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ABSTRACT

The industry is on the brink on what many consider as paradigm shift due to disruptive technological developments. The current trend of automation, Internet of things, big data analysis, cloud computing, together with the emergence of artificial intelligence, advanced robotics and autonomous vehicles has been labelled as a digital disruption. A combination of better computing power and data storage, together with more reasonable pricing structures makes the digital disruption more accessible and possible to any industry. There is broad consensus among think tanks, experts and industrial leaders that organization needs to embrace this development to stay relevant and competitive in the future.

The thesis is an exploratory research to examine how the digital disruption will impact the maintenances service industry in the Oil and Gas sector. To understand the complexity of the transformation, it covers analysis of multiple elements that includes: expectations and semantics, technological solutions and services, changes in competences and skill sets, changes in business model and strategy, stakeholder perspective, and a summary of risk and opportunities. The research is conducted with a mixed-method approach, which covers quantitative survey data from global trends, together with qualitative case studies and interviews from relevant stakeholders in the industry.

The research highlights that the digital disruption is more than a buzzword or an incremental change towards existing business models and practices. Digital technologies enable a whole new way to create and harness value, and is about to transform the nature of work tasks and future job requirements. Data driven technologies will require more digital literacy of the entire workforce, which puts an added pressure on training and development. Digital talents, such as data analysts and computer scientists are becoming more central to the business operations, and requires more cross-functional collaboration across the organization. Organizational structure and culture must adapt to a digital environment, where employees are empowered to make business decisions and initiate digital innovation efforts. The digital disruption will also reshape the organizational environment, which results in reshaping existing stakeholder relationships and the introduction of new ones. Change management is going to be key to succeed in the digital transformation, and viewing it as an opportunity rather than a threat will decide the fate of success for many organizations.

ACKNOWLEDGEMENT

This thesis is a culmination of two years study of the experience-based Master degree in Technology and Operations Management at the University of Stavanger. The program has been conducted in combination with the daily job, and has required me to balance both activities with steadiness. Some periods have been intense and demanding, and working in the Oil and Gas industry, which during this period was affected by the drop in the oil price, has been an added external pressure.

However, the master program has been very valuable and rich in learning that combines technical and managerial disciplines. It has required me to bring my work experience into the study, which has given the program an added relevance and interest. In addition, having classmates that have similar background and circumstances have enriched the experience. For that I am grateful.

I want to express my gratitude to my supervisors Professor Jayantha P. Liyanage and Dr. Jawad Raza for great guidance and support throughout the work with the thesis. I feel the selection of the topic has been spot on in terms of relevance and knowledge that is vital going forward. The work with the thesis has emboldened me to meet the challenges and opportunities we are facing, and is motivating me to continue pursue endeavours related to the digital transformation.

Furthermore, I would like to express my gratitude to the interviewees, for their willingness to share information and their perspective. It has certainly been insightful and given the research a stronger value and validity.

Lastly, I want to thank my organizations and managers I have had during the course of the program for giving me the time and flexibility to completing the Master's degree.

A huge personal goal has now been achieved.

Christian de los Reyes Ullevik, 15. December 2017

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ABBRIVATIONS

AI	Artificial Intelligence
IaaS	Infrastructure as a Service
IT	Information Technology
IoT	Internet of Things
OT	Operational Technology
PaaS	Platform as a Service
R&D	Research and Development
SaaS	Software as a Service

1 INTRODUCTION

1.1 Background

The industry is on the brink of a paradigm shift due to disruptive technological developments. The current trend of automation, artificial intelligence, robotics, big data analysis, Internet of things (IoT), machine learning and cloud computing are some elements of the digital disruption that are currently emerging. A combination of better computing power and data storage, together with more reasonable pricing structures makes this digital disruption more accessible and possible to any industry. There is broad consensus among think tanks, experts and industrial leaders that organization needs to embrace this development to stay relevant and competitive in the future. Many industrial sectors have already taken the first steps utilizing such technology, which have also created huge disruptions in some sectors. New competitors have emerged, and the business environment have changed and reshaped existing stakeholder relationships. Employment trends are changing, as the competences and skill sets for future job tasks and value creation will have different requirements. The rate of the digital disruption is happening rapidly in front of us, and is only a matter of time before every industrial sector is affected.

1.2 Purpose

The purpose of this thesis is to explore and examine how the maintenance service industry in the Oil and Gas sector is going to be affected by the digital disruption. What are the general expectations towards digital transformation, and does the industry fully understand what it means. The notion of the digital transformation can seem ambiguous, and understanding the concept and the consequences it brings has been a key focus for the researcher. The thesis does so by examine the underlying factors and key drivers of change that causes the expected paradigm shift. The research examines global trends, relevant case studies, and stakeholder perspectives from the industry to form a broad picture, as well as detailed factors that is key to recognize. In addition, relevant theoretical perspectives and frameworks are included to analyse their validity and relevance for the future business environment.

1.3 Research questions

Since the purpose of the thesis is to understand and form an overview of the impact the digital disruption will have on the maintenance service industry, the principal question to be answered is as following:

- **How is the digital disruption transforming the maintenance service industry in the Oil and Gas sector in a 3 – 5 years perspective?**

However, understanding the totality of the digital disruption and how the business environment is transforming, there is some underlying issues that needs to be examined. Following are a set of sub-questions which the researcher finds imperative to explore and examine to answer the principal question of the thesis:

1. Expectations and semantics

   The digital transformation that we are witnessing is loaded with technical words and concepts that can be confusing to any individual. Buzzwords such as *digitization* and *digitalization* are frequently appearing in media, white-papers, journals and spoken by experts. In this environment of disruption, semantics are important. To understand that there is a dramatic shift happening in the industry, it is important to understand the meaning behind the words. It is difficult to embrace the change if one does not understand what is changing. The thesis will therefore try to outline and define the concepts and meaning behind the technical buzzwords. Understanding the expectations from relevant stakeholders can be important to get an alignment going forward.

2. Technological solutions

   If we want to understand how businesses are changing because of the technological disruption, one of the key points is to recognize the new technological capabilities that are involved. New technological capabilities are the fundamental driver to this paradigm shift, so it is important to examine which is relevant. A sub-target of the thesis is to perform a market analysis to find technological solutions that are suited for the maintenance service industry. To understand what solutions that can be relevant, an assessment on what other sectors has done can inspire what is achievable for the maintenance service industry. Another relevant point is to understand how the technology is offered to the market. One emerging trend is the concept of product-service systems where both products and services are offered to uniquely fulfil customer's needs.

3. Competences and skill sets

   Introducing innovative technology into the core business operations will change the skills and abilities needed to successfully transform towards a digital environment. If the industry is experiencing a paradigm shift, like it has in the past, many of the current skill set and educational background are likely to become less vital, or even obsolete. Identifying and mapping the skills and abilities that is subject to change, or expected to become necessary is vital to adapt to the digital disruption. In a time of fundamental transformation, human capital is becoming more important to organizations, and having the right combination of skills and abilities is key to success.

4. Business model and strategy

   Business models and value creation will most likely change in the digital environment. To figure out the next business model for the maintenance service industry, it is important to establish a strategy for the road ahead. When undergoing a paradigm shift, especially with new and sophisticated technologies, the knowledge and the competence of the workforce is key. Do organizations have the necessary competences to adapt to this shift, or must they retrain the current workforce and acquire new talents to do so? Is the current organizational structure sufficient to cope with the changes or is restructuring necessary?

How does organizations transform from the current status quo to a new digital business environment, while still operating and serving its customers? Strategy and roadmaps are important part of the transition and the thesis will include this assessment.

5. Stakeholders
   In a new digital environment there is likely to be a reshuffle and emergence of new stakeholders. The thesis will try to map relevant stakeholders in the new digital environment to understand if existing relationship will be reshaped, and if new stakeholders will emerge, and what role will they play.

6. Risks and opportunities
   In any paradigm shifts there is always going to be many uncertainties involved. A paradigm shift is essential moving towards the unknown, and can make many individuals reluctant to change. Changes creates uncertainties, and uncertainties creates fear. If we can identify risks and opportunities involved, we are also able to allocate resources and focus on the main drivers of uncertainties to ease the fear of change. As part of the work with the thesis, a reliable assessment of risks and opportunities that organizations are facing is included. The technological disruption has already happened in other sectors and businesses, so it can be useful to examine experiences other organizations have gone through and draw relevant comparison. Reaching out to experts and stakeholders to get their perspective may also help identifying further uncertainties.

1.4 Limitations

The thesis covers the expected impact of the digital transformation with focus on the maintenance service industry, in the Oil and Gas sector. Due to high uncertainties and rapid change in technological innovations and business environment, the research is limited to a conceivable perspective of 3-5 years ahead. Given the breadth and scope of the research, there has also been other limitations that were necessary. The vast amount of technological innovations and capabilites that are emerging are too extensive to cover due to time constraints and the inclusion of other focus areas. The in-depth analysis of technological solutions is therefore mainly focused on data-driven technologies, which is a key driver of change for maintenance service business models. Data-driven technologies have a relative appropriate level of maturity in the Oil and Gas sector, and innovative capabilites provide new methods to create and harness value. The perspective of cyber security has been intentionally left out.

1.5 Contribution

The thesis tries to highlight key elements that organizations are facing because of the digital disruption. Entering a period of high uncertainty and complexity, the business environment is set to become volatile, and incumbent companies are facing multiple threats and opportunities. By exploring global trends and comparing business cases, the thesis may provide an in-depth analysis and understanding of the digital transformation that organizations must undergo. Input from relevant stakeholders in the Oil and Gas industry provide another relevant layer and insight to the

research. The research combines quantitative survey data from renowned institutions, together with qualitative data to form a holistic and relevant overview. It includes future changes towards competences and job requirements, changes in organizational structure and culture, and market research of available solutions. In addition, the thesis includes modern theoretical perspectives and frameworks that is relevant and useful in the current business era.

1.6 Report structure

The thesis consists of six chapters in total and each are divided into sub-chapters. Chapter 1 introduces the thesis, and provides information about the purpose, research questions, limitations and contribution. Chapter 2 covers the theoretical perspective and framework that is included in the analysis, while chapter 3 highlights the research methodology, project execution and timeline. Chapter 4 covers the analysis of the thesis, and is disintegrated into subchapters that each covers the sub-questions of the thesis. The sub-chapters of the analysis follow the chronological numbering of the sub-questions presented above, with a summary of key findings at the end. Chapter 5 and 6 present the discussion and the conclusion of the research. It addresses the findings, implications, and future research opportunities.

2 THEORY

This chapter presents the theoretical literature covered in the thesis. The theoretical framework used in the thesis is a culmination from personal research together with lectures and literature the researcher has obtained during the master program. It provides the reader with relevant background of principles and concepts that is applied in the analysis.

2.1 Organization theory

The digital transformation is about to reshape the nature of work, the internal relationship of the workforce, and how organizations are structured and managed. Operating in a digital environment requires change in existing mindset, competences and organizational culture. In the book, *Organization theory,* Hatch (1997) explains how organizations have developed since the introduction of the factory in the late eighteen century, towards the post-industrial society where the introduction of computers changed the way value was created.

The industrial age was typical focused around the control of labour in the production of goods, were organizations were structured around the assembly lines of factories. The work consisted mostly of standardized, routine tasks to increase production and efficiency. Workers were typically low-skilled and specialized to perform separate functions. The organizations were hierarchical with a vertical structure, where the workers were managed by a foreman who got directions from the general manager or the factory owner. The image of an organization of the industrial age resembles a machine designed and constructed by management to achieve predefined goals, and is still feasible today. Many organizations are still constructed and influenced with the characteristics and mindset from the industrial age.

The introduction of the computers revolutionized the way information was acquired, processed, and distributed. That led to a change from focusing on the production of goods, to the creation of knowledge and the uses of information. It reshaped the society, where the term *post-industrialism* where coined by the American sociologist Andrew Bell. The emphasis on information, led many to label the current era the information age, and predicted the rise of the service sector and the decline of manufacturing (Hatch, 1997).

The post-industrial organization consists of flatter hierarchies, where networks, strategic alliances and cross-functional teamwork emerged. The organizational boundaries that existed in an industrial age organization disappears. The workers become more high-skilled and knowledge-based, and the nature of work shifted from specialized functions towards solving complex problems in cross-functional collaborations. While the technology of the industrial age mainly consisted of large machines and assembly lines operated by workers, the technology in the information age allows for flexible and automated machines, and computer aided design. No longer is there a need to concentrate workers in single building or area, since communications and information sharing can be done through computers and the internet. The post-industrial society connected the world closer together, opened new markets, and introduced new competitors for the companies. The business environment in the post-industrial age is highly uncertain, ambiguous and complex.

2.2 Futures oriented management

The changing nature of works tasks, value creation and organizational structure prompted by the transformation from the industrial age to the post-industrial age, also changed the management requirements. The industrial companies were highly labour intensive, and as the organization grew so did the management organization. More managers where needed to enforce control over the production line and related activities. The line managers work under the directions of the top management, and the whole organization were managed from above.

When technological innovations, especially the computer, transformed the industry towards the post-industrial age, traditional manufacturing declined. The post-industrial age gave rise to the service industry, and the emergence of sophisticated technologies required fewer but more skilled workers. The organizational structure shifted from vertical and linear hierarchy to a more flat and complex structure. Frankel (2008) states that management in the post-industrial age involves less management of people, and more management of systems and change. Today, changes happen so rapidly that managers must constantly stay alert and sense their business environment for threat and opportunities. They must delegate decision making powers to the workforce to free themselves from the daily operations.

The post-industrial business environment is complex, dynamic and globally inter-connected. Threats and opportunities may emerge from anywhere, in any shape and form. It can be technological, economic, social or cultural, it can be internal or external, and managers must be aware and anticipate what the future holds. They must also understand that past events do not necessarily reflect future trends, to avoid confronting new issues with old methods. This type of management approach introduces the term *Futures Oriented Management*, which is more concerned about the present state of the company, future prospect and development, as well as customer requirements, than with the trends from the past (Frankel, 2008). Futures Oriented Management work under the assumption that the future is less a reflection of the past, and their main task is to sense the environment to manage the short-, medium-, and long-term future of the company in strategic terms. They understand that the business environment is dynamic and constantly changing, and must therefore adjust and improve business strategies, products and services, and business processes to adapt to customer requirements.

Another important ability for a futures oriented manager is to be open-minded and welcome ideas and suggestion from anyone within the organization, regardless of level in the hierarchy. They know that the whole organization contains more knowledge and ideas, than any individual alone. For organization to create value, they must use the combined knowledge and competence from all members of the organization, including feedback from customers and suppliers.

The requirements of a futures oriented manager have changed significantly from the management requirements from the industrial age. Today, managers must develop superb interpersonal skills and system skills to interact and collaborate across management functions and organizational boundaries. They must be technological literate, and understand how technological innovations can change or disrupt existing business models or customer behaviour. By staying alert to

opportunities and threats, futures oriented managers and organizations are more likely to stay competitive and adapt to ever-changing environment.

2.3 The environment of organization

The business environment for any organization consist of a diverse set of stakeholders that influences the organization. They consist of suppliers, customers, competitors, unions, regulatory agencies and special interests. Those are stakeholder that are in the immediate business environment that organization deals with on daily or weekly basis. In addition, there exist external forces that may influence the business environment from the outside. In *Organization theory*, Hatch (1997) provides a modern perspective to analyse the business environment of organizations. They are defined by their elements and can be divided by the following: the interorganizational network, the general network, and the international and global environment.

To analyse the business environment, first is to identify the links with stakeholders in the interorganizational network. Figure 2-1 shows a model of relevant stakeholder that generally exist within the interorganizational network, and places the organization in the center of its environment. However, in modern perspective, organizations are part of a network in a complex web of relationships. Some stakeholders may be more influential and have stronger links to the organization than other, and the network analysis provides a more accurate representation of interactions and linkage to the organization.

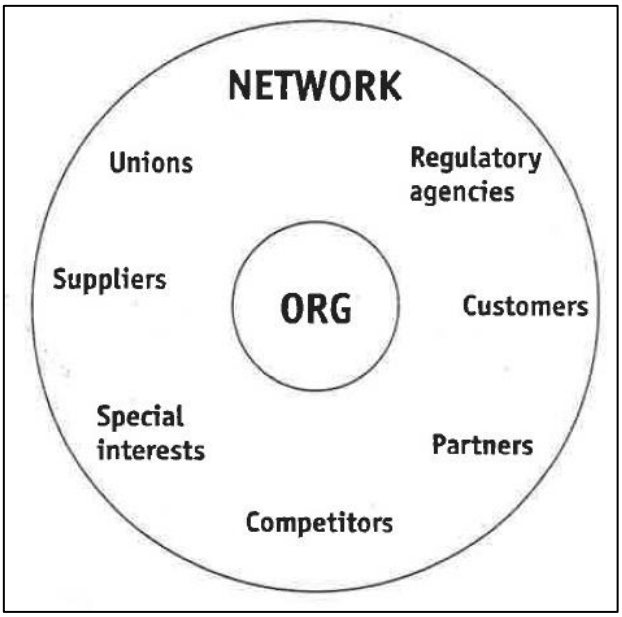

Figure 2-1 The interorganizational network (Hatch, 1997).

Figure 2-2 shows the interorganizational network in more balanced view where stakeholders are positioned with regards to their relative relationship among each other.

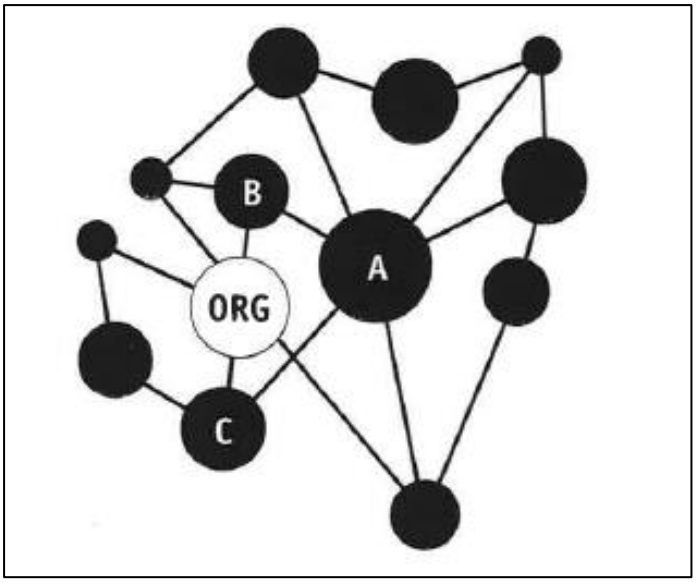

Figure 2-2 The interorganizational network in a balanced perspective (Hatch, 1997).

The next part of the analysis is to understand the general environment that may influence the interorganizational network. The general environment consists of external forces or trends that may compose as a threat or an opportunity to the organization and its network. Most often, they are forces that organizations have little influence over, and organizations can only deal with the impact they have. To help analyse the external forces, they are divided into different sectors, shown at Figure 2-3.

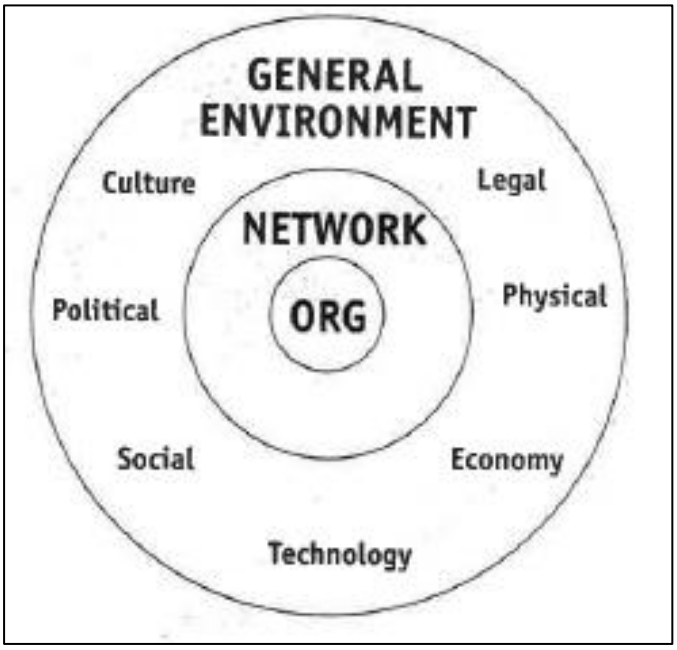

Figure 2-3 The general environment (Hatch, 1997).

The last element of the environment is the international and global environment, which consist of global entities and corporations that crosses national borders. This level of business environment adds to the complexity of perspectives and makes the organization inter-connected with other interorganizational networks across the world. To analyse the business environment with regards to the general environment and the international and global environment requires a more expanded and macro level perspective.

2.4 Scenario planning

Scenario planning is an analysis tool and planning instrument used for strategic planning for organization to make flexible medium and long-term plans. It differs from forecast and prognoses by analysing plausible futures, or scenarios. While forecast and prognose tend to measure the expected future by quantitative analysis and extrapolation of current trends, scenario planning creates different and vivid futures caused by chain of events. It deals with the unexpected and the ambiguity of the distant future by developing multiple scenarios that are either possible, probable or plausible (Lindgren and Bandhold, 2009).

