning	lessons learnt purpose	If they are doing them, I would say they are maybe, they are definitely doing them for the outside audience. So there are lessons learnt that goes into the final report.
Learning	lessons learnt purpose	We'll have lessons learnt in some of our trials.
Learning	need for lessons learnt	We are hoping that we will have lessons learnt from this project and then ultimately what we learn will be called a GA product.
Learning	need for lessons learnt	And the report said: the analysis showed X, Y, Z, but it didn't say that we struggled to find the time or money to do that.
Learning	need for training	I'm not sure that any of our project managers know how to update the pages of Confluence. We do have some upcoming trainings to get everybody a little more educated on how to use Confluence.
Learning	new hire	I only joined SP about 15 months ago
Learning	new hire	I'm a kind of back fellow of Tawanda
Learning	new hire problems	There is no formal training or learning.
Learning	new hire problems	Over the past few months there've been a lot of new team members and the team has done nothing to try and help get more rigorous
Learning	new hire problems	When I first started, I felt like I as asking the same 1 or 2 people lots of questions all the time for different things. Not that anybody has actually changed, but I felt like I must be annoying them now, because they must be busy with their own things.
Learning	new hire problems	But for someone who is coming into the organisation who has been around for 4-6 months it can be a hard task.
Learning	new hire taining	whenever there is a new person to do wind analysis for instance, they first come to Glasgow office for training for a few months. That doesn't happen in solar.
Learning	new hire taining	We've been trying to keep that updated, so that if someone was new, you could say – here is the book, read this. It's a work in progress.
Learning	trials	quite often you come up with what you think the solution is and you try it with the client, an early adopter.
Learning	trials	We'll after interesting things in meetings and conferences, they are a good way to chat, it's not too official, and it's good to get feedback that way.
organisational aspects	company size	we only support 18 employees.
organisational aspects	company size	it's not such a big company, it took me a few months to figure out who works on what, what teams we have.
organisational aspects	company size	we have 500-600 people
organisational aspects	company size	61 people in the team

organisational aspects	dynamic environment	It's also a company that's evolving very rapidly. These Silicon Valley companies are a bit of a different breed to the companies where I've worked before, where top standards are required and things have been around for a long time
organisational aspects	non-dynamic environment	people do not change that easily, especially in the oil&gas industry.
organisational aspects	organisational structure	It's a very matrix organisation
organisational aspects	organisational structure	We are matrix, we have functional areas obviously
organisational aspects	organisational structure	whereas the model here is that it's people like me, generalists that do project management on the ground, for the relatively small projects, projects that don't justify having a full time stuff for services that we are working on
organisational aspects	organisational structure	In the manufacturing facility you normally have people, who is assigned for completing the order, it's more order oriented, we have different departments, they will handle different stages for.
patents	patents problem	Patents are of limited value and the dilemma between generating interests and keeping things secret, but the only way we can generate interest is to share information, but when we share that information we lose power.
process improvement	process improvement problems	Sometimes we do implement some ideas, we request that, and then you have to wait for 6 months before anything happens.
Project management	project diary	it gave me some information, they could probably be more detailed, I think. If somebody has to pick up the phone and ask me where I'm with the project and what I'm doing at the moment, then there is obviously some information lacking, where it should be easy enough to particularly for people like my boss, who have got multiple projects, it should be easy for him to know where each of them are, but I could probably use something like the project diary to be more detailed.
Project management	project diary	On the three larger projects, because we each have got a dedicated project manager, we don't do that, because we work on a full time.
Project management	project diary	they keep that because the project managers tend to dip in and out of them
Project management	project diary	anyone can update that, although it's the project managers responsibility to makes sure, that it's updated
Project management	project diary	in theory the project manager keeps a project diary, which they should update a kind of every day or every week
Project management	project management best practice	I put together a kick-off document, which covers the key information about the projects size, who the parties are, what the scope is, what the timelines are, what stage the project is in
Project management	project management best practice	I maintain Confluence status around my projects, any relevant information around my projects that I feel I need to document for future reference as well as share with people in Silver Spring: project schedule, any specific architectural design or unique thing for link, to other cases, that are relevant to my project by creating typically a project page for each project.
Project management	project management best practice	When I've used it before, it was, you were then trying to put actions onto people at the meetings, when you were talking through rather than having all different logs for the meeting, where it should be just a quick find that presents, here is where the projects is and how it ends.
Project management	project management best practice	The way I've done it in the past, the project dashboard, where I've done it physically on an A3 piece of paper, where you can look at whether the program or a project, they've got various status areas and issues through the right blog.
Project management	project management procedure	Then we go on site, and then there is a report, and then there is testing and assembling document, then there is an installation report. And then there is a project management sheet that has an explanation of what has happened

Project management	project management procedure	Project management wise we use lean project management. We only do gantt charts to get a schedule, because there is a lot of parties involved, etc. But for £800 maintenance job we wouldn't have a gantt chart because the amount of time to create a gantt chat is…
Project management	project management procedure	There is a short term – 3 weeks ahead, and then I have a program management spreadsheet that has all the jobs that we are booking in, dates. And then there is a project management spreadsheet.
Project management	project management procedure	One of the things was how to capture documentation for new employees and PMs. So the documentation was put together and it's actually great. I just hired somebody and handed it at them, they went through it and it was just perfect.
Project management	project management procedure	But we don't use gate process, 6 sigma or ISO. We manage our project to the milestones in the contract which is very similar to the gates,
Project management	project management procedure	instead of making the linear process of going to gate 0, gate 1 we say: I finished this one job, what comes next. We have the list of all the tasks to complete, we have a plan to follow and then we look at whether this tasks have an order
Project management	project management procedure	we don't go through a process or anything, we just make it up as we go along.
Project management	project management procedure	We might start a project and then think that it's not actually meeting our needs, in which case we'll stop it or look how to reshape and align it with what we'd need. We have a stage gate process, where it's got past certain stage or meeting certain criteria before we would look to continue.
Project management	project management procedure	just when the project comes in, we use different stages, different targets. So in 2 weeks we'd have to come up with high level options. We then pass them across to get costed. And then they need to come back with the cost in 2 weeks.
Project management	project management procedure	I get involved with PM at the start of the project, then we create learning capture forms, identify the key learning objectives and the details of how they will be delivered.
Project management	project management procedure	PM should do knowledge management, stakeholder engagement and responsibility, responsible manager. So project inception, reviewing previous projects, interaction with the KM manager, KM in order to produce learning and objectives plan, then going to gate 1, so at that point we are making an internal decision, if there is gonna be sufficient knowledge and learning, sufficient innovation for this project to continue and be funded.
Project management	project management procedure	Then there is a dissemination.
Project management	project management procedure	if it's collaboration only, like I said, with the SP, I have a copy of a project plan, that may say, yes or no. I don't know, because I was not involved in the start-up. I happened to know, that that one does have a project plan, which I maintain as well.
Project management	project management procedure	for anything above 5-10 mln pounds, we've got an additional project called a large capital projects process
Project management	project management procedure	we have a project management procedure that we follow in the future networks
Project management	project management procedure	Because between gate 0 and gate 1 that's the business time, because that is the time when we are doing the project initiation documentation and because there are so many different pieces of information needed to create this project pack, you have to do detailed business case, proper risk management strategy, QA, all that has to be done upfront before the registration happens
Project management	project management procedure	If the project Is over 10 mln, you have to use that framework, if the project is under 10 mln, we have to use out departmental framework.

Project management	project management procedure	PRINCE2 model for project management. A lot of the things that we do, do actually follow that model although it's not what we use officially.
Project management	project management procedure	NPI process is a standard tool that Weir uses for projects
Project management	project management procedure	there is a slight flaw in it. But it's good to have these documents at place, you can run through the questions and make sure that they've answered them all, because along the way people forget things: to ask the customer, do certain marketing surveys. And then if you've missed those key concepts, then you project will start to have issues.
Project management	project management procedure problems	I have a formal process, but I would say that there is no generally accepted formal process in Silver Spring management. We all use do our own thing.
Project management	project management procedure problems	I think it does, particularly to those we are trying to plan and get resources from, like our manufacturing team, engineering team and various group that we need help from, operations teams, everyone is engaging and communicating with them in a different way, and it's challenging for those various groups to assemble all of those different information and react to different PMs, and it's PMs who get things done, they are the most engaging.
Project management	project management procedure problems	If we are doing integration, deployment, every project is different. We don't have any templates that tell, here is the task, you perform it for every project. It's not possible. It comes down to their competences and what they want. So that's part of the issue of having a gating process
Project management	project management procedure problems	they are very different. And I think that's the reason why we haven't come up with the specific gate process.
Project management	project management procedure problems	For the sort of projects that I'm delivering here we don't really have a very formal project delivery process
Project management	project management procedure problems	the flipside about that is that means that you have to go a little bit harder to make your project work with the processes that are in the city. Because there is no formal project delivery process there.
Project management	project management procedure problems	we've got 50 lights that we need to roll out, it's often very difficult to drive those processes and frustrating, because you have to carry out steps which really don't make much sense for the project of that size
Project management	project management procedure problems	For the NIC projects we do it, but something like that, we don't have it for NIA projects, because they are a bit smaller.