Scenarios planning is an effective strategic planning for medium to long-term planning. It is useful when the future is uncertain, and can help reveal risks that otherwise would not have been identified using more traditional planning instruments. It does so because thinking in scenarios helps understand the logic development of events and clarifies the driving forces behind it. That may reveal key factors, key players and the organization's own position in different outcomes. When organizations become aware of the multiple scenarios that is plausible, they are more likely to understand the consequences, which can be a threat or an opportunity. With such knowledge or anticipation, the long-term strategy can be adapted to steer the organization towards a successful future. Threats can be mitigated or prepared for in advance, and opportunities can be exploited much faster than the competitors. It also highlights for the management that the business environment is not stable and linear, but instead dynamic, ambiguous and complex.

Since scenario planning is effective to use when the horizon is uncertain, Lindgren and Banhold (2009) claims that the method can serve multiple purposes. In addition to long-term strategic planning, organizations can use it to assess product and business development. By developing scenarios related to industry, technology and consumer change, scenario planning may assist traditional research and development approaches. It can also be used to evaluate existing business concepts, strategies or concepts, or challenge existing paradigms and longstanding assumptions. Figure 2-4 illustrates the different purposes scenario planning technique can serve.

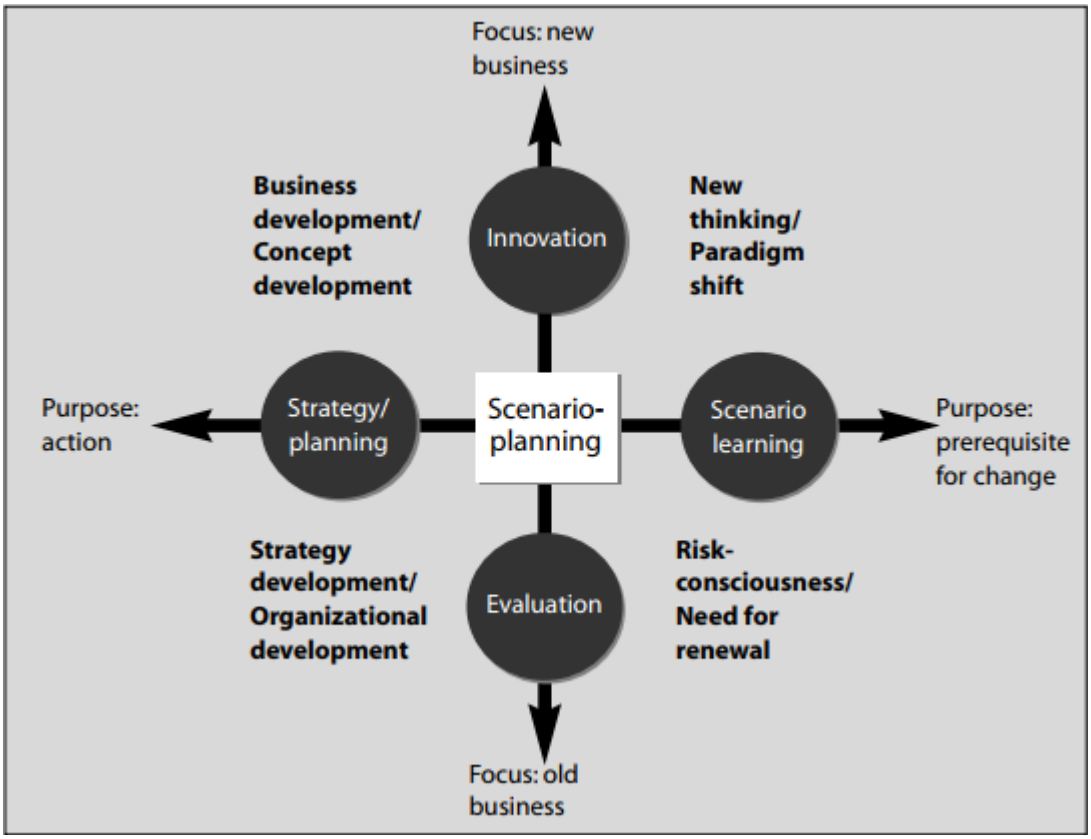

Figure 2-4 Scenario projects in different purposes (Lindgren and Bandhold, 2009).

3 METHODOLOGY

This chapter aims to describe the research strategy and design used in the thesis, together with research methods, selection methods of sources, and how the information is use in the analysis. In addition, a project timeline describing the main activities of the thesis is provided.

3.1 Research strategy and design

The research strategy used in this thesis has been approached in an exploratory manner, meaning exploring the research questions to understand various level of depth and elements of the topic. Exploratory research design does not aim to provide final and conclusive answers to the research questions, but to help understand the problem better (Singh, 2007). Such approach fits the topic of thesis because the digital transformation is expected, by many accounts, to be a paradigm shift in the industry. Since we are relatively in the early stage of the digital transformation and moving towards an unknown territory, conclusive answers to the research questions is not viable. Exploratory research gives the researcher flexibility and adaptability to change direction as a result of revelation of new data and new insights (Saunders et al., 2007), and has been common aspect during the work. On a daily basis, new insights and revelations from articles, survey reports, and real-life examples emerged during the work period, which could either result in change in direction or change in sources. A challenge that kept occurring was to assess the relevance of new sources, and set a definite limit of including new ones.

The exploratory research strategy has also given flexibility in the research method. In this thesis a combination of quantitative and qualitative method has been used. That has allowed for collecting data on a larger sample size that are representative for an industrial or a global trend, and at the same time examine realistic examples and deeper insights to understand the objective of the thesis. This is often referred to as mixed-methods research, and is used to provide better understanding of the results provided from quantitative research (Johnson et al., 2007).

3.2 Research methods

3.2.1 Quantitative research method

Quantitative research methods emphasis on objective measurement, and is a statistical, mathematical or numerical analysis of data collected through polls, surveys or questionnaires. The data is usually gathered using a structured framework, and the results is based on a larger sample size or population (Rubin and Babbie, 2011). Using quantitative analysis has been important to understand the research questions in a larger scale. Digital transformation is a global phenomenon that affects many industries across the world. To understand the affect it has, using survey reports that capture such data has helped highlighting the problem in a larger context and examine global trends.

However, with the natural limitations of time, capabilities and resources of this thesis, conducting such survey was not feasible. Instead, the quantitative research data has been relied on public available survey reports provided by renowned institutions. Since it is secondary data, meaning the collection data has been conducted by someone other than the researcher, the selection of source

materials has been carefully assessed. To keep the validity and reliability of the quantitative data, the selection of sources has come from public and private institutions that are known to be trustworthy, have solid reputation, and is relevant for the both topic and the industry. Those sources have generally a strong degree of validity and reliability in their methods, which the researcher of this thesis does not need to re-examine.

There are three survey reports that are central in thesis, and are published from the following institutions: PricewaterhouseCoopers (PWC), the World Economic Forum, and MIT Sloan Management Review in collaboration with Deloitte. The survey reports provide a baseline for the primary research, where the quantitative data is compared to theoretical perspectives, business cases, and other insights that has been collected in the research. Following is a description of relevance and research methods from the secondary sources:

- PWC – Global Digital IQ survey (2017): Is used in the thesis to provide a global industrial expectation and understanding of the digital transformation. In addition, it provides an expected investment trend of innovative technologies in a five years perspective. The survey report is annual research conducted by PWC, and includes 2,216 respondents from 53 countries. The respondents are evenly divided between IT and business leaders. 62% of the respondents work in organizations with revenues of $1 billion dollars or greater, and 38% have revenues between $500 million and of $1 billion. The survey was conducted September through November 2016 (Curran et al., 2017).

- The World Economic Forum – The future of jobs (2016): Provides a survey of global expectations of future jobs and job tasks, employment trends, changes in demand for core work-related skills and abilities, and technological drivers of change. The dataset is a result of an extensive survey involving Chief Human Resources Officers and other senior talent and strategy executives of leading global employers. The respondents represent more than 13 million employees across 9 broad industry sectors, including the Oil and Gas sector, and span across 15 major developed and emerging economies across the world. The survey collection process was carried out via online questionnaire in the first half of 2015, where the research team worked in close collaboration with regional teams to ensure maximum numbers of responses from target companies (World Economic Forum, 2016).

- MIT Sloan Management Review & Deloitte – Achieving Digital Maturity (2017): The survey provides an understanding of the challenges and opportunities associated with the use of digital technology. It captures insight on how organizations can adapt to a digital environment, and what is expected of digital maturing company. The respondents were asked to imagine an ideal organization transformed by digital technologies and capabilities, and where asked to rate their company against a scale from 1-10 in terms of digital maturity. The survey includes more than 3,500 business executives, managers and analysts from organizations around the world. The survey was conducted in 2016, and the respondents was selected from number of sources, including MIT Sloan Management

Review readers, Deloitte Dbriefs webcast subscribers, and other interested parties. In addition to the survey results, interviews with business executives from several industries and academia was conducted to understand practical issues organizations face today. Their insight contributed to a better understanding of the data (Kane et al., 2017).

3.2.2 Qualitative research method

While quantitative research method operates with numbers to measure and explain a particular phenomenon, qualitative research method is an empirical assessment to understand the nature of reality and provides an in-depth inquiry to the problem. Qualitative research method is based on human interpretations, and is constructed by the intimate relationship between the researcher and what is studied (Denzin and Lincoln, 2005). The method examines the problem by asking "why" and "how", which is essential since the core question of this thesis is to understand *how* the digital transformation is reshaping the maintenance management business in the Oil and Gas industry. The characteristics of qualitative research is that it is naturalistic, emergent and purposeful. Meaning it refers to real-world situations, adapts the analysis as more knowledge is gained or situations are changed, and the cases selected is relevant to the topic (Denzin and Lincoln, 2005). The technological development is happening in an accelerated pace, and with additional information and understanding that emerged during the work, adaptation or change in direction has sometimes been required.

Qualitative research is a broad methodological approach that includes many research methods in collecting data. In this thesis, the qualitative research methods that has been applied are personal experience within the industry, multiple case studies to understand real-life context, and semi-structured interviews with relevant stakeholders to capture different perspectives and expectations. Using a broad qualitative approach, together with quantitative data, has helped to explore and makes sense of the totality of the topic. Having limited knowledge about the phenomenon of what digital transformation really meant, at the beginning of thesis, using qualitative research methods to perform an in-depth analysis has been essential for the reseaercher.

3.2.3 Case study research

Performing case studies during the research has been essential to understand the topic of the thesis in a real-life context. Yin (2003) defines case study as an empirical inquiry that investigates a contemporary phenomenon within its real-life context. Technological innovations present novel tools to perform a task or to create new value. Often are such innovations prototypes of a product or applicable in a narrow domain. At least at the beginning. To understand how novel technologies can be used and how it may impact an existing business model or an industry, real-life examples must be examined.

The selection of cases has varied from sources of various industries, and not only the Oil and Gas sector. Since the digital transformation that is happening consist of many different technological innovations, each with different purpose and method to create value, multiple case studies have been included. Technological innovations and changes in business models have different level of

maturity in separate industries. The same applies for organizational changes and adaptation to a digital business environment. To understand the implication digital transformation may do the maintenance service industry in the Oil and Gas sector, comparison from other sectors, that are perhaps more matured or have been disrupted, has been necessary to provide better insight.

The case studies chosen in the thesis, have been analysed and compared because of its relevance to the topic. They provide an in-depth analysis and insight of the quantitative data. Most of the technological innovations and value creation that is covered, is viewed by the researcher as directly transferrable to the Oil and Gas sector. The same applies for changes in organizational structure, business models and strategies that more digitally maturing organizations from other sectors have done. The cases, in addition to its relevance, have also been analysed against theoretical perspectives that is included in the thesis.

The challenge of comparing from other industries, is the implication of different regulatory regime, culture, convenience and external factors that influences the industry. While the digital transformation may be more matured for technological companies and non-physical sectors, such as finance and IT, the Oil and Gas sector operate under completely different circumstances that can affect the progress. The Oil and Gas sector operate under a strict regulatory regime, that sometimes prevent or delay innovative technologies or changes in maintenance strategy. In addition, the recent drop in oil price has put many companies in a recovery mode, where short-term financial goals have been prioritized against investment and development.

3.2.4 Qualitative interviews

3.2.4.1 Semi-structured interviews

In addition to case studies, qualitative interviews have been conducted in the research to provide insights from different stakeholder perspectives in the industry. A qualitative interview captures the direct insight from people's individual experiences and knowledge, which allows for collecting detailed information about the research question (Boyce et al., 2006). The methodology used in the thesis to collect such information is a semi-structured interview, where the researcher provided a set of questions to the interviewees in beforehand (See appendix A). The interview guide consists of open-ended questions which allows the interviewees to explain and elaborate their answers. In addition, it allows the researcher to ask follow-up questions or further explanation of answers if needed.

Because of the dispersed location of the interview objects, the interviews were conducted through oral communication tools, using Skype and mobile phone. The interviews were conducted in both English and Norwegian, dependent on the interview object's preferred language. Later, the interviews were transcribed to English, to the researcher's best effort. The translation is subject to the researcher's knowledge and ability of the English language. The interviews were approach with an open mind and a friendly tone. The interviews started with a brief introduction of the thesis, and a casual presentation of the participants. When conducting interviews through oral communication tools, there is an extra effort not to interrupt the interviewees, and allow them to speak freely

without displaying any disagreements in any form. The objective is to capture their insight and avoid any bias from the researcher.

The limitations of conducting qualitative interviews is that the result only captures a small sample from individual insights and experience, which make it hard to draw useful generalizations from the findings. Their perspectives may also not be representative for their organization or industry, as they may have their own biases and experiences (Yin, 2003). The researcher's limited experience in conducting semi-structured interviews is also a factor to take into account.

However, given the limitation of such interview, they provide valuable insight into the status-quo and organizational ambitions towards the topic. The data collected from the semi-structured interview provides additional perspectives towards the case studies and the quantitative data. Capturing the experience and expectations from different individuals offers another layer to the analysis.

3.2.4.2 Unstructured interviews

Due to the nature of the research strategy, the exploratory approach has also allowed for conducting unstructured interviews (Brown, 2006). Since there are new problems and topics to investigate, the thesis also includes two unstructured interviews. One was conducted as part of market research to find new solutions, and another was a presentation about machine learning systems, provided by a scientist from Christian Michelsen Research. No questions were provided prior to the unstructured interviews, as the goal was to enhance the researcher's knowledge about the digital technologies.

3.2.4.3 Selecting interview objects

The interview objects were selected through various criteria and limitations. The interview objects in the semi-structured interview were selected based on their stakeholder perspective. They include the perspective from an Oil and Gas operator, a technological service provider, and an independent actor in the industry. The access to the interview objects were made available from the researcher's personal network, and the network from the faculty supervisor for the thesis. The interview objects from the unstructured interviews were selected by initiating contact during the market research. They are included due to their availability and their willingness to contribute to the thesis.

3.3 Project timeline

Figure 3-1 shows the project timeline together with a simplified description of activities related to the Master's thesis. It highlights the schedule that the work was intended to follow. Some deviations from the plan did occur that required adaptations, but in overall it was manageable adjustments. Would also point out that periodically status meeting with the supervisors were conducted throughout the project.

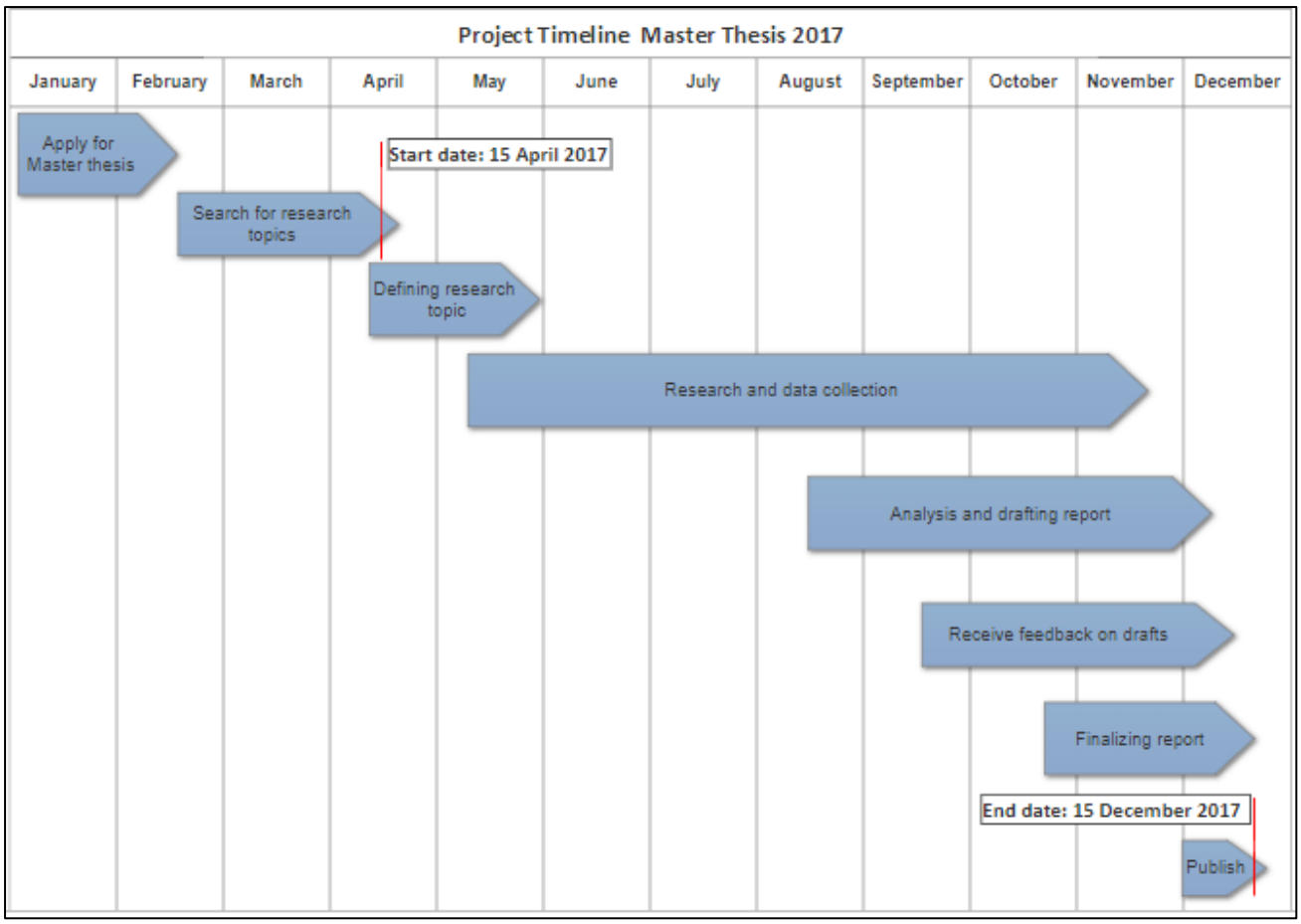

Figure 3-1 Project timeline

4 ANALYSIS

4.1 Expectations and semantics

4.1.1 Disrupting the landscape

We are amidst a technological revolution that has already shown dramatic and radical changes to various industry sectors. The wide-ranging consensus among experts and people familiar with the technological developments believes it will affect almost any industry, regardless how much, or little, certain industries relies on technology. The fundamental question has gone from “if”, to “when” and “how”.

However, many people and organizations are still unaware of this upcoming revolution, or how it will affect them and their businesses. Failure to recognize and adapt to this dramatic shift can cause the downfall of any organization, regardless of size and market share. The stakes are high, and some will argue that the business environment has never been more fragile for incumbent companies.

According to a study by Innosight, a growth strategy consultant firm, about half of S&P 500[1] companies will be replaced over the next 10 years. (Anthony et al., 2016). The average life span for companies listed in the S&P 500 has gone from 33 years in 1965, and is forecasted to drop to 14 years by 2026 (Figure 4-1). The study points to the growth of start-ups and increased merger and acquisition activities as leading factors for the corporate volatility.

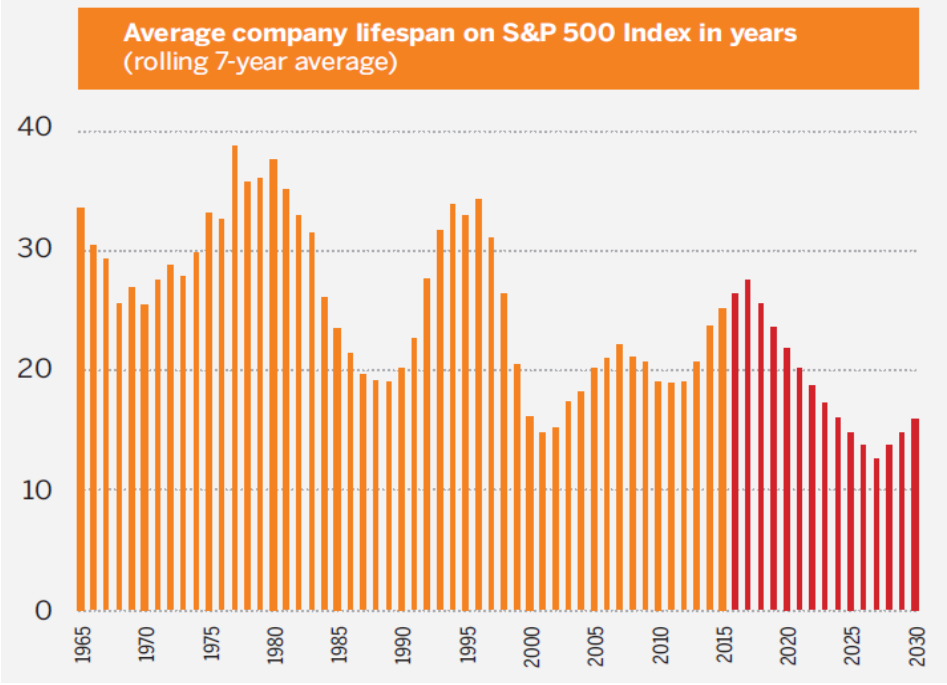

Figure 4-1 Average company lifespan on S&P 500 Index (Anthony et al., 2016).