Project management	project management procedure problems	How the project should run? No, we've got a standard, we've got a process for set up and closure of the project, but I don't think, there is anything other, that tells you, we go through various stages of the project and we have late monthly reviews, we are giving update on the project, like to me, to my boss, and then he says, through that kind of hierarchy. I don't think, there is anything actually that tells me what I should be doing throughout the project.
Project management	project management procedure problems	The issue with it is at the early stage of the project the first question that gets asked is feasibility. And then it's the 3rd gate. And to tell that, you need a round-about estimate to actually just kick off the project, because if you have to wait all the way through until your feasibility review comes down the line and you find out that it's actually not feasible, the entire project gets chucked up.
Project management	project management procedure problems	Unfortunately not everyone follows this process

Project management	project management procedure problems	we can do it more decently in China. At least we are not really using a lot of project management tools, like Gantt charts.
Project management	project management training	our project managers have to get some training on our processes, governance, compliance issues
Project management	project management training	We had a project management training, we had external trainers to come and teach people how to do that.
Project management	requirements collection	Some people use it to put requirements in the form, because it's an easy way for my engineering director to look at it, and we don't have to worry about both of us accidentally changing the same document.
Project management	team change	Yes. It depends on the speciality and the customer needs.
Project management	team change	I rely on them to do an appropriate hand-over and make them speak to each other.
Project management	team change	I'm trying to have a kick-off meeting and start to see if everyone is on the same page, and I put together a kick-off document, which covers the key information about the projects size, who the parties are, what the scope is, what the timelines are, what stage the project is in, and something that I can just send people a link to that in the future, so if they come along onto the project, we want to give them quite a log of background information on the project.
Project management	team change	if something happens, people will just take over the project and know exactly who is who and see who is in charge of this diligence... So I can see, how useful that is for other people and how useful for me.
Project management	team change	For the part of the work that is repetitive, yes, but it does take a bit longer.
Project management	team change	the project manager is actually in charge of getting the knowledge transferred from the project team leaving to the project team coming on board, and also later making others familiar with what this person has been doing.
Project management	team change	We do transitional meeting, we document the open items that the project manager currently has, we review the progress, we document it
Project management	team change	there is an exit interview process, and there is a hand-over process
Project management	team change	we do tend to lose project managers
Project management	team change problems	And nobody seems to know about it, because PM just did it because the customer requested.
Project management	team change problems	The executives sometimes get involved and help find new project manager, but we usually lose out team members before a person in a new role moved in.
Project management	team change problems	There are just things that's been done that I'm not aware of, like customers, and the publications that are being produced together with the reports.
Project management	team change problems	Sometimes yes, sometimes not so easy, it depends on what has been written down and how available people are to discuss.
Project management	team change problems	there is so much intrinsic knowledge that gets lost, and relationship knowledge that gets lot, particularly on the big projects
Project management	team change problems	The biggest reason why it isn't is because of due diligence there is so much paper work in each project. If I give you 3 PhD project, which we are sponsoring, we get 250 pages report every 3 months. You need to read it
Project management	team change problems	this is something that still does affect us due to team dynamics sometimes.

Social aspects	cultural differences	I used to find going to meetings not so much with our office internally, but with other organisations we'd be working with. We'd have a meeting which I thought went fine, and I thought we agreed and had the whole list of actions. And my Chinese colleague would go: they are not going to do any of that, they said they would, but actually they are not.
Social aspects	cultural differences	I tend to find people commenting are based in India and Dubai, they are much more happy to comment, whereas in UK we just don't want to show that we are interested.
Social aspects	cultural differences	India was one of the best experiences in my life. The cultural difference is very much, people would go into the offices and work 12-13 hours, but it's a much more sociable atmosphere.
Social aspects	cultural differences	It's very award-based, and I think it would work well in the UK, if we were less (not giving it for everything), and also we are quite modest, nobody likes to be in the centre of attention.
Social aspects	cultural differences	I find it quite easy to get on with people through email or text, but once it goes to a group conference call with people around the world, it start to get communication issues. People tend not to follow others very easily.
Social aspects	cultural differences	I think culture is a big problem for some of the people what move around. You tend not to understand some of the big areas, ways people express themselves.
Social aspects	cultural differences	Language is another issue, which might be more likely to occur at the beginning. Sometimes what people use, I don't get the meaning at the very beginning. Culture is another factor, and people are not that eager to change.
Social aspects	demographics	I think as a new generation is coming in, they are more open to social media ideas and challenges, and essentially just being more sociable at work.
Social aspects	demographics	I used LinkedIn to contact people, but that tends to be the younger guys.
Social aspects	demographics	If it's senior staff, I email them or use chat.
Social aspects	demographics	in the UK it's an aging workforce for engineers especially
Social aspects	demographics	most of the guys were getting to their retirement and we've had this skills gap problem
Social aspects	demographics	setting challenges for people internally and externally to solve problems, hopefully will push them more towards it. I think it would be a really good platform outside the older generation.
Social aspects	demographics	The average age in India is 30, whereas in the UK it's 45-50.
Social aspects	demographics	these initiatives are looking in the future, but if you go to our engineering team, guys in their 40-50s, and try to encourage them do things like this, they just won't do it.
Social aspects	mood	I'm getting paranoid about being recorded.
Ideas management	motivation	that would be quite a proud thing for the employee, because they could say: yes, my idea contributed to so much more sales, and as a result, I got this reward.
Social aspects	no cultural differences	cultural differences? 20:08 No. not at all.
Social aspects	no cultural differences	But generally there were not that many cultural differences that impacted the office life.
Social aspects	no cultural differences	I don't think so, I would say, the British and the American culture, particularly the people that are working in England for Silver Spring, are very similar, it's very hard working committed culture. People do try hard to help generally. I wouldn't say there is any cultural mismatch.
Social aspects	organisational culture	We are trying to change the culture, which is I think a good thing.
Social aspects	organisational culture	when you are trying to change culture, change process, it's all about change management plan.
Social aspects	organisational culture	In the last 2-3 years we are moving into the innovative mindset, but it's a big change. Probably the fact the process efficiency is so ingrained in the culture, it makes it difficult.

Social aspects	organisational culture	We used to have meetings where everyone would speak about their projects, and that was actually quite nice, because you understood where everyone was, even if it didn't concern you, everyone would feel like a group unit.
Social aspects	reputation	I'm trying to be helpful. People ask me a question and try and give them a useful answer. I'm trying to build a reputation as somebody giving useful answers.
Social aspects	resistance to change	It can be challenging to adopt new technologies. You obviously have a mindset of people who have many years of experience of doing things in a particular way.
Social aspects	resistance to change	The ability to change that is extremely hard, unless it's mandated at director level.
Social aspects	resistance to change	you went to these guys, pointed this out to them, proved the concept, that one button would gather up all this network, export it. And it just didn't put things exactly how they wanted, they didn't really want to get involved in it
Social aspects	resistance to change	if you are trained to do things in a certain way, with the new way you need to learn something completely new, and it will cause problems, that's why change is quite a problematic thing for us, getting people to accept change and accept people to use more innovative things.
Stakeholders	choosing partners	somebody had used them before on a project, so they had a contact
Stakeholders	choosing partners	we chose University of Strathclyde is partly because they are local, they are handy, you know, we can, we are trying to do something on a short time scale, that makes a lot easier.
Stakeholders	choosing partners	what would be nice is in future if we could say that we need people who know about X, and then we could say, ok well, here is the database of researchers or of teams, you know, so certainly we'd engage very early in the day
Stakeholders	choosing partners	it would be useful to follow that list, but list wouldn't actually tell it all.
Stakeholders	choosing partners	That (partners' database) could be useful, but that could be also quite confidential, because if that list had to get out with all the contractors that we are working with, you can imagine that there is a bit of an IP issue over there.
Stakeholders	choosing partners	Until we interview the person, we won't find out if they actually meet your needs.
Stakeholders	customers engagement	if a project is gonna engage directly with the customers as NINES and SAVE and TVV in the south, there needs to be a customer engagement plan put in place, and that needs to be signed off by Ofgem, that we are gonna be engaging with these customers in an appropriate manner.
Stakeholders	customers engagement	Shetland there is like 3 new windfarms, and we are managing their constraints, and they as customers are just important as much as anyone else is. So that definition has become quite broad.
Stakeholders	partners engagement	It might be that we don't want to take all the risk with a particular project. So we ask if other operators want to be involved in it.
Stakeholders	partners engagement	one of the DNOs always has to be a lead
Stakeholders	partners engagement	There seems to be maybe progress meetings, where you maybe have an update and can all be on a conference call or a meeting. But on a day to day a lot of it is just emails, phone calls.
Stakeholders	partners engagement	other times it's us, we've come up with an idea, an issue, and we've asked a few people, what we can do about it, and you know, our universities sometimes come up with good solutions. And we pretty much project manage that to get all the outputs that we want. We are treating them like a supplier.