[1] The Standard & Poor’s 500 index is an index of 500 stocks seen as leading indicator of U.S equities and a reflection of the performance of the large cap universe. The list of companies included are selected by economist (Investopedia 2017).

Because the technological revolution is based on digital evolution, it is lowering the bar for new entrants to enter the market. The digital domain makes innovation faster than ever before, and the speed for new entrants to gain market share and reach a valuation of a billion dollars is staggering.

We can only look at the transportation sector, where Uber has radically disrupted the taxi industry worldwide. Since their official launch in 2010, the company is now valued at $69 billion dollars, which exceeds the market cap of giant companies such as General Motors and Ford (Blystone, 2017). Uber is harnessing the power of digital technologies to remake the landscape and business models in an industry that has been viewed as very conservative.

Before Uber, the personal transportation industry had seen minimal changes. In some cities, they use taxi medallions as a licencing system to regulate the numbers of taxi in the streets. This system helps the local government to regulate supply and demand, which sustain a stable market price for taxi fares. For owners of taxi medallions in New York, this has always been viewed as a stable business and a lucrative investment. In 2014, the value of a taxi medallion was listed around $1,3 million. To many owners, this was their pension investment (Holodny, 2016).

Forwarding the time only two years, the New York taxi medallion was listed around $ 250,000. For the owners who had invested when the price was at its peak, have taken a heavy hit. With the entrance of ridesharing companies such as Uber, who can operate without a taxi medallion because of their innovative business model, are disrupting and cannibalizing taxies industries across the world. This has created a collective outrage among taxi drivers, and only government interference and regulations has been able to slow the total disruption.

4.1.2 Creative destruction

What we have witnessed in the personal transportation industry is something we see in other industries as well. New entrants are harnessing the capabilities of the digital revolution to create new markets and business opportunities to challenge incumbent businesses. This behaviour is something the Austrian economist, Joseph Schumpeter (1943), coined as “creative destruction” in his book *Capitalism, Socialism, and Democracy*.

The principle of creative destruction is when innovative technology, processes or products are harnessed to cannibalizing existing market by creating new ones within that offers better return on investment. The new market, often created by new innovative entrants, might start in a small scale, but will over time surpass and destroy the old market. Together with the destruction of the old market, job losses will occur, and businesses that are not able to adapt to the new market will face bankruptcy. Schumpeter argued that creative destruction was the process on how free markets evolve through innovation to become more productive, increase wealth and create better jobs and products. The loss of jobs, ruined companies, and vanishing industries are part of the growth pain in this dynamic economic system.

History have shown us many times the result of creative destruction. Many household names in business have been on either side of the process. When Henry Ford revolutionized the car manufacturing industry with his innovative assembly line process, he created a new market within

the automobile industry. Since his method greatly reduced the production cost of a car, a new market emerged towards the middle class buying and owning automobiles.

If we look at the perspective of a company on the other side of this process, there is the infamous story of Kodak's failure to realize the opportunity of digital photography, a technology invented in-house by a Kodak engineer. Since digital photography was a direct threat to Kodak's existing film based business model, they declined to let the novel technology cannibalize themselves. Kodak's decision to stay in denial of harnessing the opportunities of innovative technology caused them their downfall, and in January 2012 they filed for bankruptcy protection (Mui, 2012).

Another well-known example of a company's failure to recognize innovation that disrupt the existing market, is the story of Nokia. Nokia was the dominant brand in the mobile phone market for over a decade. In 2007, they had a market share of 49,4%, their products were solid, and the company had an excellent brand reputation (Lee, 2013). The short story of their downfall, is their failure to respond fast enough to software innovation on their products. When Steve Jobs, at Apple, launched the Iphone, with a completely new operating system on mobile phones that the worlds had never seen before, it disrupted the mobile phone market at a rapid pace. Many points out that the top management of Nokia had become complacent after being on the top for so long, when they eventually had to react to the new threat, it became too little, too late. The new entrants in the industry had created a market that became too fast and innovative for Nokia to keep up with. In 2013, Nokia decided to sell its mobile phone business to Microsoft.

The previous cases are examples of creative destruction happening in the consumer market. However, creative destruction happens in any domain, and if we look at Oil and Gas industry, which is as business to business market, the same rule applies here.

The Norwegian technology company, Robot Drillings Systems, is on a mission to reshape drilling operations by developing a fully electric and robotic drill floor. The company has collaborated with Odfjell Drilling to build and implement this robotic drilling system, where robots seamlessly cooperate with other machines without the need for human intervention. Using a new software platform, the robot can program itself to operate autonomously, or by remote control from an operator. The system can be installed on new builds or retrofitted to existing rigs, and has potential to save up to 40 rig days per year per rig. In addition, fewer personnel on the drill floor reduces safety risks, improves operational costs and reduces operational downtime (Robotic Drilling Systems, 2017). Such technological innovation is a significant threat to the existing drilling market, which consist of human personnel and manual labour, and has the potential to fully replace it.

4.1.3 "Digital destruction"

We are entering a time where the process of creative destruction is expected to occur more frequent. As the report from Innosight states:

> "We're entering a period of heightened volatility for leading companies across a range of industries, with the next ten years shaping up to be the most potentially turbulent in modern history." ((Anthony et al., 2016), p.3)

The technological progress has come to a stage where computers have the ability to learn, sense, see, listen, and understand human language. Autonomous vehicles are driving on the roads, robots are doing more complex tasks, and we can now create complex products by additive manufacturing, also known as 3D printing. All this technological progress is taking shape in a digital domain, setting the stage for a period of "digital destruction".

Klaus Schwab (2016), the founder and Executive Chairman of World Economic Forum, tries to explain the impact the technological development will have in his book "*The Fourth Industrial Revolution*" . He points out the innovations that are happening now is a new industrial revolution because of three significant characteristics; velocity, breadth and depth, and system impact.

The speed that this development is undergoing is happening in a remarkable pace. Since it is based on a digital foundation, it evolves at an exponential rate. In addition, many of the new technologies are linked and works combinatorial, which helps accelerate each other's progress. The world has also become much more interconnected through the age of the computers, which also gives it a wide range of breadth and depth. This will create a system impact because it will transform entire systems across countries, companies, industries and society.

To put it into perspective and see the pace and breadth of this development, we may compare how certain innovative technologies reaches mass adaptation. Figure 4-2 shows the comparison of scaling to reach 50 million users. The conventional radio took around 38 years before reaching 50 million users, while the TV took 13 years to reach the same number. If we compare those disruptive technologies too modern innovation, the scaling to reach 50 million users has gone dramatically down. Mobile phone applications such as Twitter and WeChat needed only a couple of months to reach 50 million users.

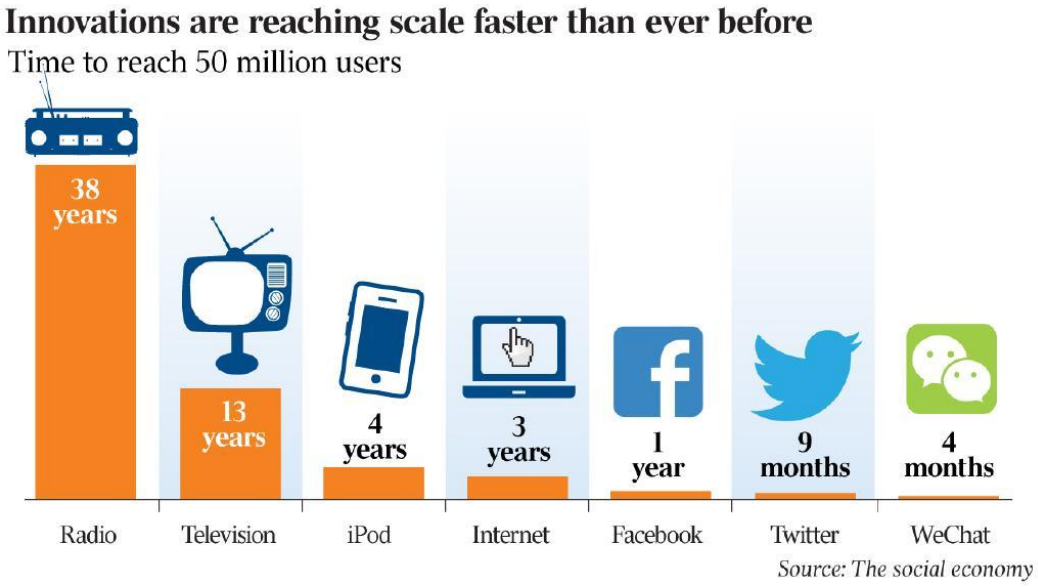

Figure 4-2 Innovation scaling (Chui et al., 2012).

Scaling to mass adaptation is happening faster than ever before. At the same time, scaling has become very cheap. Products in the digital sphere consist of bits, rather than physical goods. The cost of digital storage has dropped exponentially, and in 2016 the average cost per gigabyte were $0,019, compared to $11,00 in 2000 (Statistic Brain Research Institute, 2016). The same goes for computing power. The power per dollar has grown exponentially since the 1980s, and it creates a strong incentive for companies to utilize this capacity rather than employ expensive labour (The Hamilton Project, 2015).

When the cost of digital storage and computing power has become cheap and affordable, the bar for new innovative entrants gets lower. The returns to scale is increasing towards investment cost only, meaning output may increase with limited or just the initial input (The Editors of Encyclopædia Britannica, 2016). This will allow new entrants to grow fast, large, and with the agility to challenge incumbent market leaders.

4.1.4 Is the industry aware?

In a time where a new industrial revolution is looming, it is imperative to understand if organizations and business leaders are aware of what is happening. The technological developments that are emerging are providing industries and businesses with completely new opportunities to improve, change or disrupt the way business is conducted. At the same time, it possesses an existential threat to any organization that is oblivious or do not believe it will impact them or their industry.

One of the main challenges that this revolution has is that it may be disguised as an incremental development in the domain of Information Technology (IT). The word "digital" is commonly synonymous or related to IT, and therefore many may threat it that way. At a digital conference called *Insight 2017*[2]*,* many experts said that this was also the common misconception about this digital transformation. As one of them put it: "Many believes that the digital transformation we are undergoing is simply to put electricity on paper". That conviction is just about digitizing manual processes.

The difference about the digital transformation this time, is that it is more than digital products and processes. It also involves more than just the IT departments, and the impact will span across the organization. This digital transformation is going to be a fundamental change in future business and value creation, and has often been given terms such as *digitization* or *digitalization*.

The Norwegian Business School, BI, is one institution that is embracing this transformation, and in 2016 they created a *Centre for Digitization,* with the aim to help and educate top managers to understand the impact of digital technology. They define digitization as following:

[2] *Insight* is an annual digital conference in Oslo hosted by the IT company Evry.

> "*Digitization is the transformation from IT being a support tool in the business, to become part of its DNA. This means that business model, organization and processes are designed with respect to utilize today's and tomorrow's technology*" (Sannes, 2016).

With such profound change on the doorstep, business leaders and organizations must understand the full concept behind digitization to comprehend and embrace the transformation. When business leaders are facing the challenge to redesign their business model, organization and processes with respect to new digital technology, they must understand the reason for this change. Otherwise, they will remain in status quo when the world around is entering a new era.

The global consultant company, PWC, released earlier this year a research about digital transformation among high earning businesses from 53 countries. The research included 2,216 respondents from IT and business leaders, and the purpose was to understand how well companies are ready to handle the changes that are coming. They measured their *Digital IQ*, which they define as the measurement of an organization's abilities to harness and profit from technology.

In the report, *2017 Digital IQ survey (Curran et al., 2017)*, 52 % of the companies rate their Digital IQ as strong, which is an all-time low and a drop from 67 % from the previous survey. When asked about the organization's definition of digital (Figure 4-3), the response varied differently, and 29 % of the companies still believed that digital is synonymous with IT.

That indicates there is still a way to go for industries and organizations to comprehend the transformation that is happening.

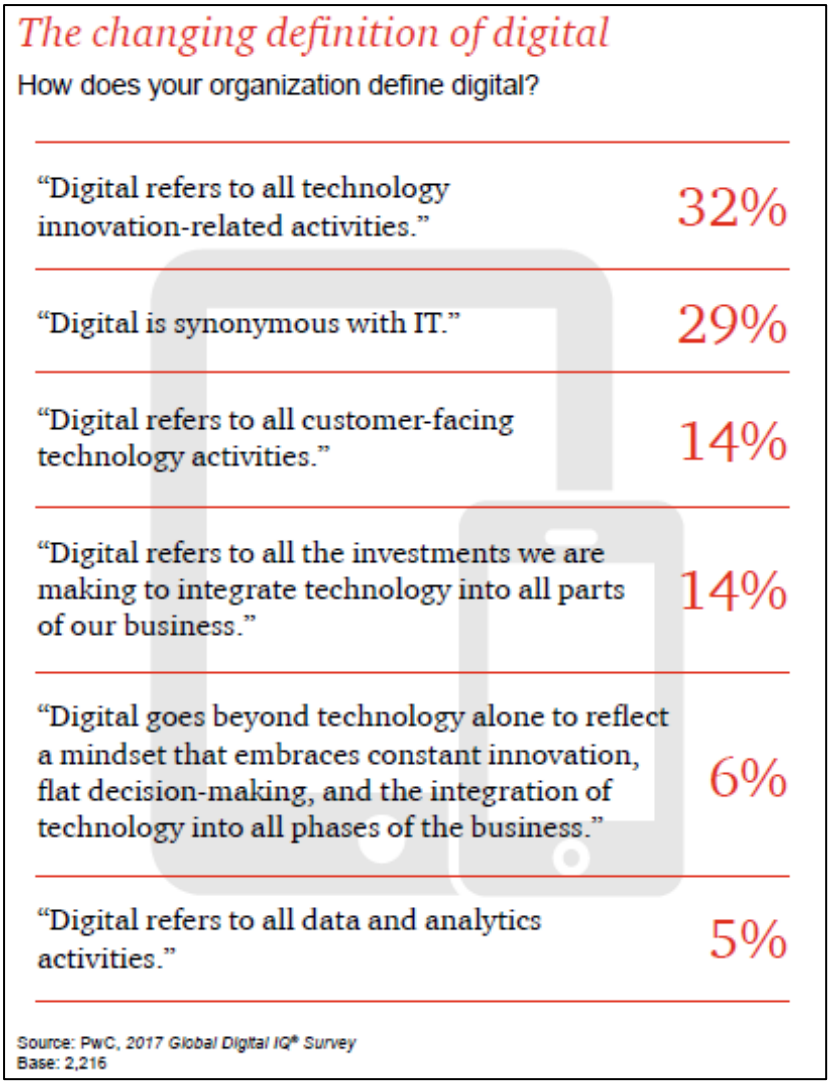

Figure 4-3 The changing definition of digital (Curran et al., 2017).

4.2 Technological solutions and services

4.2.1 Disruptive technologies and drivers of change

To understand the paradigm shift that is happening, we must recognize the technological innovations that are making this possible. Since the term "paradigm shift" is used in this case, it should mean that the technological innovations will most likely provide new methods and approaches to harness and provide value. In addition, we need to understand how value may be created.

In a survey report conducted by the World Economic Forum's Global Agenda Council on the Future of Software & Society (2015), with the aim to identify technological tipping points and social impacts, they recognize six megatrends that are shaping society in novel ways:

- People and the internet
- Computing, communications and storage everywhere
- The Internet of things (IoT)
- Artificial intelligence (AI) and big data
- The sharing economy and distributed trust
- The digitization of matter

Each of the megatrends may contain sub-groups which may impact various industries in separate ways, and in a different timeframe. For instance, a sub-group of AI, we find advanced robotics which may be more achievable to manufacturing in a shorter term, than other industries. Probably, the only certainty is that these megatrends are in the pipeline, and is only a matter of time before the impact is felt throughout all industries.

In a more recent report from the World Economic Forum (2016) , *The Future of Jobs*, they estimate the timeframe and significance of technological drivers of change. The result is based on an extensive survey among senior leaders and strategy executives of leading global companies, in developed and emerging economies. Figure 4-4, which also includes demographic and socio-economic drivers of change, shows which driver of change that has already made an impact in a global scale.

Technological developments tend to influence socio-economic behaviour. Changing work environments and flexible working arrangement are becoming more widespread, and is enabled mostly because of mobile internet and cloud technology. While this impact has been already felt, remote office is now common, we see from Figure 4-4 that many more technological drivers of change are still in the pipeline for the coming years. That means that we are yet to see and fully comprehend how new technological developments will affect and change business models, organizational structure, skill sets and value creation in the future. In addition, since the technological innovations are combinatorial and amplifying each other's progress and effect, the picture is becoming more complex and uncertain.

As Figure 4-4 shows the expected timeframe of technological developments among many different industries put together, the impact felt for each innovation may vary from industry to industry. The technology sector, which sits in the forefront of digital innovation may have already felt the impact of many of the developments already. While industries that are subject to comprehensive regulations and approval may have a different maturity level. Another factor that may influence the maturity level for each industry is the relevance of use.

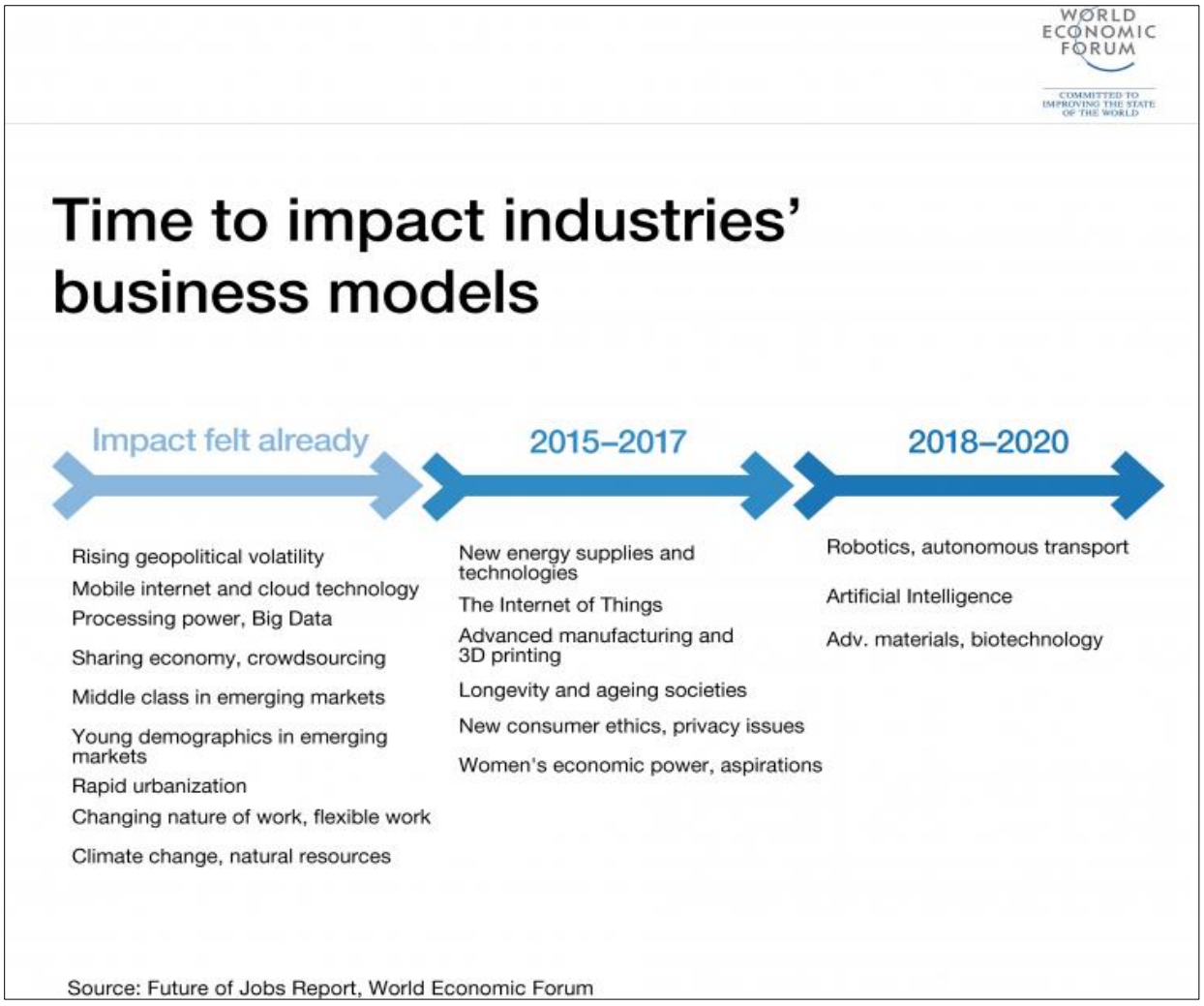

Figure 4-4 Time to impact industries' business models (World Economic Forum, 2016).

To get a holistic view of the technological maturity level in the Oil and Gas industry, the Vice President for Digital Platform at Kongsberg Digital, shared some of their insight during a Skype interview. They have together with a client in the industry mapped the technological maturity level in the Upstream Oil and Gas sector, as shown in Figure 4-5.