Stakeholders	partners engagement	Sometimes it's the University or the manufacturer that has come up with an idea and they bring the project to us, then we are basically just funding it, so we are just signing the bills at the end of each month and get the output at the end
Stakeholders	partners engagement	I tightened the scope and yes made it really-really specific

Stakeholders	partners engagement	she was keen to get it done as well
Stakeholders	partners engagement problems	As a project manager myself, I maybe wouldn't be comfortable with just receiving a project and an update from the Scottish Power that everything is good. I would want more details than that.
Stakeholders	partners engagement problems	I always prefer follow-up phone call with an email. From previous experience people tend to deny things at times.
Stakeholders	partners engagement problems	I engaged far too early, so they had like a year to do it. So you know, I got a feedback really quickly, and there's been nothing you know for like 7 months,
Stakeholders	partners engagement problems	I think the scope was never really well defined, but so I get a sense that they are having an awful lot of meetings and not really getting anywhere, because you know, they get sucked into these conversations about all the great things they could do and all the create analysis that can be done, and never actually agree on what they are going to do.
Stakeholders	stakeholder identification	a list of external organisations that are involved in the project and context for that.
Stakeholders	stakeholder identification	I make sure, almost all my projects have the big long list of external organisations, external contacts. So basically everybody I've spoken to on the project, is put against the project externally.
Stakeholders	stakeholder identification	I will do if I don't know anybody is I'll just ask around, mostly on delivery or sales for feedback
Stakeholders	stakeholder identification	that will usually go through the project managers to help us with that introduction.
Stakeholders	stakeholder identification	First it was recommendation, but it wasn't looking through a bunch of companies and saying: let's just select them.
Stakeholders	stakeholder identification problem	most of the oil companies have security concerned, where if you lose contact with somebody if they move away, you cannot easily find the organisation or who has taken over in that particular operator.
Stakeholders	stakeholder identification problem	quite often people change out. The project team that was involved in, has moved on, and we don't have a contact any more.
Stakeholders	stakeholder identification problem	sometimes even the distinction may not be that clear
Stakeholders	stakeholder identification problem	how do you distinguish between real-time systems, national telecom centre, IT communication? If you look at those departments, there are a lot of overlaps.
Stakeholders	stakeholder identification problem	That does happen, but it's a few cases where that happens and it's mostly with complex projects, like projects that last over many years and have a lot of technology, but with the actual technology it's quite sophisticated, it's impossible to foresee everything
Stakeholders	stakeholder identification problem	You probably miss out an essential stakeholder only because maybe in the time of commencement of the project you don't understand why they might become an important stakeholder.
Stakeholders	stakeholder types	Both internal and external.
Stakeholders	stakeholder types	For example, a government department might not need to be informed about the findings until the end of the project, however the local councils might want to be kept informed throughout, so we might speak to them at the start, at the middle and at the end.
Stakeholders	stakeholder types	trying to involve two categories of stakeholders, the first ones are the ones that will be affected by the project and the second ones are the ones that are interested in the results in the way the project is progressing
Stakeholders	stakeholder types	we have 2 types: those who are affected through the trials of the projects and those who have an interest in that.
Stakeholders	stakeholders engagement	Third parties normally already have contracts at place with clients

Stakeholders	stakeholders engagement	we have to deal with the 3rd parties, that are often hired by a client, and we have to deal with the inspectors as well.
Stakeholders	stakeholders engagement	We get an enquiry, sometimes the enquiries come from the third party rather than the end user.
Stakeholders	stakeholders engagement	having third parties involved that I'm responsible for aligning with the projects, getting them informed and participating in a project (e.g. our contractors, like a meter vendor, installation team or other third party software companies, that are utilising the information that our network provides), absolutely (my responsibility)
Stakeholders	stakeholders engagement	I've got templates that are used for a project, which set up my scope: who is involved, what we are trying to accomplish.
Stakeholders	stakeholders engagement	I just do it for myself
Stakeholders	stakeholders engagement	I've actually types up some documents: hey, here is the group I worked with, this gentleman was very competent, this engineer was extremely competent, and I do monitor that for myself, because it's just good to know you contacts
Stakeholders	stakeholders engagement	There are others that are more engaged, e.g. the consumer portal, they are actually offering it to their customers, they often feel a lot of ownership as well in the products, because they want either to reflect their wording or something else.
Stakeholders	stakeholders engagement	we have a process for pricing product, we have a process even for doing a new release, where you go present to core stakeholders before start doing development at the end
Stakeholders	stakeholders engagement	when we are doing some of the design work, we will often schedule a Q&A meeting with some of our key customers and show them that design that we are thinking about, and get some real feedback from them.
Stakeholders	stakeholders engagement	In terms of third party stakeholders, you tend to just keep them within the project.
Stakeholders	stakeholders engagement	we have all the key stakeholders at our customer in a databases, and it's shared across not just the project team but also the customer service teams and all the people that do the support and maintenance of our customers.