In the Oil and Gas industry, the maturity of technological drivers of change are in close correlation with the global trend. Mobile internet and cloud technology is well established, and the technology of Internet of Things is already under solid development and implementation. Valve and instrumentation vendors, such as Emerson, are already providing the energy and processing industry with wireless sensors and transmitters to remotely monitor the processing system, without the need for manual inspection.

The expected maturity level of technological drivers of change in the Oil and Gas industry are seemingly following the pattern of what kind of technology that is already established, together with the technology that is most relevant and available to use. As mentioned earlier, technologies such as robotics and automation may have a stronger maturity level within manufacturing, than within Oil and Gas because of lower barrier of implementation and less strict regulatory regime.

To better understand how different technological drivers of change are going to disrupt the Oil and Gas industry, we may look at the how companies and organizations have implemented and utilized the various technologies. In the Oil and Gas industry we are able to examine how already matured technology has affected the market and business models. But for other less matured technologies, we may look to other industries to understand the business impact those technologies have had when reaching a more mature or applicable level.

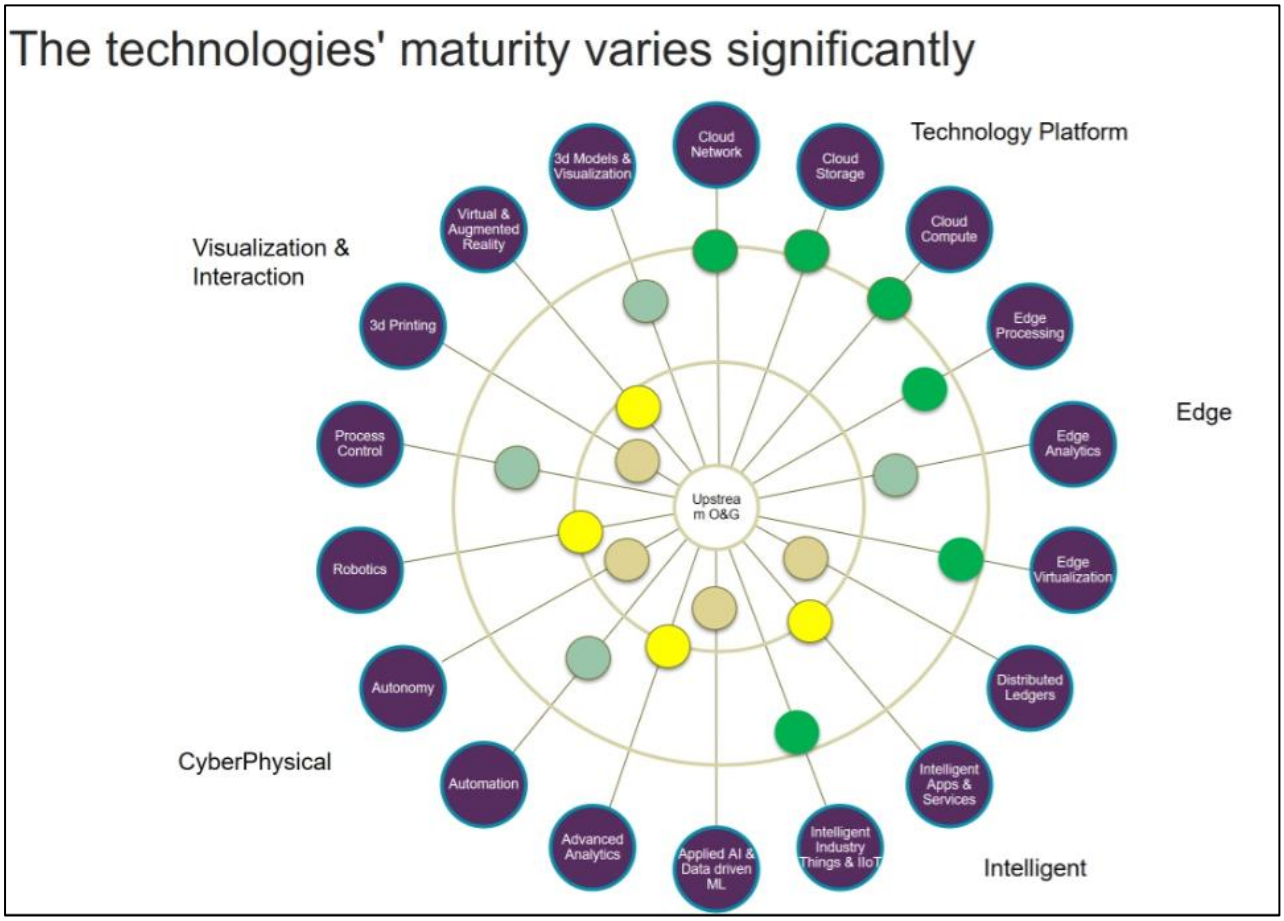

Figure 4-5 Technology maturity in Upstream Oil & Gas (Sverdrup, 2017).

4.2.2 Cloud technology

Cloud technology is probably one of the most matured driver of change among the megatrends that is shaping society, besides peoples' access to internet. At the same time, the concept of cloud technology is to some extent misunderstood. As private consumers have benefited from nearly free and unlimited storage from technology companies, such as Apple, Google and Dropbox, to store private photos and documents, the term "cloud" has become almost synonymous to online storage. Storage is only one part of the cloud technology, as it also contains the service of strong computing power, networking, servers, databases and more. All delivered over the Internet, hence the term "cloud".

For businesses and start-ups, cloud technology has a more significant impact and benefit than only online storage. Cloud technology services may significantly reduce investment and operating cost

within IT resources, and reduce IT capability planning to a barely minimum. In addition, it could provide the users with numerous advanced applications without the need to develop complex coding and algorithms. For start-ups and businesses with limited resources, cloud technology is enabling them to have the same, or even better, IT capabilities than larger and more resourceful companies, and is one key factor that are allowing new entrants to challenge incumbent companies in a much larger and faster scale.

Cloud technology is normally offered in three categories: infrastructure as a service (IaaS), platform as a service (Paas), and software as a services (Saas). Figure 4-6 illustrates how the different services is provided.

IaaS is basically the service of renting IT infrastructure such as servers, virtual machines, storage, networks, and security systems. The providers offer a pricing structure where the user pay per use, which allow the user to limit the IT resourcing cost to effective use only. For start-ups and small business, this solution will reduce investment cost significantly, and still have top quality, secure and reliable IT capabilities. If there is a need to scale up or down capabilities, or adjust to various demand or peak performance hours, the IaaS service automatically adjust to the demand.

PaaS is a computing service that provides a platform to allow developers to create, test, deliver and manage software applications in an online environment. The purpose is to make it easier for developers to quickly create web or mobile applications without the need to worry about building and maintaining necessary IT infrastructure. With PaaS, developers are able to create, test and deploy applications in much faster pace than before. Ideas can be turned into a product or service instantly, while the planning and acquisition for required infrastructure is no longer a concern.

Saas is application service that is already developed and ready to use. Normally users pay a subscription for licencing or pay per use, and enables them to use applications over the internet using only a web browser. Many cloud technology providers offer a good and solid variation of sophisticated software applications to attract users. In addition, many external developers that is using the PaaS option are also offering their own applications on the same platform, which helps increase the assortment of software applications.

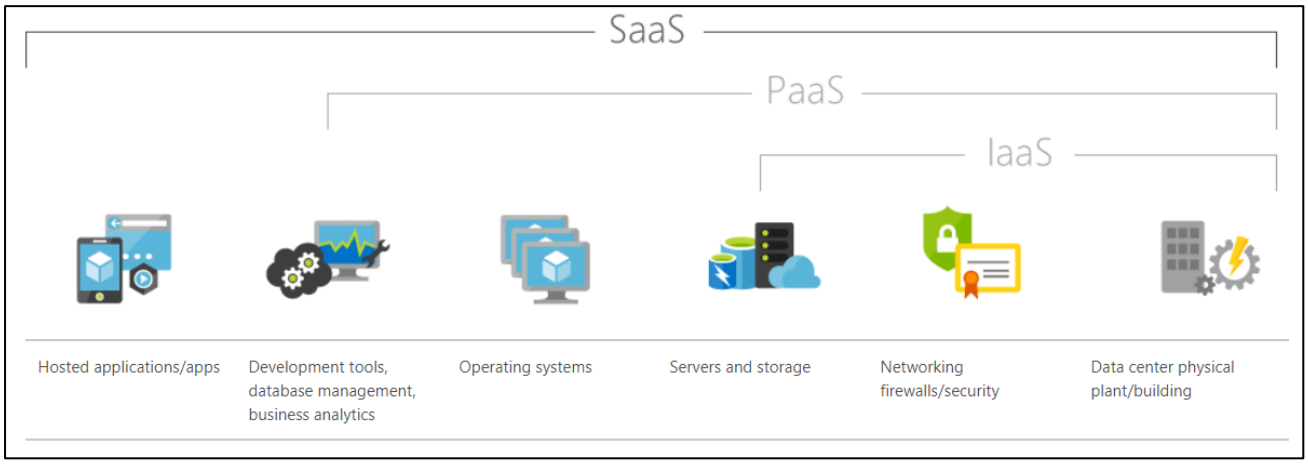

Figure 4-6 Illustration of cloud technology service (Microsoft, 2017).

Kongsberg Digital is one company that is investing on delivering PaaS and Saas services towards the Energy and Maritime industry, two major industries in Norway. They have partnered with some of the major cloud vendors, such as Microsoft Azure, to deliver strong IT capabilites. With the release of their digital ecosystem, Kognifai (Figure 4-7), one of the goals is to create a cross-industry collaboration platform where asset data can be collected and analysed to find synergies or common patterns and practices. This could be asset data from motors, pumps, valves, or other objects that generates performance data.

The platform is open to every stakeholder in the industry, ranging from customers, partners, vendors, industry clusters, and entrepreneurs. In addition, the platform will be open for academia and research organization. With such variety and complementary participants included in the platform's ecosystem, there is an enhanced condition to break down silos and bolster innovation.

Kongsberg Digital is offering software applications that is already developed and customized towards the targeted industries, but the platform is also open for participants to develop their own software application and offer it to other users in the ecosystem. In that way, all stakeholders have the possibility to benefit from new innovations created in the ecosystem.

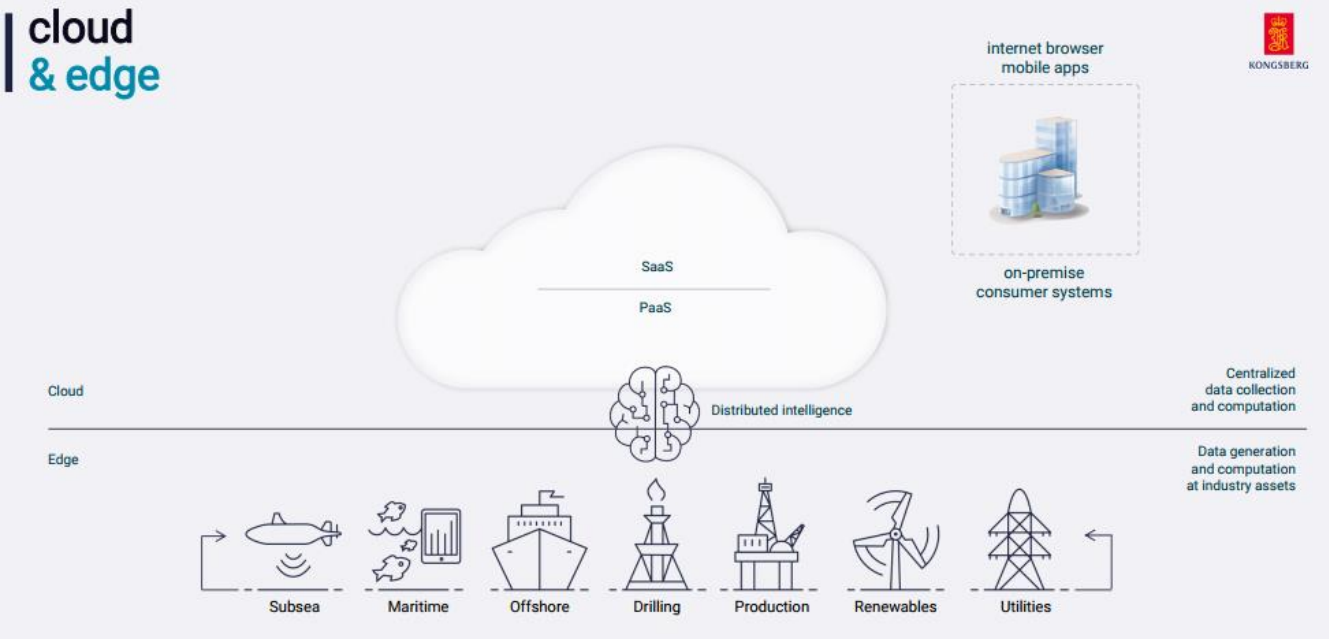

Figure 4-7 Illustration of the Kognifai ecosystem (Sverdrup, 2017).

Another company that is investing in a digital data platform is DNV GL, the independent advisory and risk management company. Their solution, called Veracity, is built on same the idea as Kognifai, to provide a digital platform to collect and analyse cross-industrial asset data.

Having vast amount of asset data from different industries, collected and distributed to a common platform may enable valuable insights that is never done before. In a collective digital platform, data can be analysed from a broader range of experts and analytics providers, which may improve the quality and accuracy of the analysis.

4.2.3 Internet of Things

The development of Internet of Things (IoT) is another driver of change that has matured well within the Oil and Gas industry. More assets and machinery have now sensors that are connected to a network and monitor the performance.

The definition of IoT is still debated among experts and might vary between industries and organizations. IEEE, a global professional engineering organization defines IoT as:

"A network of items – each embedded with sensors – which are connected to the Internet." (IEE 2015).

Gartner, a research and advisory firm within technology, define IoT as:

"The network of physical objects that contain embedded technology to communicate and sense or interact with their internal states or the external environment." (Gartner 2017)

However, as there is no official definition of IoT, the essence of the technology remains the same. It is smart devices that generate data about activities, events or influencing factors that provide visibility into performance of physical objects.

Connecting smart sensors to physical objects allow us to capture the performance data in real time. That allows us to monitor and collect a large amount of data without physical presence. This technology is one of the key enabler for creating the digital ecosystem, as performance monitoring of assets and machinery are at the edge, which is at the source of the data.

Like the development of digital storage and computing power, sensors are also keep getting smaller and cheaper. With lower prices and more practical size of sensors, it lowers the bar to integrate them into products and physical objects. Probably the clearest evidence of that is the smartphones we carry in our pocket every day. Smartphone now contains several sensors that can detect lights, sounds, motion, electromagnetic fields, global position, gravity, rotation, temperature, biometric data and many more. Having such capabilities in our pockets, and in such scale, would be perceived as science fiction only a couple of decades ago.

The pace of this development is increasing fast. By 2020, Gartner predicts that twenty-five billion things will be connected to the internet (Velosa et al., 2014). Almost any industrial product made today can be integrated with sensors, which allows the manufacturer to understand the product's behaviour and performance in real time, and with better precision. More sensors integrated and connected to a product will increase the amount of data collected, which in turn results in higher accuracy of diagnostics.

The trend of increased sensors on products is something Mark Raskino and Graham Waller, a researcher and a vice president at Gartner, defines a resolution revolution (Raskino M. & Waller G. 2015). They compare it with the evolution of the digital camera, where the increase in megapixels increases the clarity and quality of the photos (Figure 4-8). The more megapixels on a photo, the more you are able to see and zoom in.

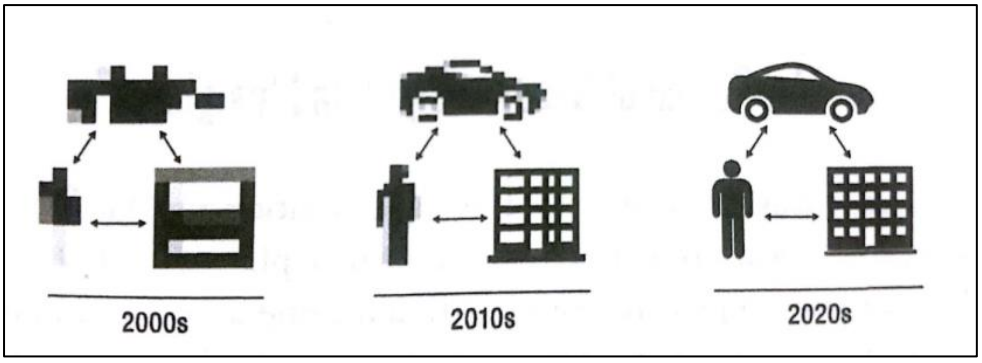

Figure 4-8 Resolution revolution (Raskino and Waller, 2015).

The same idea is applied for connected sensor on products. The more sensor connected, the more precise becomes the information we want to analyse. Instead of just tracking a car, which manufacturers are able to do today, they can with smart sensors monitor every component of the car. That means keeping track of the engine, the breaking system, the heater, the suspension and so on. Like a digital photo, we may "zoom" in to a car with better resolution and monitor the performance of every component in real time.

This means that the performance and maintenance schedule for each component can be much more optimized and predictive than ever before. For the manufacturer, they can use this data to improve product by analysing behaviour and performance over time. The driver of the car can get information of when and which part that needs maintenance or need to be replaced, and gone are the days where auto repair shops takes advantage of the customer. In addition, since each component can signal the need for replacement, the process of ordering new parts can be automated, where the sensor tells the car dealership's computer that a new part is needed. Then the order can be requested and scheduled without human involvement at all.

To get a sense on how small and sophisticated a sensor has become, we can look at Proteus Digital Health. Their innovated product, Proteus Discover, is a small pill with an ingestible sensor the size of a grain of sand, a small wearable sensor patch, a mobile application and a provider portal. When a patient takes the pill, the sensor, when reaches the stomach transmits a signal to the patch worn on the body. Then a digital record is sent to the patient's mobile device and to Proteus cloud system where health care providers, doctors or even family can get access with the patient's permission. The digital record can help the patient keep track of their medication, heart rate, blood pressure, activity and rest (Proteus Digital Health, 2017).

With this real-time information available to healthcare providers and doctors, it may help them to determine the correct diagnosis and treatment. Family members can remotely monitor if an old parent or grandparent remembers to take their medication, and alert them if they forget or take the wrong pill.

More companies are investing in IoT. According to the survey from (Curran et al., 2017), investment in IoT is at the top of the list of the technologies companies are doing substantial investment in (Figure 4-9). This seems to correlate with the survey also finds that IoT is the technology that is

expected to be the most disruptive to industries and business model the next five years (Figure 4-10).

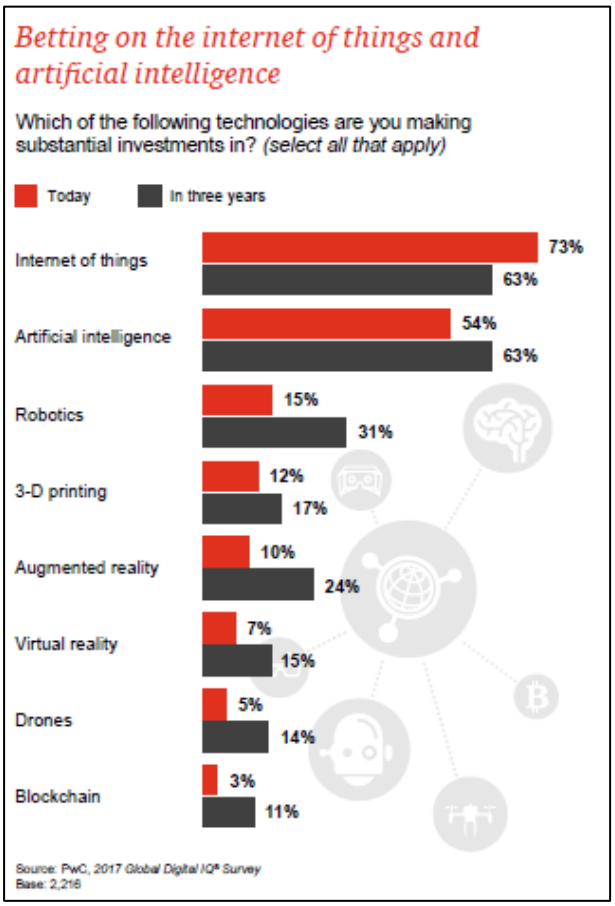

Figure 4-9 Technology investment (Curran et al., 2017).

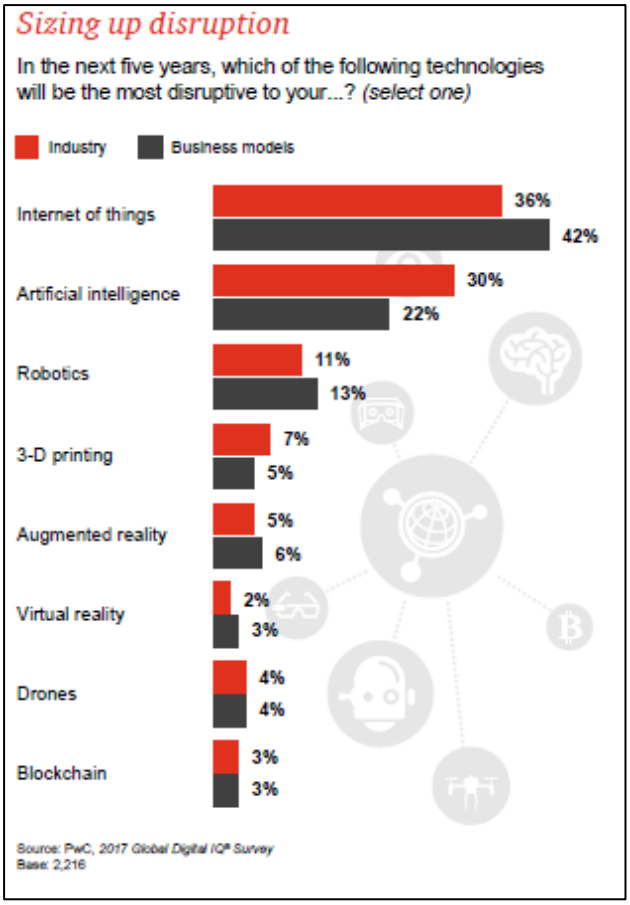

Figure 4-10 Technology disruption (Curran et al., 2017).

4.2.4 The convergence of IT and OT

The traditional structure of the industry has for a long time divided information technology (IT) and operational technology (OT) into two separate units. IT usually worked from the top down, deploying and maintaining data-driven infrastructure led by the organization's IT team. OT is built from the ground up, from machinery, equipment and assets to monitoring and control systems. Those units have normally worked independently from each other, and found their own effective solution to problems. It is a practice that is still relevant today, and some may consider it as the "norm" in traditional organizational structure.

With recent technological developments, the trend is moving towards a convergence between IT and OT. Some may argue that the convergence has always been ongoing incrementally as technologies develops, but with the development of smart machines, big data and particularly the Internet of Things, the convergence is happening much faster and in a broader scale. Using data that is collected from sensors on operational technologies to enhance production, collect information for better decisions making, or reduce downtime and maintenance is becoming widespread. In 2011, Gartner (2011) predicted that the convergence of IT and OT is not only happening, but is inevitable. Survey data from the previous section supports this argument, as the industry is set to invest more in IoT. The current trend is toward greater and more specific data penetration into the world of operational assets.

The convergence of IT and OT opens many possibilities never seen before. From OT being just a physical product, they are now a source of vital information ranging from customer behaviour to operational excellence. For maintenance management, this convergence is highly applicable and will most likely change existing maintenance approach and strategies. Better and real-time insight into asset performance can eliminate maintenance strategies of the past, such as preventive maintenance and corrective maintenance. Those approaches are usually reliant on past data or a fixed schedule, and may sometimes initiate a repair or an inspection even though the equipment is fine. People familiar with maintenance know that is sometimes a mistake because it may introduce new source of failure, rather than maintaining it. Having real-time performance data from equipment allows for a more precise predictive maintenance strategy, where every part can be monitored and diagnosed correctly.

Although, IT and OT convergence provide many opportunities, there is also challenges that needs to be managed. Not only will the technology side of it unite, but so will the organizational structure. The convergence requires stronger collaboration between the IT and OT organization, which introduces new set of challenges. Cultural differences must be managed, and it is necessary to divide ownership and responsibility for the management and maintenance of the IT/OT infrastructure. Otherwise, tension and blame game may occur between them. In their prediction, Gartner (2011) states that the Chief Information Officer (CIO) and other IT leaders may revaluate their roles and responsibilities. Their new role and authority may cater the needs of planning and coordinating a new generation of operational technologies alongside existing information- and administration-focused IT systems. When converging IT and OT, new organizational alignment is a key factor for effective transformation.

4.2.5 Big data and analytics

The recurring notion that the technological drivers of change are combinatorial and enhancing each other progress and capabilities becomes valid in the case of big data and analytics. The amount of data that is being produced in the world is exploding, and with the increase in sensors connected to physical objects, the rate of data produced will only increase exponentially. Connected sensors that streams real-time data from assets, collects huge amount of data on a daily basis. In order for this data to become valuable, it must be stored and processed by computers with strong computing power. Not every company can afford to invest in such large IT infrastructure, so the development of cloud technology services has made it available for many companies to harness the value of big data.

The combination of cloud technology, IoT and big data and analytics is a leading example on how combination of separate technological driver of change are used together to create new value. This combination represents a technological paradigm, and is transforming business models across industries.

An example of this is the case of Rolls Royce and the aviation industry, where big data analytics has a relative strong level of maturity:

Rolls Royce, mostly recognized as a car manufacturer, is also an aircraft and ship engine manufacturer that has successfully transform their aviation business from a struggling position to become one of the leading aircraft engine providers. It has done so by investing in connected sensors and big data analytics, and has reshaped their business in three key areas: design, manufacturing and after-sales support (Marr, 2015).

During the design phase they generate terabytes of data when simulating each jet engine that is under production. With data manipulation and visualization, they are able to understand how the jet engine will perform under any conditions. This insight allows them to identify improvements to the design or various parts before the jet engine has even been manufactured and tested. Having such key information before manufacturing reduces a lot waste in terms of raw materials and product development time to produce and test different prototypes. At the same time, the quality of the product is improved, which reduces a significant after sales cost in terms of warranty and call-backs of faulty products.

The second impact on their business is a transformation of the manufacturing process. The manufacturing system at Rolls Royce has become networked where each system communicates with each other through connected sensor. The industrial Internet of Things environment at the factory has allowed for automated measurement schemes and large data capture to monitor the manufacturing process. Each component can be monitored throughout the entire process with data analytics, which enables them to predict and control the quality with better precision.

Probably the biggest impact IoT and big data has had on Rolls Royce is on the after-sale part of the business. Evry jet engines that is produced are fitted with hundreds of connected sensors which records every detail about their operation and sends real-time engine performance data back to their engineers. With this information, they can analyse the health and performance of every engine during mid-flight and signal to the airlines when maintenance or inspection is necessary. For airlines, such predictive scheduled may save a lot cost during operation. Since every component is connected to a sensor, the engineers also know which part needs inspection, which reduces also time troubleshooting. For an airplane in between flights, delays can be significantly reduced and saving the airline company additional costs.

With such detailed level of data that is captured in real-time from their jet engines, has allowed Rolls Royce to offer new services to clients. The launch of the TotalCare program has moved the traditional business model from selling the engines as a product, towards a leasing subscription model where the clients pay per engine flying hour (Rolls Royce, 2017).

Rolls Royce believes with their big data analytics, they can predict the health and performance of each engines which allows them to cover maintenance planning, scope of work, repairs and overhaul activities. The client only pays for the performance of the engines, rather than the physical product.

In addition, with real-time performance data, Rolls Royce can with data analytics improve airline’s efficiency in terms of engine performance and fuel consumption. In 2015, they signed a five-year

deal with Singapore Airlines to use big data analytics to reduce fuel consumption across its fleet. With data collection from on-board monitoring system, flight planning, operations control and engineering systems, they claim to be able to reduce the airline's fuel consumption through predictive analysis. This service complements the existing Rolls-Royce TotalCare long-term service agreements with Singapore Airlines (Rolls Royce, 2015).

The investment in IoT and data analytics has been a success for Rolls Royce, which has transformed the company from a struggling position to significantly change how business is performed in the jet engine manufacturing industry.

4.2.6 Artificial Intelligence

The expectations towards Artificial Intelligence today has probably never been this high since world chess champion Garry Kasparov lost to IBM's supercomputer Deep Blue, twenty years ago. After that stunning victory by a machine, the expectations of AI surpassing all human abilities was the growing beliefs. Leading computer scientist argued that since a computer was able to beat the best human being in a such cognitive and complex game as chess, the glass ceiling for AI development was broken (Hassabis, 2017). Since the famous chess match in 1997, the development of AI has failed, or very limited, delivered to the expectations back then.

The AI technology has been pretty much reserved to computer scientist for the last decades, where the application has been narrowed to special interest areas. The reason is that previous AI technology has been hard-coded with ruled-based programming to deal with specific tasks. Like the super-computer Deep Blue, which was programmed to use algorithms specialized for chess game only, but could not perform any other tasks without being reprogrammed (Hassabis, 2017). That means it was programmed to search through a database that had almost every combination in chess, so the "intelligence" part was down to strong computing power using algorithms to match every move that was played. Applying this type of AI to perform general tasks in a real world where rules and environment changes rapidly are not very effective, unless you have programmers recoding the algorithms to adapt to every new rule that it encounters.

The difference with AI technology this time is because of a breakthrough in a method where machines learn by themselves or with human assistance. It is a field called "machine learning", and can be compared with the way a young child learns language, walking or distinguish physical objects. A young child learns all of this by experience and repetition, the same principles applies for machine learning AIs. The more experience it gets, the better it will become. For AI, that means the more data it gets fed, the better it will become to recognize patterns to improve its cognitive abilities. The timing of this breakthrough in machine learning coincides with other digital developments. Stronger computing power with reduced costs is believed to be the most significant factor, and cloud computing has opened the way for more AI researcher with smaller budget. In addition, more data is generated than ever before through digital videos, texts, pictures, sensors, and so on (McAfee and Brynjolfsson, 2017).

Today, tech companies like Google, Microsoft, IBM and Amazon are offering AI algorithms available to the public as tools within their cloud solutions. Developers or computer scientist with the skills and knowledge, can now build and train their own AI system using the cloud services from the tech companies. The only thing that is required, besides the cost of using computing power, is feeding the algorithms with data. Such availability means that any company or organization, regardless of size, will have the same AI capabilites. The difference will be access to data and how each applies the technology into their business.

For Google, the machine learning technology is not only a part of their service offerings, but also a tool they benefit for themselves in terms operational cost reduction. Google runs one of the largest data centres in the worlds to provide servers, computing power and data storage to all its applications and services such Google Search, Gmail, Cloud computing, YouTube and so on. Running such complex data centres generates a lot of heat that needs cooling, which requires high energy consumption. For Google, optimizing the energy consumption throughout their many data centres will reduce costs greatly, and has been a major focus for the company. The challenge to optimize this consumption is complex. Servers operates unpredictably because peak operational performance varies over time, the outside weather and temperature is a factor to consider, and humans controls the pumps, cooling towers and other systems. In addition, they monitor thermometers, pressure gauges and other sensor manually to make best decisions. The big breakthrough for Google came when they applied their machine learning system, DeepMind, and fed the system of neural networks with years of historical data from computing performance, sensor readings and environmental factors. With all this information, the system trained itself with the goal to find the most optimal power usage. When the controls of one data centre was turned over completely to DeepMind, the AI system manage to reduce energy usage for cooling by 40% (Evans and Gao, 2016).

Using AI technology in maintenance management will surely be beneficial, and the basis to apply AI is very much present. The use of historic data is already an established concept in maintenance management, and with increase data collection from connected sensors, there is certainly no shortage of information to feed and train AI systems. To get an understanding of the potential AI technology has towards maintenance management, we can look at how it is being approached in the health care industry. Those industries have many similarities, as they both aim to provide care and repairs to a "patient" with complex behaviour and many sources of information.

Like any other industries, health care is experiencing the same data explosion, and sources of information is more diverse than ever before. Humans have also followed the trend of using connected sensors, as we wear personal devices that can monitor our pulse, heart rate, blood pressure other vital information in real time. For doctors and health care providers, this information is valuable, but the volume of medical data is increasing to rapidly for them to consume. In addition, they need to keep track of the increase in clinical data, genomic data, medical research and treatment options. Such information is normally fragmented, and it is close to impossible for a doctor keep up with everything that is published in his or her field of interest.

This is where advances in AI technology may help doctors to collect and analyse huge amount of data, and assist them with greater precision in finding the right diagnosis and treatment to each patient. AI systems features the ability to understand natural language, image and video analysis, and pattern recognizing, which is vital attributes for a doctor. By feeding a trained AI system with unstructured patient data, they can use this information and compare with it all medical information that is available in real time. Figure 4-11 shows a variation of unstructured medical records, such as medical research paper, doctors' notes, x-ray images and MRI scans, that an AI system can analyse and find a treatment that is personalized to each patient much faster and with better accuracy than a human is able to do (Ahmed et al., 2017).

In the field of health care this is a huge breakthrough which will have huge benefits for both the providers and the patients. Diagnosis and treatment decisions will become better and more personalized to each patient, doctors can care for more patients as they free up more time from searching after information, and cost of treatment will probably be lower. Transferring the same principles to the care of machines and equipment should pose the similar possibilities and challenges.

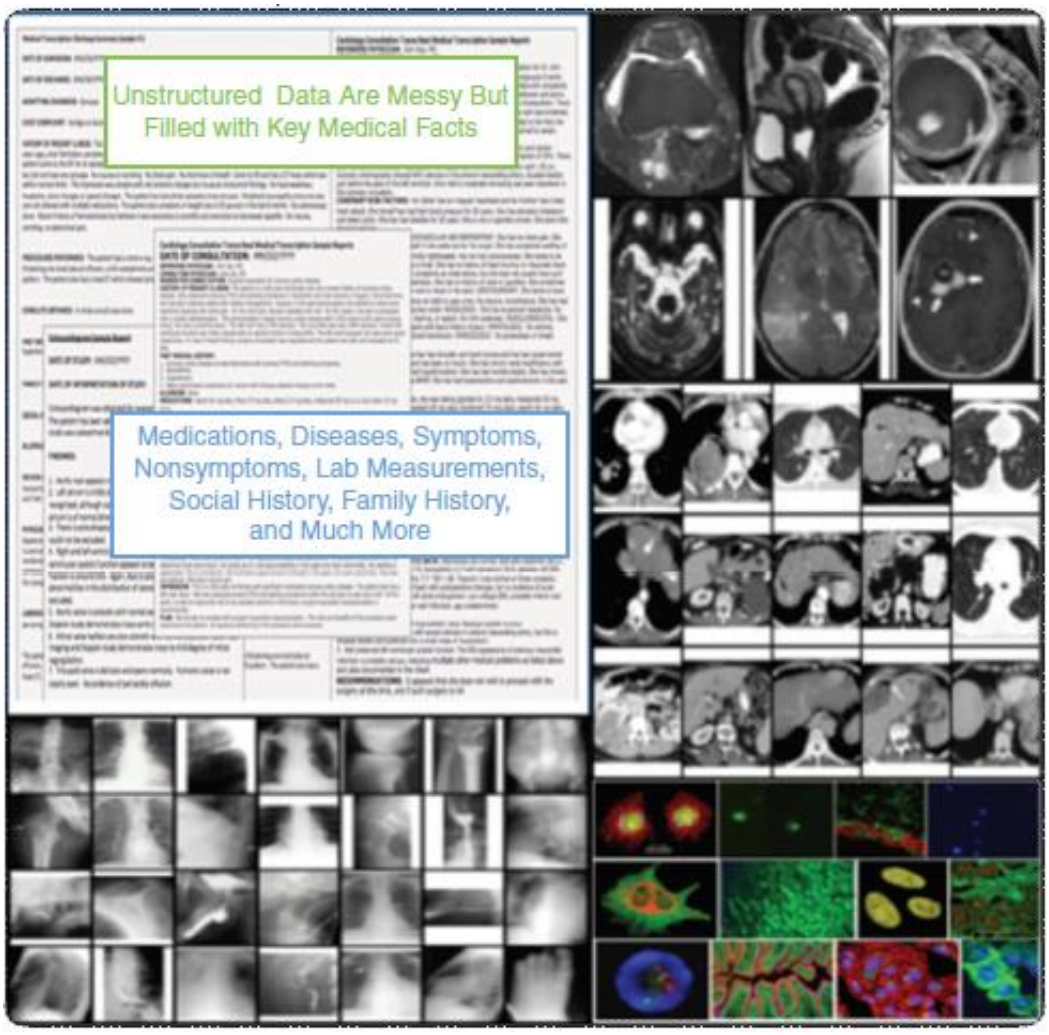

Figure 4-11 Unstructured patient data (Ahmed et al., 2017).

4.3 Competences and skill sets

4.3.1 Disruptive change of jobs

The introduction of disruptive technologies that we are experiencing are changing the society in many ways. Consumer behaviour changes, new ways to create value emerges, and production and business models consequently adjust to the changes. The same applies to jobs. The technological drivers of change pose both risks and opportunities to the existing workforce. Some jobs will become redundant and obsolete, while other jobs will grow, get augmented or emerge to become critical to any organization. In addition, existing tasks or functions will also require a change of skill sets to perform effectively in a digital landscape.

The technological developments that is changing the industries can be viewed as introducing a new tool. The tool replaces former manual tasks, but it requires a new set of skill to operate correctly. For companies and organizations, it is critical to understand what new set of skills is required when the tools are changing. Otherwise, they may invest as much as they want in them, but without the correct competence, the tools become ineffective or even useless.

4.3.2 Data-driven technologies

The digital transformation is fuelled by a large amount of data. More data is collected than ever before, together with an increase in variation of sources. The rate of data collection is expected to increase exponentially as more connected sensors and cheaper storage cost follows the development. The challenge that emerge for companies is making sense of all the data. Just collecting data will provide little value if the knowledge to use them is inadequate, so having the skills to organize and make sense of the data is going to be critical.

Skills such as data analytics and computer science are in growing demand. More companies, regardless of industries, are hiring such talents. At the very moment, FRAMO, a pump supplier for maritime ships and the Oil and Gas industry, are in the search for a computer scientist to develop their products (Figure 4-12). A position that they probably not anticipated to hire a couple of years ago. The hiring of a computer scientist signals that FRAMO has ambitions to collect large amount of data from their products, most probably from connected sensors, and they need the appropriate skills to extract the insight from the data collected. FRAMO is not only a provider of pumps, but also carries out maintenance on their products, so having real-time information about the health and performance will certainly be valuable for the company.


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Mechanical/electrical/computer science

Framo is a pump manufacturer based in Bergen. The company was founded in 1938 and is now a worldwide organization with a presence on three continents. Today, the company has 1,100 employees and is a leading manufacturer of pumping systems used in the chemical tanker market and the oil and gas industry as well as for oil spill recovery. Framo is part of Alfa Laval, and Bergen is the organisation's competence centre for marine pumping systems. Framo sells and carries out maintenance of all Framo products.

Figure 4-12 Vacant position at FRAMO (FRAMO, 2017).

For companies that has ambitions to take part of the digital transformation, but sits passively and wait for more advance technologies, such as AI, to mature before implementing it to its business, can risk heading into a dead-end. That is because AI technologies and machine learning algorithms is dependent on large amount of data that is structured to its purpose. Companies that just invest and starts feeding an AI system with unstructured data will discover that the system will reach wrong conclusions. That is because the system is analysing data that are perhaps out of date or not relevant to the scope. Collection of data should be automated, standardized and structured before companies are ready to apply AI systems. Leapfrogging to AI without having the foundation of structured data, are most likely doomed to fail. Even the most complex and advanced machine learning algorithm will become useless if the data it gets feed is chaotic. Therefore, companies must invest in critical skill-sets to lay the foundation, such as data analytics and computer science, in order to be prepared for advanced data-driven technologies. Skipping the basics will be like attempting to run before you can stand up (Harrison and O'Neill, 2017).

4.3.3 Cross-functional collaboration

Even though new roles emerge in a company, does not automatically means removal of existing ones. Like in the case with FRAMO, introducing computer scientists working to improve the service of their products, does not results in removing existing roles, such as service engineers or technician that has specialized knowledge of the pumps the company produce. Quite the contrary, the introduction of a computer scientist requires closer collaboration among them to create the value and service they aim to provide using data analytics. The service engineers have the in-depth knowledge of the pumps that is needed when structuring the data. They know how the pumps' operational performance should be, their failure mode, and probably other tacit knowledge that can help diagnose the data that is collected. Sometimes sensors can be offset and show unnormal readings, but as long as the performance is good, and the readings are consistent, they can calibrate the data. This information is important when using data analysis or training AI systems to predict failure because the system need to know which data set indicates normal behaviour and which indicates failure. A computer scientist's role will be to structure the data and using it to train the AI systems to predict performance, scheduling maintenance and detect failure modes of the pumps. This cross-functional collaboration is an on-going loop, as the AI systems must be continuous fed with data to gain better experience to reach more precise predictions.

In a meeting with a scientist at Christian Mikkelsen Institute, who is working with machine learning systems, emphasised the importance of the collaboration between the data providers and the computer scientists. He was working on training a machine learning algorithm to predict the performance of an equipment from an actor in the Oil and Gas industry. For the machine learning algorithm to diagnose and predict correctly, he was dependent that the owner of the equipment provided him with pertinent data. Providing data that is useful for machine learning systems requires skills and understanding from both perspective, and the scientist predicts that this is a role that is going to become important going forward.

4.3.4 Measuring the disruption of job impacts and skill sets

Last year, World Economic Forum (2016) released a global survey report called *The Future of Jobs* to understand the current and future impact of key disruptions on employment level, skill sets and recruitment patterns in different industries and countries. They asked the Chief Human Resource Officers, senior leaders and strategy experts at today's largest company to imagine how jobs in their industry will change towards 2020. The respondents represent more than 13 million employees, and the report aims to serve as a call to action and improve the understanding of anticipated skills and recruitment patterns that is changing. For any industry or company that seeks to be proactive and understand how skills and jobs are changing, this report can be a good indicator due to its extensive scale and spread.