Stakeholders	stakeholders engagement	he was organising stakeholder events and was initially involved to give input into our network conference, whether being involved in awards or submitting for awards or sponsoring awards, like stakeholder engagement, both external and internal.
Stakeholders	stakeholders engagement	There are other part of the business that do stakeholder engagement, and we'll update them on what our current thinking is, what we might be approaching. So they'll raise this with the customer to see if that might be of interest to them.
Stakeholders	stakeholders engagement	With some of the projects there is quite a lot of stakeholders engagement activity.
Stakeholders	stakeholders engagement	before we do a project at gate 1, if it's a big project, we'll look to identify key stakeholders, internal and external.
Stakeholders	stakeholders engagement	find companies that know that sort of stuff. Our suppliers would be interested in this project as well, so they are really capturing all this stakeholders improvement and engagement plan for how the project will engage with them throughout its lifecycle
Stakeholders	stakeholders engagement	the internal stakeholders will be from the business, they'll sponsor the project and we'd hopefully pass it on to them at the end.
Stakeholders	stakeholders engagement	at the early stage of the project we are able to sit with the project managers and say: ok, what kind of organisations do you think you'll be engaging with or will find the learnings valuable. So we then start writing those down at high level. As we progress through the project, and it goes to the next stage of approval, we then go: ok, do you think it's worth doing. And then we need a bit more time with specific individuals in the organisation. And then figuring out how often or when do we engage with them?

Stakeholders	stakeholders engagement	For example, a government department might not need to be informed about the findings until the end of the project, however the local councils might want to be kept informed throughout, so we might speak to them at the start, at the middle and at the end.
Stakeholders	stakeholders engagement	helping to engage with them through the things like social media, twitter or LinkedIn and also in terms of communicating learning
Stakeholders	stakeholders engagement	it comes from trying find a subject matter expert at the early stage. We'd have a good idea of what part of the business it'd have an impact on, and then there is a case of using perhaps an expert who can say: you should involve this person.
Stakeholders	stakeholders engagement	most of our projects do tend to involve or impact our customers or certain stakeholders.
Stakeholders	stakeholders engagement	we are trying to reach out for them, whether it's myself or Fraser, or the project manager. At least one of us will be in touch with them.
Stakeholders	stakeholders engagement	one other thing that is very important is if it's possible bring use to customers. For example, I'm interested in a particular development, but it affects cable lines, so we need to identify the stakeholders for this, and in most cases we run it as a parallel process.
Stakeholders	stakeholders engagement	We do a lot of stakeholder engagement, we do a lot of interaction within the organisation, it's not like there is a document that says that him or her does this, for some reason we just know.
Stakeholders	stakeholders engagement	I highly doubt that. You usually get recommendations from the companies of who to use, and then you figure it out on the first meetings.
Stakeholders	stakeholders engagement problems	sometimes it's quite troublesome, it's not that straight-forward, because they don't understand, what we are trying to achieve, so you have to explain them, then they have to follow their own rules and regulations, find the way to implement our way of thinking into their design.
Stakeholders	stakeholders engagement problems	I wouldn't have any sort of a formal record that I could just hand it over to somebody else
Stakeholders	stakeholders engagement problems	I personally have done a poor job of maintaining that on my end. I got the data scattered, but not in one central repository.
Stakeholders	stakeholders engagement problems	We could get a knowledge base of real world stuff we work on.
Stakeholders	stakeholders engagement problems	we don't have a database, which would say that there is a stakeholder for this, there is a stakeholder for that.
Stakeholders	stakeholders engagement problems	A lot of the times, it's really hard for me to say: I want your feedback, but I'm not taking requirements from you.
Stakeholders	stakeholders engagement problems	it also depends on what the customer has been used to purchasing. If they are used to buying products and using them, then it's not too much problem for them to understand that we have our customers. If we are working with the customer who is used to primarily buying consulting work and custom products, then it's really hard
Stakeholders	stakeholders engagement problems	it's consumer engagement which is always very different from our core.
Stakeholders	stakeholders engagement problems	And it just didn't put things exactly how they wanted, they didn't really want to get involved in it, we couldn't sell it to them for some reason
Stakeholders	stakeholders engagement problems	the weakest area of GIS is the linkage between individual customers and the network. That needs to be improved. I keep telling the rest of the business, keep nocking their head against the brick walls: you've got to improve this if you want to get benefit from that.

Stakeholders	stakeholders engagement problems	There is some key nexus points in the business, buy you just can't buy time of these people, because they are vital to the normal running of the business. Within any innovation project these are key people to talk to, but there is no space to talk to them.
Stakeholders	stakeholders engagement problems	They recognise how innovation could help them, but they don't want you to come and say: well, give me a business expert for a week of his time to help me define and build the projects
Stakeholders	stakeholders engagement problems	at this point of time we haven't done that particularly well. It's been more of we just send ad-hoc information to specific stakeholders, but the system is already utilised up to now.
Stakeholders	stakeholders engagement procedure	That's one of the actions that we want to put together, have matrix of stakeholders for our customers.
Stakeholders	stakeholders engagement procedure	it's only been this month where we drafted the process.
Stakeholders	stakeholders engagement procedure	we need to identify the stakeholders for this, and in most cases we run it as a parallel process. The time we actually get to the case approval is the time when you get this idea known to potential stakeholders, so that they can actually support you or say that if you go with this idea they are not going to use it.
Formalisation	need for formalisation	It can be challenging to adopt new technologies. You obviously have a mindset of people who have many years of experience of doing things in a particular way.

11.8. Appendix 8. Zappos Case study. Codified results of the interviews.

Second-order code	First-order code	Coded Text
Badges	Compensation badges	everyone has, any position has kind of a badge and a compensation that is linked to it right now
		Now you need references, you need credentials, you need experience, you need all these different things before you can think about obtaining this badge. It's a really unique system.
		serious badges, that are compensation badges, that you have to complete a lot of serious things and meet the goals to get those, and there is a kind of compensational ladder
		So there is a badge called “Teal badge”, and it means that you basically read all the material, and you understand what it means. So with teal you basically have to go forward, but it’s pretty long, it’s really 40 hours of working time... So every thing that you’ve read or watched, you need to write about what you’ve learnt, and then you write about an overall understanding of the teal, and then you submit that, then somebody approves that, and then you are certified.
		We don't want all these people with their talents and abilities to go down this path and a being compensated fairly for what they are able to accomplish,
		We’re exploring a badging system where skills and work can be turned into badges with requirements that allow people to earn them and can even be tied to compensation.
		you want them to strive for greatness. We want them to say: "I have these skills and these abilities, I'm going to learn this to get this badge."
	core value avatar badge	For me, I was the humble, which is really funny, because I'm really loud and outgoing, so usually, when you think of someone humble, you think, that this person is quiet, intimate, shy and exactly the opposite of someone's loud, someone's whatever. But me being humble means me working with other people, me making sure that other people get it right, making sure, that everyone are doing the right things, other people come first, and that's the whole point of being humble, that other people come first. And when people see: "oh, you badge is humble?", "that's what they say."
	Fun badges	There are some that are fun, just a kind say what you did.
		We actually just created a badge within our circle. And this one is a little bit for fun, but it’s also you know a kind of appreciation.
	Skill badges	skill badge, or the latest one I've done was because we are moving toward the latest best customer strategy, and there is whole bunch of articles, how best customers were selected and things like that. And then at the end there was a test, and once you complete the test, you have to pass no less than 90%, and then you get that badge.
		So the badging system a kind of taking over for endorsing. It’s that criteria, every badge has that you a kind of have that skill, so with every badge you have to prove that you have those skills.
Contest	Hackathon (project contest)	there is this thing called Hacketun and another one that is called in a similar way. But yes, Hacketun is where people, who are interested in new projects, join in and it usually lasts for a few hours. There's been some good things, that came out of that
		The execution is very organic – a tech person gets to pick their team and gets to decide what idea to work on. On hackathon day, the different teams present their ideas to the rest of the company and we get to vote on the winner.
Gifts	WISHEZ	My favorite wishes are the ones when someone isn’t asking for something for themselves, but when someone is asking for someone else,
		the whole platform is that people put on their wishes and you can go and look through: "o, I can grant this wish." Because let's say somebody needs something and I have it, then it is granted. But some are a bit harder, so there is the whole team that works on that, and they are trying to find the ways.
		Things like that, you know: "I really need to bike to work." "Here is your bike." it's a great way to keep in touch with a company

Groups	Circles	we don't have teams any more. They are so called teams, but they are like circles
		It's just, imagine, like a university, you have your classes, but you also have those extra activities. You go to the organisations, volunteering, so you get this primary role, but you can get involved in all the extra activities. Then you can get involved in the different things around the company too.
Points	People points	let's see people points are 100, and 80% of my people funds would be HR, and then 5 points in the parking circle, and the other 5 points in the garage circle, and the other 10 points elsewhere. Indeed just a great way to spread your wealth if you will
		whatever circle you're in, if you're not putting enough time to your circle, they can move you from the circle.
	Power points	At the end of the month they get swiped and you start all over every month.