4.3.4.1 Employment trends

Figure 4-13 shows the outlook of expected employment trends among different job families in the period from 2015-2020. The largest decline of jobs is expected to within Office and Administration and Manufacturing and Production. Office and Administration jobs are continuing to decline because administration processes keep getting more efficient and digitized. Digitized processes can automate many manual and repetitive tasks, and cover far more range than a human is able to, with the fraction of the cost as well. The expected decline in manufacturing and production employment corresponds with the development of advanced robotics and increase automation of the production processes. With connected sensors on manufacturing equipment, the machines can communicate with each other without human involved. Advanced robotics are being able to do more complex tasks, and a compound effect of the technological development will reduce the need for the traditional blue-collar worker on the factory floor.

We also take notice that employment within Installation and Maintenance are expected to decrease. Having better insight on the performance and health of equipment allows for more optimized maintenance planning and reducing the overall maintenance interval. Reduced maintenance activity will therefore result in reduced workforce.

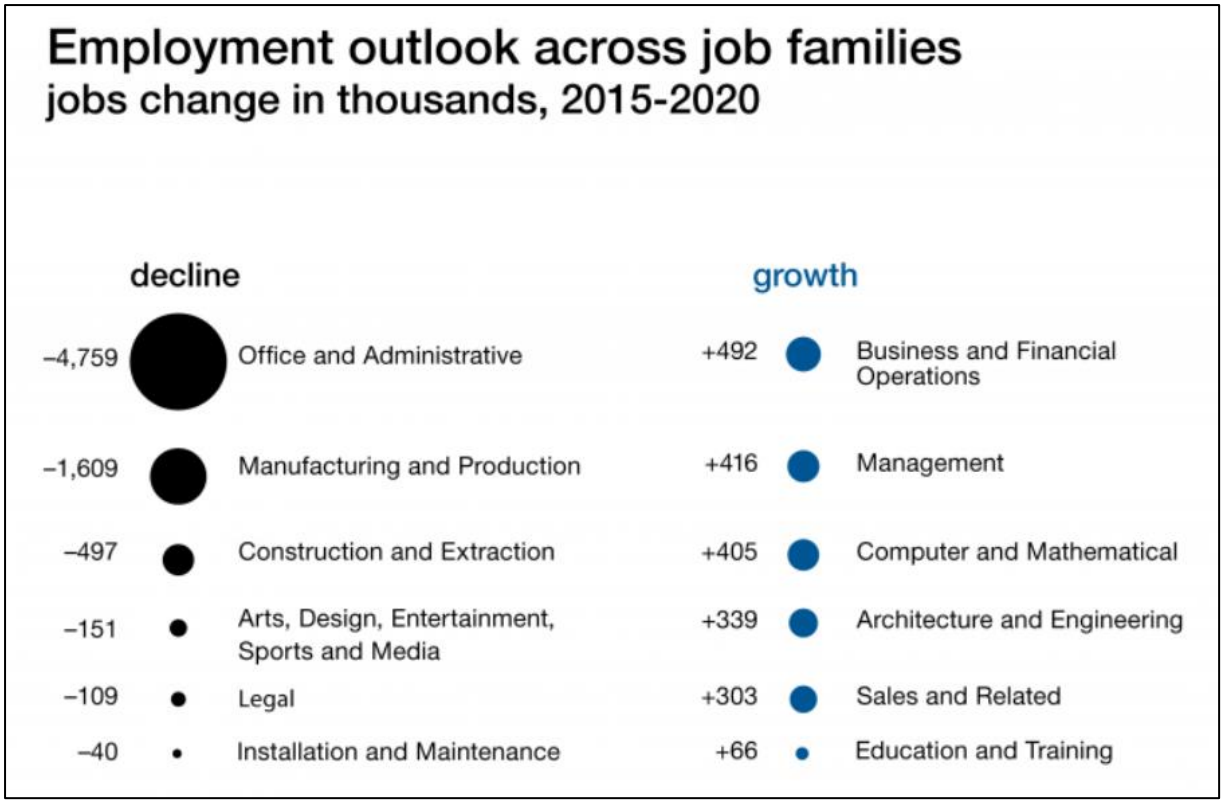

Figure 4-13 Employment outlook across job families (World Economic Forum, 2016).

In the other end, the expected employment in job families such Business and Financial Operations, Management, and Computer and Mathematical is increasing towards 2020. An increase in Computer and Mathematical jobs is highly anticipated as the growth in data analytics and software applications are transforming the business landscape. Data analytics and software applications skills will no longer be exclusively in high demand in IT related industries, but across a wide range of industries that are embracing the digital transformation.

The expected employment increase in Management and in Business and Financial Operations is relatively a normal trend, but might be more critical going forward. In a new digital landscape, companies will also need the skills on how to create and deliver value provided by innovative technologies, and management skills to steer the organization during times of disruption and uncertainty.

The report points to two jobs that particular stands out due to frequencies and consistency across all industries. The first are data analysts, which is needed to manage and extract insights from the vast amount of data that is collected. The second is specialized sales representation, because the companies need adequate skills to commercializing and explaining their innovative products and services to business or government clients, consumers or new markets. That is perhaps why jobs within Sales are also expected to increase towards 2020.

4.3.4.2 *Ease of Recruitments*

The change in demand of employment and skill sets will put pressure on the current pool of talents. The employment outlook towards 2020 seem to favour high-skilled workers with high-level education. The digital transformation is making manual and repetitive tasks more automated which reduces the demand for traditional blue-collar workers and employees with relative low education level. This shift in demand will make the competition for high-skilled workers fierce, since it is critical for companies to have such skills across all industries. Rather than competing for talents within own industries, the digital transformation is blurring the borders, making the digital talent competition borderless. A data analyst or a computer scientist will be as much needed in the health care industry as within the Oil and Gas industry. The same will be for talents within Business Operation and Management, but this competition is not new. The challenge will be to recruit talents that understand the digital transformation, and have the skills and knowledge to steer the organization in an uncertain environment.

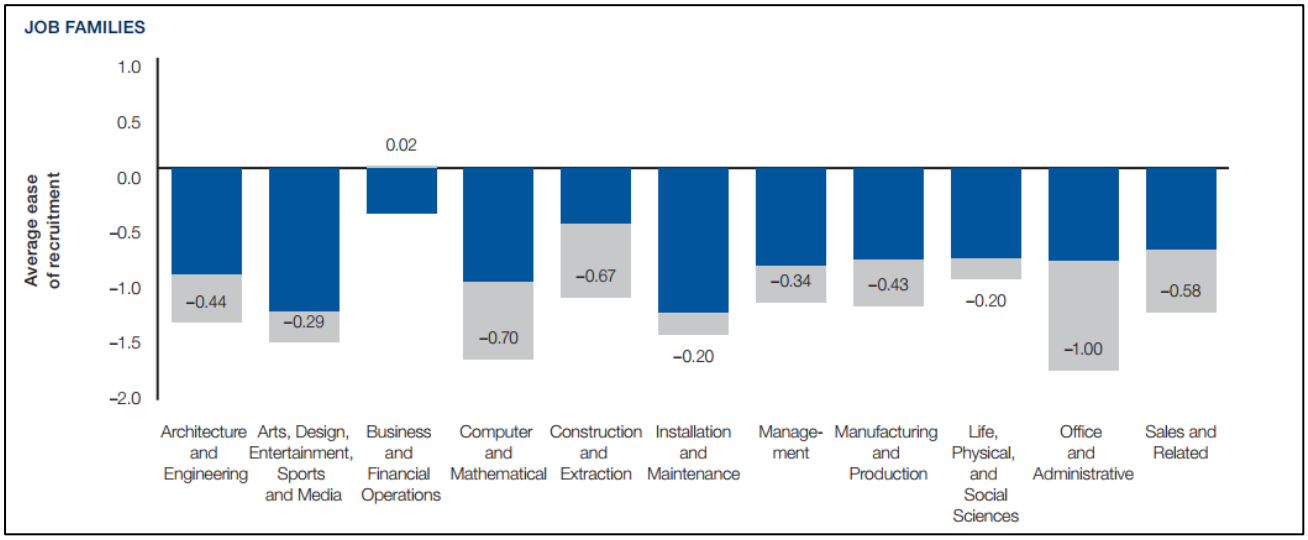

Figure 4-14 Ease of recruitment per job families, expected change (World Economic Forum, 2016).

Figure 4-14 shows how the respondent is experiencing the ease of recruitment for talents within different job families, and how it is expected to develop towards 2020. Recruitment within Computer and Mathematical jobs is already hard, and is expected to be hard in 2020 as well. While recruiting talents within Business and Financial Operations is rather easy and are not expected to increase in difficulty. The talent pipeline within traditional white-collar education is perceived as stable and is expected to grow in the future, making recruitment relatively easy.

The major surprise from the survey is the spike in difficulty in recruiting workers in Office and Administrative jobs in 2020. Presumably, that has to do with the overall decline of demand in such jobs, making it less attractive for workers to pursue a career in this field. In addition, changes in skill requirements this field may have in the future will affect the current pool of talents.

Another notable development is the ease of recruitment in the field Installation and Maintenance, which is currently perceived as hard to recruit. But with the increase in technology that optimizes maintenance intervals, the demand of workers in this field is expected to drop.

4.3.4.3 Skills stability

With technological development happening in an accelerated pace and changes business models and value creation, the exiting skill sets of the workforce are bound to change as well. The digital transformation is moving the boundary of human-machine interface in a completely new direction with a much greater depth and spread. The skill sets companies will need to operate in a digital environment is becoming more complex and is expected to shorten the shelf-life of existing skill set.

The rate of technological developments is also becoming a challenge for many students in the pipeline, as many core curriculum content is being disrupted just as fast. According to one popular estimate, 50% of subject knowledge acquired during the first year of a four-year technical degree is in risk of being outdated by the time the students graduate. Resulting in a skill shortage on not just the current workforce, but also for the talent pipeline (World Economic Forum, 2016).

In many cases, innovative technologies will not replace human labour completely. Instead there will be a redistribution of the tasks where the machines support or augment the human. Like in the case with AI technology in health care, where AI systems augment the doctors' abilities to reach correct diagnosis and treatment much faster and more precise than the doctor could do alone. The AI systems will do what it does best; analysing large amount of data to find the correct treatment based on the patient's medical data. This will free up the doctors' time to focus on new tasks or enhancing existing tasks, like spending more time with the patients. Such transformation will change the core skill sets that is required for the job.

In addition to formal qualifications and hard technical skills, employers are also concerned about practical skills and abilities employees needs to have to perform various tasks. These are soft skills such as cognitive abilities, social skills, process skills and so on. Changing tasks and job functions will have an impact on how workers interacts, how work is performed, and what type of mindset is required. To map the skills and abilities that is becoming relevant in a digital landscape, the Future Jobs Report uses a framework of 35 core work-related skills that are widely used across all industries (Figure 4-15).

Data technology is going to be more central, in some form or another, on how business is being conducted. The rise of computing power and the collection of extensive data requires the abilities to translate the data into valuable insight and make data-based decisions. Employers also need to be aware of its limitations, and understand that even the best algorithms are only as good as the data it gets fed. This will require the workers to develop various set of skills to perform the tasks, such as system analysis and logical reasoning skills to make sense of the data, while critical thinking and judgement skills needs to be developed to make sound data-based decisions. Other cognitive

abilities such creativity and visualization will be important to be able to present the data in an effective and comprehensible manner.

The work dynamic going forward requires employees to work more in cross-functional collaborations across organizations. That means working in teams where the participants have different set of skills and offer different perspectives. If FRAMO is changing their business model from offering products to offer the performance and service of the pumps instead, they need to involve different stakeholders from the beginning of the process. Product designers, data analysts, service engineers, sales representation and perhaps clients must be involved and work alongside each other. Such collaboration will require social skills to build trust and the ability to coordinate with people. In addition, the team members must be able to teach each other from their field of business to align the team to a common goal.

The challenge working in cross-functional teams may not only be divided by their field of business. Another challenge is the cultural difference that may include diversity in age, ethnicity, thinking styles and knowledge. Working in a such diverse team will become a core competency for employees as they need to build relationships, communicate, and identify shared goals to work together effectively.

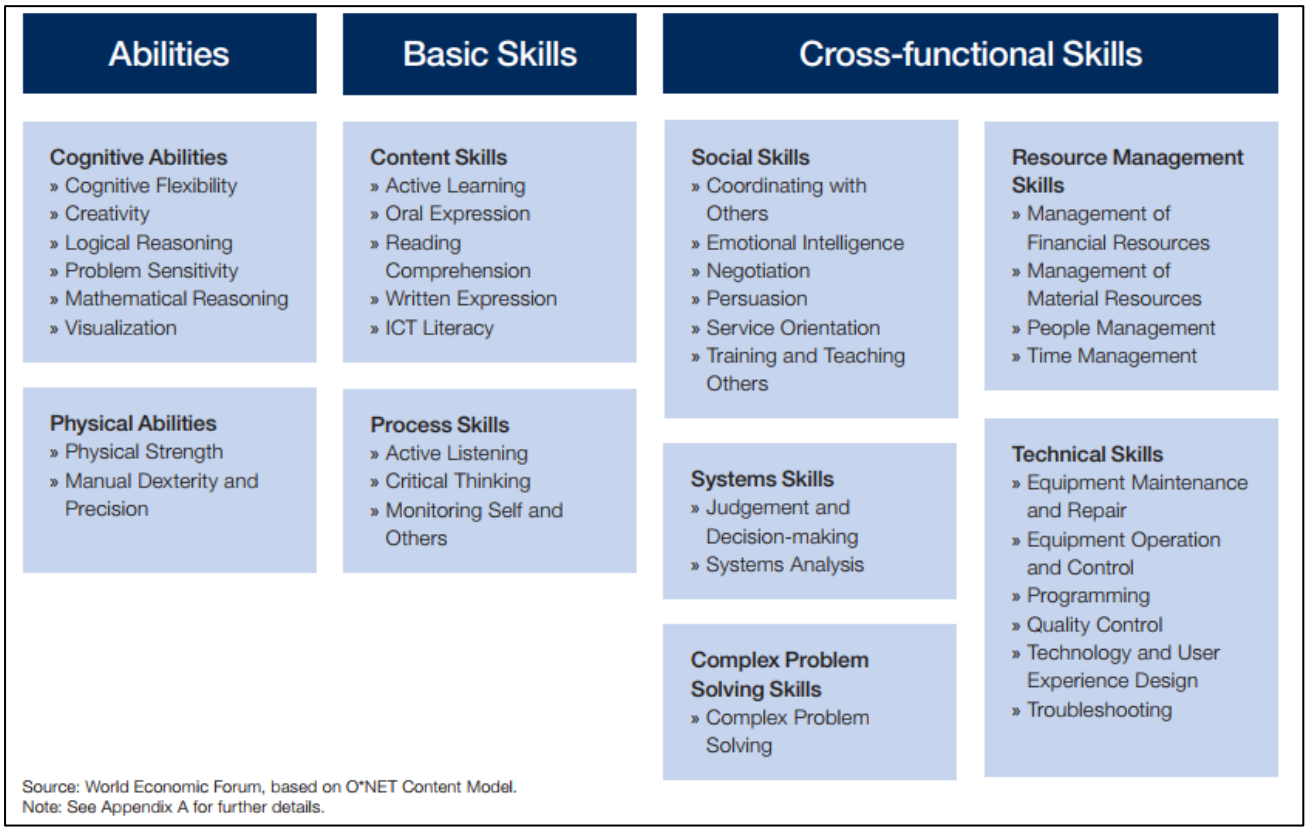

Figure 4-15 Core work-related skills (World Economic Forum, 2016).

If we look at the expected change in demand and composition of core work-related skills in Figure 4-16, we see that across industries there is a growing demand for cognitive abilities and system skills, together with complex problem-solving skills and content skills. We also see that process

skills and social skills will be in higher demand in 2020. Such development may indicate that new jobs, or many existing jobs and job tasks are changing the requirements for performance. Manual and repetitive tasks that requires limited variety of skill-sets are being substituted for tasks that requires more knowledge, elevated thinking process and abilities to work in collaboration with others.

The digital transformation is not only going to disrupt business models and value creation, but also have a significant impact on skill requirements needed. Many jobs will require a wide range of skill sets beyond hard skills and formal qualifications, which will add to the pressure on the current talent pool.

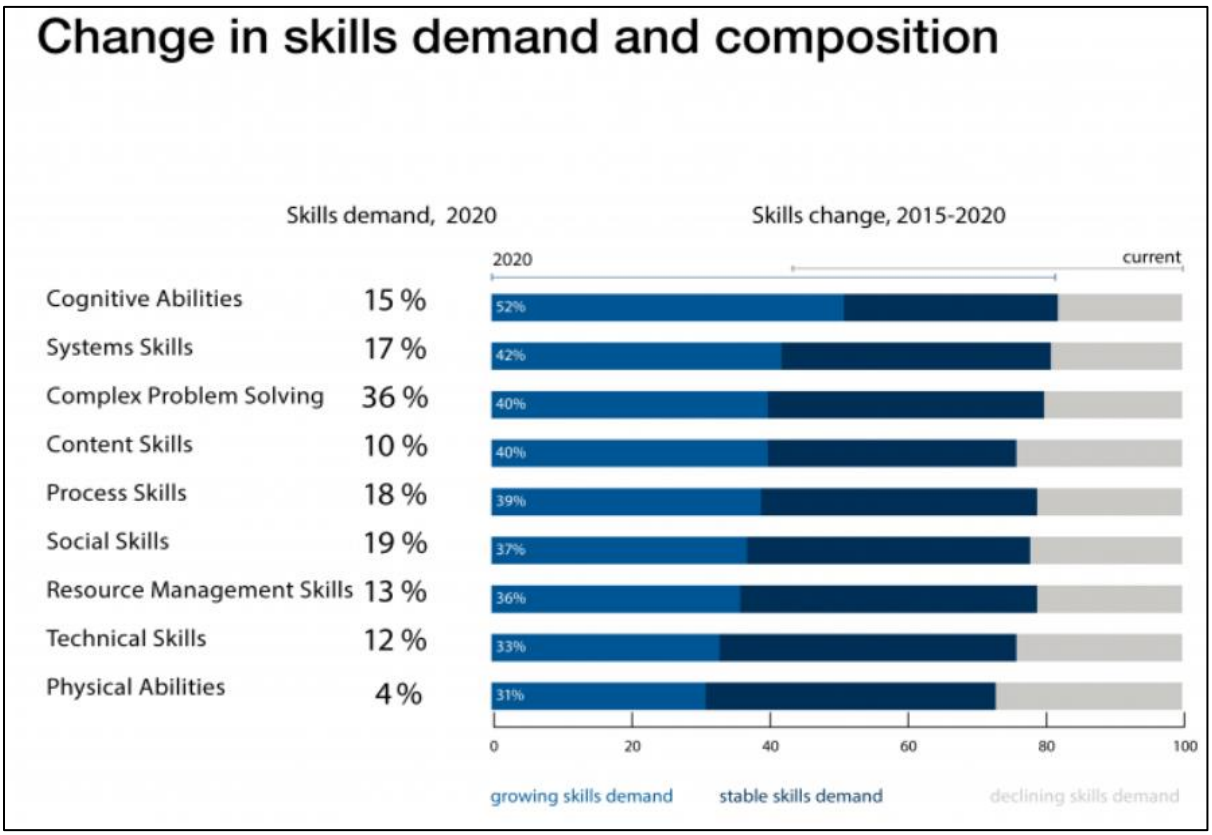

Figure 4-16 Change in skill demand and composition (World Economic Forum, 2016).

4.4 Business model and strategy

4.4.1 Value creation

It is becoming logical that collecting vast amount of data will be the next valuable resource for any industry. In an editorial article from The Economist (Parkins, 2017), they argue that data has become the most valuable resource in the world, even surpassing oil. Backed by the fact that the five most valuable listed companies in the world are data driven technology companies, where profit surges, it is not hard to understand their argument. Rolls Royce, as mentioned above, changed the jet engine industry by harnessing the value of data, which took them from a struggling position to industry leader.

With the growth of connected sensors at cheaper cost, there will be an abundance of sources to collect data from in real-time. The sensors are getting smaller and more sophisticated, which allows for capturing data from sources once not thought possible. The challenge when collecting a lot of data is to make sense of it all, so it does not turn in to noise and difficult to interpret. Such data becomes more of a problem than a solution.

Structuring the data to fit its purpose will provide value for anyone that can analyse and extract the insight the data has. In addition, AI techniques such as machine learning systems are dependent on large structured data to train itself and gain experience to predict outcome precisely. Machine learning systems need to be fed continuous with data to build up experience and knowledge about the objective they are programmed to predict. No matter how complex and sophisticated the algorithms are, the machine learning systems are depended on interpreting relevant set of data. The more recent the data is, the better the prediction will become.

Because the technological development works combinatorial, it has given big data a new value in a broader span. Collecting data becomes easier because of smaller connected sensors, data storage cost keeps get cheaper, and computing power increases. Combine those factors with the fact that AI systems needs to be fed continuous with data to perform effectively, it is understandable that big data are going to have a lot of value going forward.

A senior data scientist at an Oil and Gas producer, acknowledges that data is becoming more valuable. When asked him during our interview if he sees any new value in the digital landscape, he stated that the value of data is not new, but with better tools to extract additional insights, data will be more important and have a stronger impact than before.

4.4.2 Value capturing

Collecting large amount data from assets or equipment opens many possibilities to capture value. For companies that has the capabilites to perform big data analysis and interpret the insight the data has, may change their business model the way Rolls Royce did. From being a jet engine manufacturer, they shifted their business model to be a provider of jet engine performance instead. Because of the insight of big data, they are able to predict performance, health, maintenance and inspection schedule, giving them almost total control of their product. For the airliners, when buying performance instead of the product, they can remove, or at least minimize, the concern about flight delays due to engine malfunction or unexpected inspections between flights.

Such transformation in value offering provides benefits for both manufacturer and client. The manufacturer, now owns the liability of their products' health and performance throughout its lifetime. This liability incentivises them to design and manufacture better and more solid products. Any failure of the products during operation falls on the manufacturer, so it is in their best interest to have the most solid product as possible. But with the help of connected sensors on every part of the product, they can analyse the performance and health, and use this data to design better products.

For many companies, investing in skills and capabilities to analyse big data may, for various reasons, not be an option. Whether it is resource constraints or insufficient talents available, there is still value in collecting data. With the introduction of open digital platforms from companies such as Kongsberg Digital and DNV GL, the industry can bring their data to an ecosystem of collaborators to harness the value.

The digital platforms offer application services, tools, and third-party services that has the skills and capabilities to analyse and makes sense of the data. The Digital Manager at DNV GL, believes that data will become a commodity that can be shared or monetized on a digital platform. Actors from different industries can in the digital platform trade or collaborate and combine asset data to extract additional value. Companies can also collaborate with external developers to develop new applications or analytics based on their asset data. The intention of the digital platforms is to become a digital marketplace and ecosystem where data providers, service providers, developers, research organizations, academia and entrepreneurs participate in cross-collaborations and innovate across industries. Figure 4-17 shows the concept of the digital marketplace, Veracity, from DNV GL.

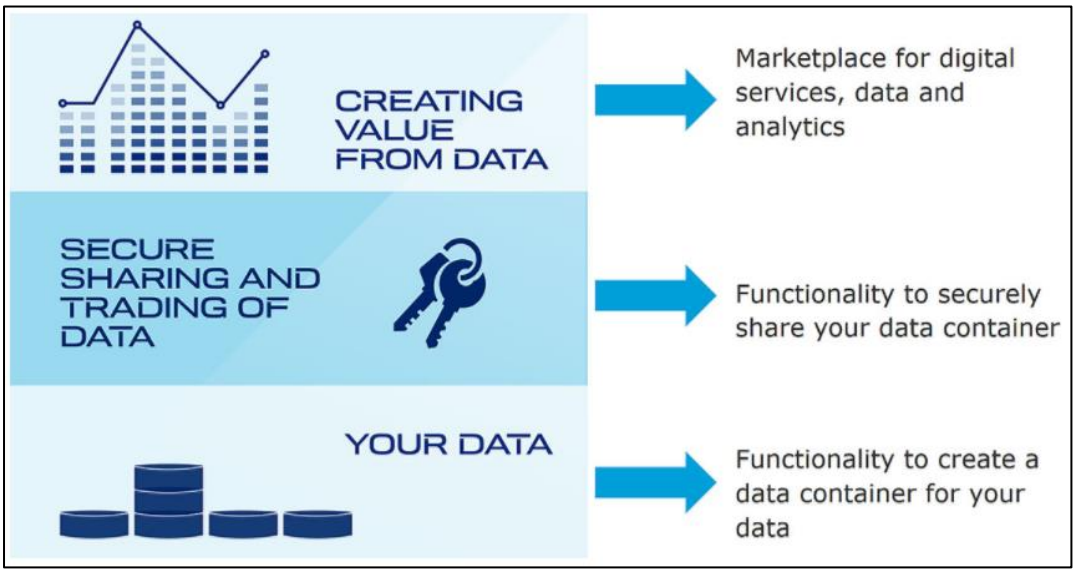

Figure 4-17 Veracity concept (DNV GL, 2017).

Such platforms create what economists refers to a "network effect", where the platforms become more valuable when more people use it (Katz and Shapiro, 1994). In the case of the digital ecosystem, data providers will choose the platform where they can get the most services from their data. On the other side, developers or data analytics will join the platform where their services are most likely needed. In such case, the membership of one user has a positive effect on other users to join, thereby increasing the size and value of the platform.

Having a strong digital platform with diverse participants will benefits all users, which again will increase the overall operational performance for the industries involved. Such ecosystem encourages collaboration between stakeholders that previously did not find it logical to

collaborate, or had an applicable platform to facilitate relevant partnership. Sharing own data will also increase the quality and result of the analytics, since having more eyes looking at the data will discover any discrepancies much better. In addition, fresh perspective on a data set can unlock additional insights or find other value of the data.

4.4.3 Achieving a digital maturing organization

The digital transformation is changing many aspects of an organization's ability to deliver and capture new value. From changes to job functions, work tasks, skill sets and technological tools, the organization itself needs to adapt to those changes. Just hiring new talents or investing in innovative technologies without aligning the organization to the changes may cause friction or ineffectiveness to harness the value the digital economy may provide. In worst case, it may lead to the loss of key competences or failed investment, and take the organization in to a dead end.

Organizations, especially in large enterprises, are usually static and difficult to transform. In a time where not only technological innovations, but also the business environment is changing rapidly, there is an added pressure for organizations to become agile and adapt to the digital environment.

For many organizations and business leaders, the digital transformation is a state of high complexity and uncertainties. Navigating through the information overload and create the right path for the organization can be difficult and is full of risks. To understand how organizations can adapt to a digital environment and take advantage of digital technologies, we may examine the research report, *Achieving Digital Maturity*, conducted by a research team from MIT Sloan Management Review, in collaboration with Deloitte (2017).

The report is a global survey of more than 3,500 business executives, managers and analysts from organizations around the world. The goal of the survey was to measure their organization's digital maturity, where the respondents were asked to rate their company against an ideal organization where digital technology and capabilites drove new value-generating business models. Based on their answers, three maturity groups were observed; "early", "developing" and "maturing". By examine how the group of "maturing" companies approach the transformation may provide valuable lessons for other companies that intend to improve or transform their organization.

Probably the most significant distinction the group of "maturing" companies have that sets them apart is their integration of digital technology as a core part of the organization's business strategy (Figure 4-18). They do not just apply the technology to support existing business processes, but rethink how it may create new value and act upon it.

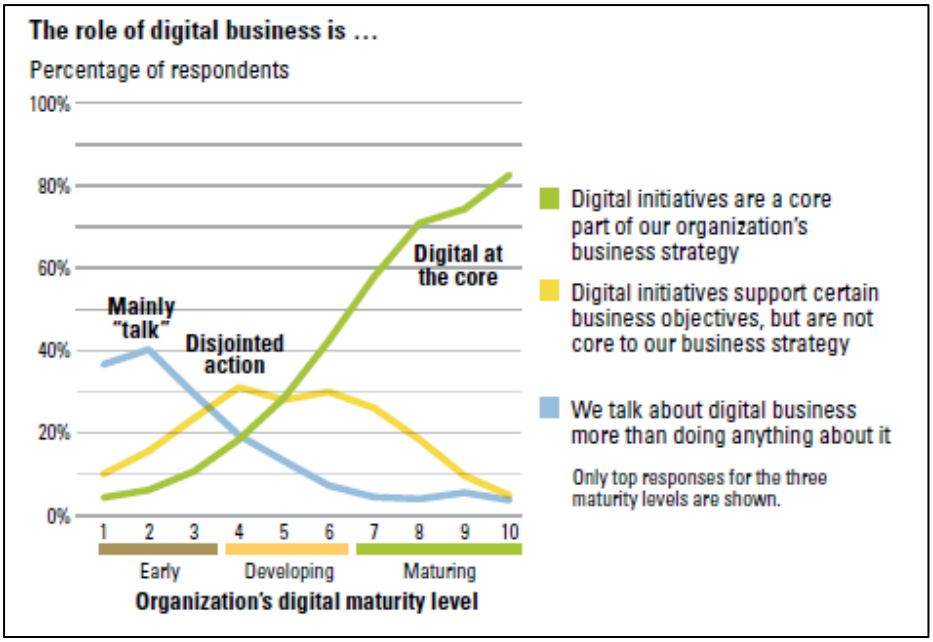

Figure 4-18 The role of digital business (Kane et al., 2017).

Becoming a digital mature organization consist of transforming the way business is being conducted and how the organization operates. The survey report identifies five key approaches that digital maturing companies are doing to transform their organization, and includes the following:

1. Implementing systemic changes in how they organize and develop workforce, spur workplace innovation, and cultivate a digitally minded cultures and experiences.

2. Long term strategic planning

3. Scaling small digital experiments into enterprise-wide initiatives that have business impact.

4. Attract and invest in talents

5. Securing leaders with the vision necessary to lead a digital strategy, and willingness to commit resources to achieves this vision.

The following subchapters will examine and try to assess each of them.

3.2.1.1 Organizing for digital maturity

Transforming the way a company organize and structure its organization due to the development of computers and information technology is not new. Already in 1973, the American sociologist Daniel Bell, argued that the post-industrial society is organized around the creation of knowledge and the use of information. Because of the revolution of the computer, post-industrial society is shaped by its method of acquiring, processing and distributing information. The ability to harness information, led Bell and others to predict the rise of the service sector, and the decline of

manufacturing. As a result, the rise of knowledge workers becomes more valuable to the industry and the society (Hatch, 1997).

Even though these principles where introduced several decades ago, they are still, and probably more relevant today. The necessity of knowledge workers is becoming more vital, as we see from the growing demand of data analysts and computer scientists to harness the value of big data. The demand for such knowledge workers are growing in every level of the Oil and Gas industry. From operators, service providers and third-party actors.

What many companies are doing is establishing a centre for digitization, where data analysts and computers scientist are situated. Earlier this year, Statoil launched their *Digital centre of excellence* to drive digital effort and innovation across the organization (Statoil, 2017). Other companies have done similar initiatives, and it has become a common approach to establish strong digital capabilities for the organization.

Driving innovation and digital efforts in the organization requires cross-functional collaboration with other business units. That means breaking down functional silos within the organization and communicate in a network of internal and external stakeholders. According to Hatch (1997), one prominent feature of post-industrial organization is the disappearance of organizational boundaries. Boundaries between internal groups like sales, production, engineering disappears to make the organization more agile and flexible. Such collaboration changes also the organizational structure from vertical to a horizontal structure of networks, and abandons the traditional hierarchy. In horizontal structures, building strategic alliances and collaborate with experts from different fields and business units becomes key, which emphasis the need for social skills to learn and coordinate with others.

The need for cross-functional collaborations and breaking down organizational silos is seen as crucial for digitally maturing companies. As we see from Figure 4-19, more than 70 % of digitally maturing companies is organized around cross-functional project teams to implement digital business efforts.

At DNV GL, digital efforts and innovation projects are driven by project teams with members from their *Data Analytic Innovation Centre* together with dedicated members from each business unit. The project team, which they refer to as a *Digital Unit,* proposes innovation projects throughout their respective business unit, and receives continuous feedback. By using an enterprise-wide communication tool, they establish communication networks across the organization, which allows them to select and progress with the ideas that gets the best feedback.

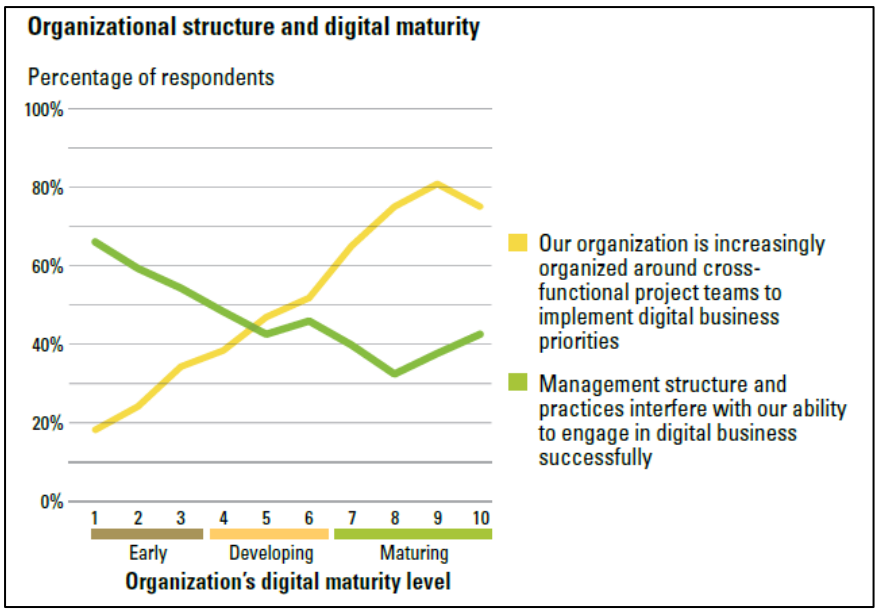

Figure 4-19 Organizational structure and digital maturity (Kane et al., 2017).

Another important characteristic of post-industrial organizations is the abandonment of the vertical hierarchy structure of command and control, which corresponds with how digitally maturing companies are structured. The traditional structure where every business decisions and initiatives are under the control of the management, is viewed as impeding the agility needed to operate in a fast-pace environment. More than 60 % of the *early-stage* companies say that their management structure and decisions rights interfere with the organization's ability to engage in digital business successfully.

An organization which consist with more knowledge workers and workers with higher education, must be able to operate with more independence and less bureaucracy. Since the nature of work shifts from routine and repetitive tasks towards complex problem solving, learning, and cross-functional collaboration, imposing strict command and control will risk discouraging and demoralize the workforce. The digital transformation puts pressure on the organization and managers to reshape existing mindset and traditional approaches. It requires people in power to loosen the grip, and devolve managerial decisions and responsibilities throughout the organization. Such transformation can be hard for managers, as they may perceive the organization becoming more uncertain, frenetic and loosely coupled. However, such characteristics is what recognizes a post-industrial organization, according to Hatch (1997).

To reshape the organizational structure and leadership approach, we may look at the organization through the four frameworks for leadership model by Bolman and Deal (2003). Organization are complex and consist of characterization and approaches from each of the framework simultaneously. However, organizations operate with different goals and environment, which tend to shape the organization in favour of one approach.

Since digitally maturing companies are less hierarchical structured and require less command and control, they move away from the *Structural Framework*. The *Structural Framework* is effective

when there is low ambiguity and low uncertainty, but in a time of rapid changes, it is difficult to manage the external environment. Organizations needs to be agile and respond to changes quickly if they want to stay ahead in the digital environment. The *Human Resource Framework* views people as the heart of the organization and emphasis on support and empowerment. This framework focus on exchanging information, developing relationships, and keep people involved, which characterises the dynamic in digitally maturing companies. In an organization where people work more independently, individuals needs the opportunity to express their talent and skills. According to Gallos (2006), the *Human Resource Framework* approaches organizational effectiveness by tailor the organization to meet individual needs, and train individuals to meet organizational needs. A symbiotic relationship where productivity gets high because people feel motivated to do their best.

With more cross-functional collaboration, flatter hierarchy, and empowerment to the workforce, the organization also becomes more dispersed and complex. To avoid the risk of developing separate cultures, it is important that the organization becomes unified with common goals and shared beliefs. That makes the *Symbolic Framework* relevant, as it emphasis on developing shared values that glues the organization together (Gallos, 2006). Such approach is important when there is high ambiguity and loosely coupled organizations.

In digitally maturing organizations they focus on creating shared goals and incentives to make cross-functional collaboration effective. Initiating many innovation projects will not be successful every time, so it is important to develop a culture that becomes risk tolerant, and accept that failure may sometimes occur and is a part of experimenting with digital efforts. Figure 4-20 shows how well digitally maturing companies incentivize and align the organization to create a common culture and shared values, even though it can be complex and dispersed.

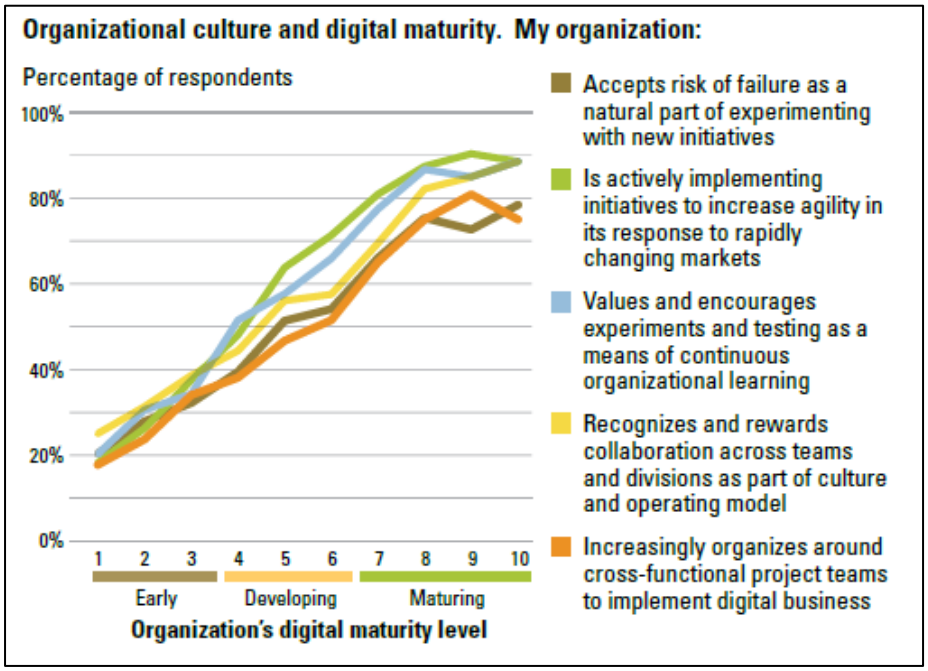

Figure 4-20 Organizational culture and digital maturity (Kane et al., 2017).

In an organization where the workforce feels motivated and have the opportunity to express their talent and skills, they become less dependent on management to steer digital initiatives. Leaders are needed to cultivate the right culture, but when the culture has progressed, and the workforce is empowered, digitally maturing organizations will become more self-sufficient to initiate digital efforts (Figure 4-21). Leadership will instead be needed to give the workforce the sufficient resources and training to do the job well, which characterize leadership of the *Human Resource Framework.*

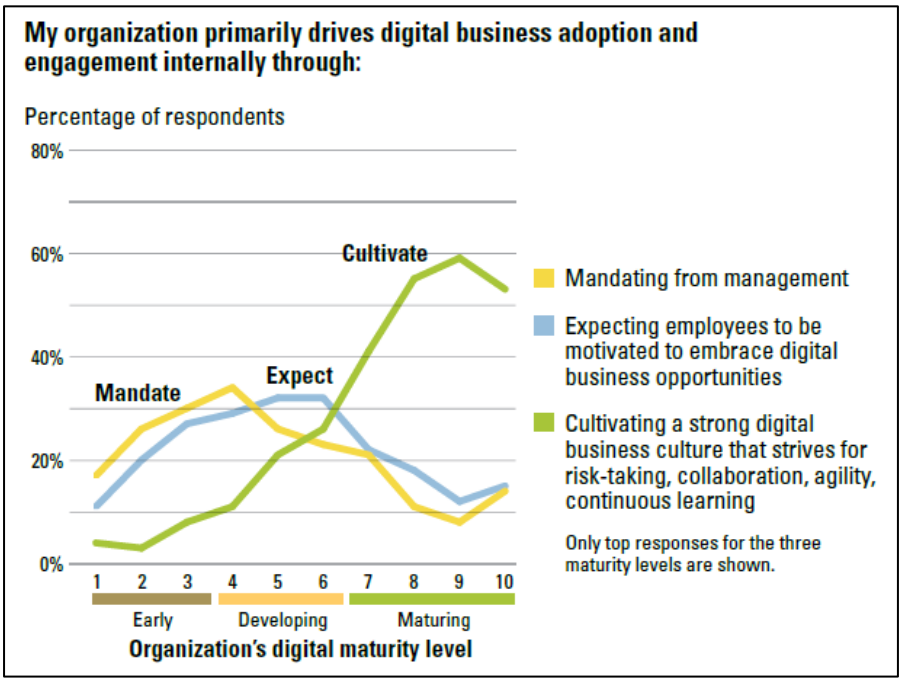

Figure 4-21 Digital business engagement (Kane et al., 2017).

3.2.1.2 Long term strategic planning

The survey conducted by MIT and Deloitte found that digitally maturing companies have consistently longer strategic planning horizon than those of less digitally mature. Nearly 30% of digitally maturing companies are looking ahead five years or more. Some companies are even looking at a ten-year horizon of its investment strategy (Kane et al., 2017). The argument of planning in a such long timeframe, is that it gives the organization the ability to rapidly adapt to a changing environment. By linking their strategy to a changing environment, they are less likely to be caught off guard by unexpected events or disruptive innovations.

However, planning and predicting for long term future is not easy as the future can be ambiguous, uncertain and complex. Especially in a period where a paradigm shift is occurring in many domains, such as in technology innovations, socioeconomic trends and business environment. The impact of a paradigm shift can move the future in several directions, and the further we look ahead the more uncertain it becomes.

For organizations trying to establish long term strategies with an uncertain future, they can use scenario planning. Scenario planning is a powerful tool to developing strategies in a medium or

long-term perspective under uncertain conditions. It does that by creating vivid descriptions of plausible futures, which are distinguished between three main categories; desirable, possible and plausible (Figure 4-22). By creating different scenarios of the future, it will expand the thinking about the range of possibilities and sequences of each outcome. It works as an effective learning tool to understand the logic of developments, clarify driving forces, key factors and uncover potential new stakeholders. In addition, understanding the reason behind each scenario, allows companies to assess their own influence and prepare them in advanced (Lindgren and Bandhold, 2009). The purpose of scenario planning is not to predict the future, because that is close to impossible, but to provide a deeper knowledge and contingencies when approaching the future.