		I know that they were picking up some of the top point earners for phone calls
		It's not completely based on them, but it's one of those criteria to see, gaining high points. If you are getting high points, they are contributing, if there is a need, you can stay in a busy time you know, not just leaving when it is busy.
		it's busy and you earn the power points
	Zollars	basically everybody has the power to give Zollars, you know.
		can be donated to one of the charities that Zappos partners with on behalf of the employee. It gives employees a warm, fuzzy feeling that every time they spend Zollars it can help others out which, in turn, makes the employee happy for being part of something bigger than themselves.
		There is this little Zappos store inside, where you can buy Zappos T-shirts, little Zappos pens, there is plenty of things, like little things, like CD holder, little back-packs, suitcases Zappos, like everything. But yes, you can use only Zappos dollars there, you can't just buy it for money.
		talk, and then they ask a question, and then sometimes they don't even have to talk, they just ask the question.
		The company actually had it trending on Facebook and they wanted it trending, so they wanted everybody go and share it on Facebook, so that it becomes very popular on Facebook, so you could get some Zollars, if you did it, some posts sharing on Facebook.
		the most I earned was during Zappos new hire training that everybody has to go through.
		Yes, for the most part you are getting Zollars for learning something. But it could be almost… like dressing up that day or even just Trivia... But for most it's a kind of educational.
Quest	charity projects	Wednesday we did the same not for homeless, but for families that are struggling. They gave them all the stuff they need for Thanksgiving dinner, like turkey, just the products to make the dinner
	FaceMail	face mail. And that is randomly once a week the person will pop up an email, and they will ask: "do you know this person?" and you say yes. And then they'll ask: "how well do you know him?" and the you press, you type in: " pretty well, decently well, enough to trust him." and things like that. And then it gives more questions, depending on your answers you'll get more questions. For example, yes, I know this person, and they'll stop. And that it gives us the way of knowing, how many people know this person, is this person sociable, do these people trust this person, do the people like this person, can this person handle the work? And then and kind of gives us a feel of whether this person leaves are to the core values.
	Scavenger Hunt	All employees at Zappos are required to go through our month-long new hire training. At the end of the training they are assigned challenges to locate employees around the company. For example, find someone with a Zappos shirt on and find out how long they have been at the company, or find who schedules training classes and take a picture with them, and find the longest tenured employee in the finance department.

		It was a lot of fun. It was more I think an activity to a kind of learn about the company and bond with your group. It was a lot of taking picture you know across the campus, and also about getting to know around the campus, this is also very new, taking a picture with you know, this sculpture or this statue. There is like a chair. There is different pictures of the places that are here in downtown Las Vegas.
Rewards	co-worker bonus	employee to employee reward, I'm allowed to give a $50 bonus to anyone I want to. Once a month I can give these $50, and it's not my money, it's the company that is paying, and I can give this money to absolutely anyone that I want to for any reason. And once you put the reason, you are a kind of attaching the reason to one of the core values that we have.
		Every month every person receives $50 to give it to someone else. Don't you decide who gets it, and they get it, no matter what.
	Hero Award	The Zappos HERO Award works in conjunction with the Coworker Bonus Program. A Zappos HERO is an employee who embraces our core values to the fullest and lives to deliver WOW to their fellow Zapponians. Our heroes are nominated by employees and chosen by the leadership team which is made up of all the heads of departments along with the CEO, CFO, and “no title.”
	Mystical Egg	the Mystical Egg, is a peer-based award passed along each month in our Tech department.
	WOW parking	WOW parking is chosen once a week (usually Friday) for a one week period (usually the following workweek). Any Zappos employee can award the parking spot to a lucky employee.
	Zollars_rewards	So there was one time, it was in all the bathrooms, the bulks of one Zollar bills. So basically you can award it to somebody, but you need to right your name, that you award, and you need to write the reason why you give it to somebody. So if I see, that somebody did something good to somebody, I can write: "ok, this person helped this old lady go upstairs."
Surprise	Wish team	Just now there is a band that played here in Las Vegas last night, and for the band singing there were the yellow cards rolling up. The bandwidth really big, a rock band. And there was someone who didn't have a yellow card rolling up, and couldn't afford to get some. So he made a wish that he wanted one to see this rock band. And so a few days ago Oasis team walked to one of our zappers, and there was music and speakers playing, and she looked up and they gave the tickets to the person
Visualisation	circle map	So they basically, you go there and you see all the circles, you see like a big picture, the general circle, where the COE is, and it includes all the other circles, and then you can zoom in and go circle by circle, and see, who is there.
		when I was in a different role and I changed the circle, the lead-link just removed me from that role, and then a new lead-link assigned me to a new role. So under my name I only see my current role right now