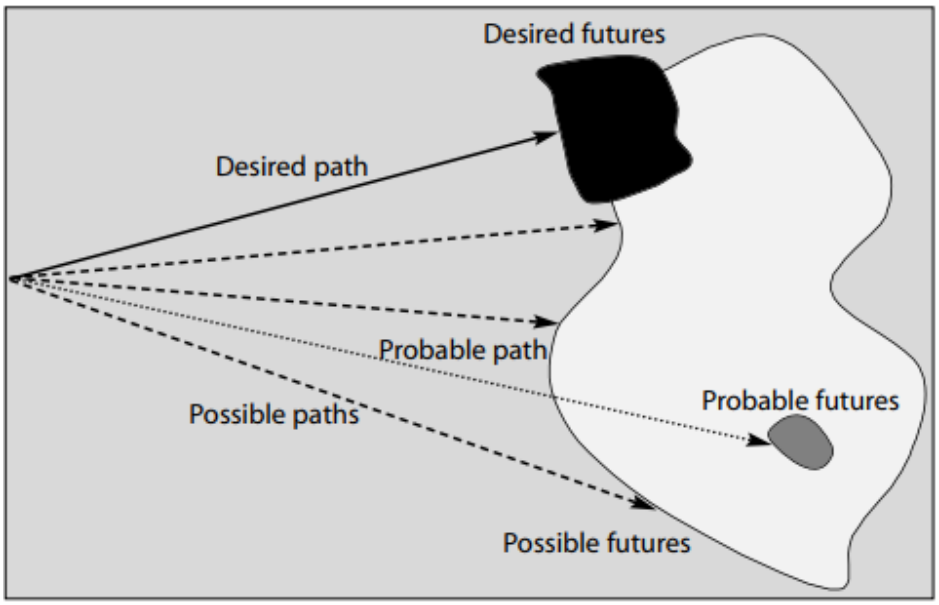

Figure 4-22 Relations between possible futures (Lindgren and Bandhold, 2009).

The Oil and Gas company, Royal Dutch Shell, is renowned for its use of scenario planning, and has been recognized as one the driving forces to use it in a business environment. Already back in 1960s and 1970s, Shell developed scenarios to help address the oil crisis and economic turmoil at the time, which in fact some of the scenario planners had to some extent envisioned in advance. However, Shell does not use scenario planning to predict the future. They see value of providing links of plausible futures to strategy making, innovation, risk management, public affairs and leadership development (Wilkinson and Kupers, 2013).

Another benefit of creating plausible scenarios is breaking the habit of most traditional business planning, which assumes that the future will look like the present. The scenarios that Shell planned in the 1970s, sketched the possibility that the power of in oil markets would shift from consumers to oil-producing nations. That meant that the oil producers could dictate cut in productions to control the market and affect the oil price. The Oil Embargo in 1973, shifted the global financial balance power to favour oil-producing nations, which weakened the economy of many consumer-nations. Predicting the future with business-as-usual lens would have not anticipated such dramatic

turn of event, but by creating plausible scenarios, Shell managed to uncover that this could be a possibility (Wilkinson and Kupers, 2013).

Since the business environment and technological innovations are creating what many believes is a paradigm shift, traditional linear planning will be insufficient to cover potential risks and opportunities. Lindgren & Banhold (2009) claims that scenario planning is particular valuable to use during paradigmatic or non-linear change, when the industry is facing rule-breaking competition or unexpected events (Figure 4-23). Since it uncovers many plausible futures, it may help companies to face the uncertainties that is coming their way. As in the case with Shell, their use of scenario planning helped them uncover an event that was not anticipated, and created shockwaves around the world.

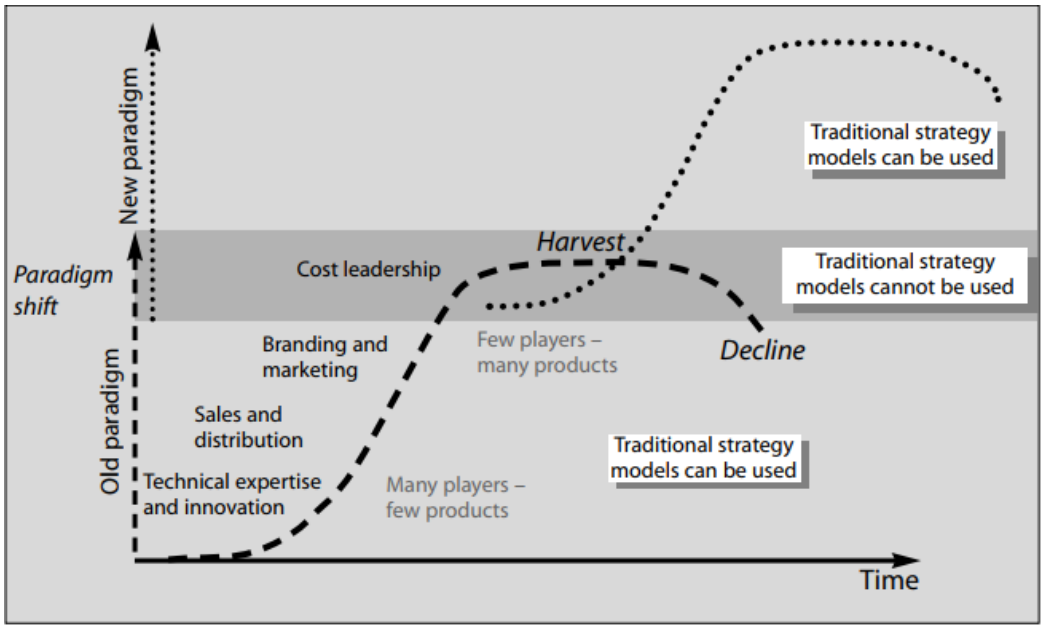

Figure 4-23 Scenario planning is well suited to dealing with paradigmatic, non-linear change (Lindgren and Bandhold, 2009).

Another company that is embracing scenario planning is Rolls Royce. After a downturn in 2014, following the low oil prices, a downturn in the Chines Economy, and cyclical decline in wide-body airline orders, the management at Rolls Royce began exploring the idea of a company-wide scenario planning. The purpose was to identify significant factors that could affect the company by the year 2040, and to develop a set of strategic questions. One strategic question included the prospect of digitization in the future, and how it can further reshape society and business environment. Another question was to examine how political or socioeconomic factors will have on the future of emerging markets. These are questions that is beyond Rolls Royce's control, but to prepare them for an uncertain future they want to link them to their strategies in a long-term perspective. They approach these questions using a variation of scenario planning, called the *Oxford scenario planning*, which distinguish between immediate actors and the diverse factors in a larger contextual environment (Figure 4-24). The purpose is to explore how larger contextual

environment might affect the organization or its transactional environment, and create plausible scenarios based on unique combinations between them (Ramírez et al., 2017).

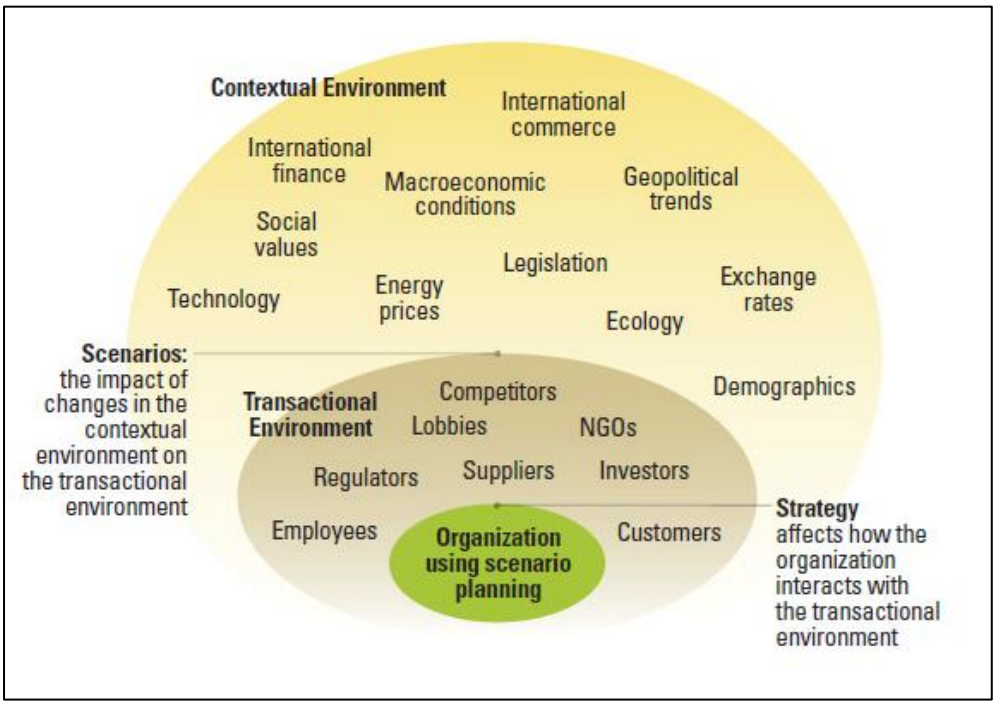

Figure 4-24 Contextual environment in the Oxford scenario planning (Ramírez et al., 2017).

For organization to cope with uncertainties, whether due to digitization or other external factors they need to become aware of external factors that may change their business environment. Especially in times where technological innovations are disrupting markets across industries. As digitally maturing companies are more likely to link their digital strategies to a changing environment, scenario planning can help them assess the uncertainties that lies ahead in a long-term perspective.

3.2.1.3 Scaling small digital experiments into enterprise-wide initiatives that have business impact.

A third factor that separates digitally maturing companies apart is their ability to scale small digital experiments that leads to big innovations efforts across the organization. Not every experiment will yield a viable result, but the ability to identify the ones that can impact the core business is key to success. Digitally maturing companies are more likely than early-stage companies to conduct both small experiments and enterprise-wide efforts, as Figure 4-25 shows.

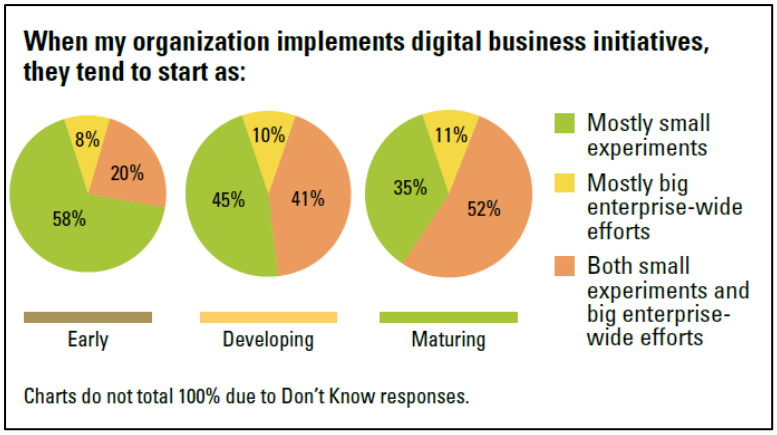

Figure 4-25 Digital experiments (Kane et al., 2017).

The result from figure 3-9 may indicate that digitally maturing companies has better ideas when experimenting, which lead to big enterprise-wide efforts more often. Quite the contrary, is comes down to the frequency of experimenting and an organizational culture that tolerates failure and risk taking. Using the mantra "fail fast" creates an environment where experiments are allowed to fail, and the workers can quickly move on to the next experiment. Martin Schrage (2016) , a research fellow at MIT, points out that in today's real time, online environment, good ideas matter less, and testable experiments matter more. By experimenting much often, the organization can learn from each experiment, whether it is a success or a failure. The value of experimental quality is almost as important as quality. One respondents from the MIT survey (2017) said he was not afraid to report to the management that he had 42 failures and four successes.

Yet again, having success with small digital experiments are due to a change in organizational culture. Experimentation are linked to employee empowerment, where experiment decisions are taken by the innovators. At Google, engineers do not need approval to pursue an idea, because the management know that when innovators have an idea, they want to build it and test if it works (Schrage, 2016).

Another important incentive that emerges using experiment and scale approach for innovation is the cost. With collaborative, digital platforms, like the ones from Kongsberg and DNV GL, the cost of experimenting is greatly reduced. In addition, experimenting on a digital platform reduces time to test in an open market, which again reduces scaling time and improve user experiences. New products or services can be created or modified faster, and the traditional innovation investment paradigm of research and development becomes less relevant.

Schrage (2016) calls this the "exponential economics of networks", and is an economic model that is compelling to mainstream businesses. With less research and development needed, long-term, fixed cost investment is reduced to a variable or marginal-cost investment. Especially, in the Oil and Gas industry, where the recent dramatic drop in the oil price forced the industry to instantly cut a lot of investment costs, this approach should be promising.

During my interview with different stakeholders from the Oil and Gas industry, they were asked if they had a specific approach towards innovation. At the oil gas operator, besides internal procedures, the respondent could not recall any specific processes. At DNV GL, when they initiate digital innovation efforts from their *Digital Unit* team, they used the Lean Startup methodology.

The Lean Startup methodology is a form for experimentation through iteration and feedback loops to determine if a product should be build. It starts by addressing problems that needs to be solved, and then develop a minimum viable product. Then early adopters and other employees are added to each further experiment or iteration, which involves measurements and learning to improve the product. If the product fails to impact the business model, they are able to change course or make improvements by further experimentations and iterations. When a product is ready to be implemented or build, it will already have established users or customers and will solve real problems for the company (The Lean Startup, 2017).

There are many benefits using experiment and scale, as it reduces long-term, fixed costs, and creates products that have already been through many test and iteration for improvements. A product that is built through experimentation have also the certification that it will make an impact on the core business, and have an established user base that makes implementation much smoother. The traditional approach of research and development is set to become obsolete or less relevant in a digital environment, as it takes longer time to process and is often capital intensive. The major challenge for organizations is to change the culture to accept the risks and failure of experimentation, and make the organization understand it is part of the process.

For new entrants, experiment and scale can work in their favour since they do not have the organizational tension that large companies have. It can make them more agile and challenge existing markets much faster. Since experiment and scale is set to become a transformation in product development that requires less investment costs, it lowers the bar for new entrants to enter the market as well.

3.2.1.4 Attract and invest in talents

As Hatch (1997) and Kaplan and Norton (1996) points out, companies in the information age creates value through human and information capital. The business environment is moving towards a service oriented economy, based on intangible assets such as innovation, creativity, complex problem solving and customer relationship. The digital transformation is rapidly increasing those features, and the need for knowledge workers with the skills and ability to succeed in such environment is growing. As the report from the World Economic Forum (2016) indicates, high-level skills and competences, particularly within mathematics and computer science is increasing in demand in almost every industry. The competition for such talents is going to be fierce, as the demand is set to outgrow the supply. In addition, many core skill-sets of most jobs will change from what it is today.

Key success factors for companies in a digital age is to attract and retain such talents. In addition, companies must also focus on upskilling and train the current workforce, to create an

organizational culture that can collaborate and innovate within digital technologies. This is also important because companies cannot just replace or hire enough digitally skilled talents. Developing the internal workforce, who already knows the core business, provides more insight and value for the organization. When a company invest in their employees by providing training and development, they are far more like to stay. It also sends a signal outward to potential new employees that this company focus on personal development, which help make the company more attractive. Companies that do not develop their talent, risk their employees to leave, as Figure 4-26 shows.

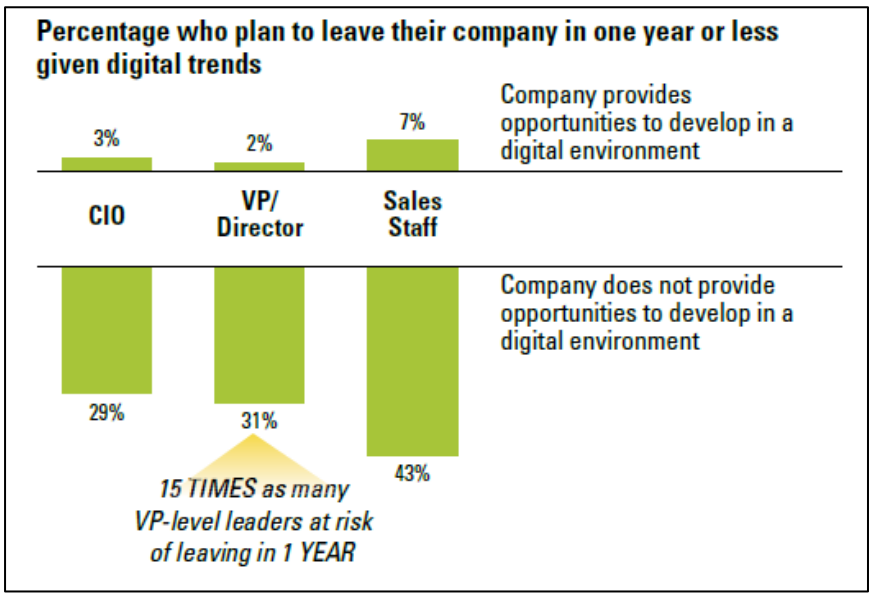

Figure 4-26 Percentage who plan to leave their company given digital trends (Kane et al., 2017).

Digitally maturing companies are far more likely to provide its employees with necessary training, resources and opportunities to thrive in a digital business. They create an environment where employers are continuously learning and empowering them to use their skills and knowledge to pursue digital efforts. While many early-stage companies lack sufficient talent, they are also lagging with the training and development (Figure 4-27).

Without necessary skills and knowledge, companies will fail to transform to a digital economy. There is no point in investing in new technology if the current workforce does not know how to harness the value it may yield. Developing skills and knowledge takes time, it is a long-term investment that build capabilities in the future. That is why it is critical for companies to start now, while the digital transformation is relatively still in its early phase, or else they risk falling behind and must play catch-up when innovative technologies hits full effect and completely changes market conditions.

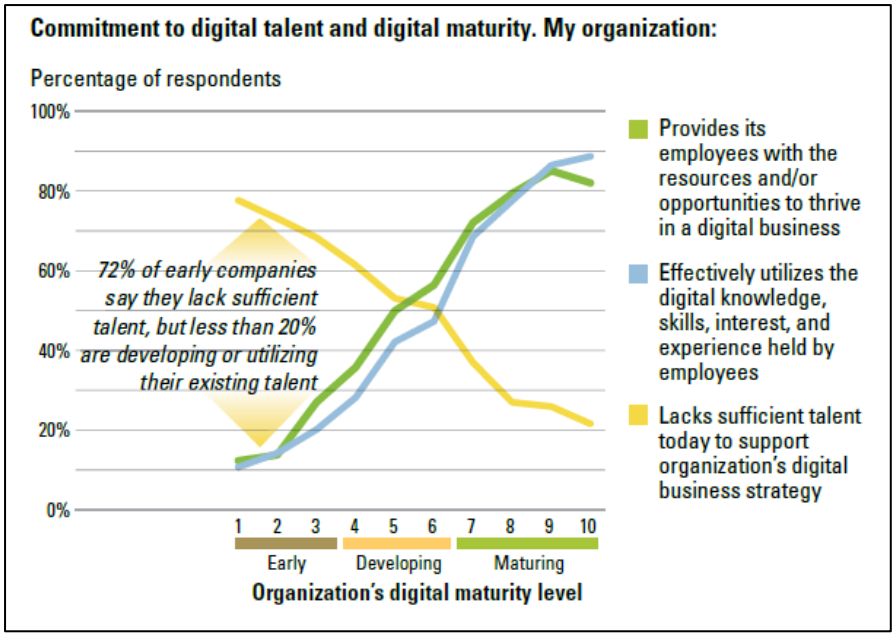

Figure 4-27 Commitment to digital talent and digital maturity (Kane et al., 2017).

Investing in talent, requires organizations to recognize that value, in a digital economy, is created by human and intellectual capital. Business-critical roles will change, and organization must identify the skills and capabilities needed going forward. That means human and intellectual capital growth must be part of their business strategy, otherwise it risks becoming a talking point and just seen as a cost for the company. Consequently, during a time of crisis, companies will cut investment cost on human capital and development to favour short-term financial performance and restore profitability (Roos et al., 1997).

That became evidently during the recent crisis in the Oil and Gas industry, when the oil price suddenly plunged. The entire industry reacted by reducing the workforce and cutting investments costs. The younger generation of the workforce was probably the ones that got hit hardest, since they have generally less seniority and experience. The interviewee from the Oil and Gas operator, acknowledges that due to the recent cut in investments and the workforce, they currently lack sufficient talents in the field of data analytics and data management. They are in the process of rebuilding this, but he also recognizes that the competition for data analytics and computer scientist is getting harder.

For the Oil and Gas industry, recruiting such talents might even become more challenging than other industries since the massive loss of jobs in the industry has given the industry an undesirable image. Combining that with a social focus on greener energy, the consequence is the industry becomes unfavourable or even worst, seen as futureless by a younger generation.

This put more pressure on companies in the Oil and Gas industry to start developing digital skills and competence internally, and take measures to become attractive to new talents. Future value creation and capabilites must become equally significant to companies as financial performance. Financial measures indicate how successful a company currently is. It is a backwards looking

measurement system that tells the performance of the past, and not how the organization is creating value in the future. In a time where future value creation is expected to undergo a paradigm shift, looking at past performance would be inadequate and dangerous, and risk steer the business into a dead end.

For organization to start focusing on future value growth, while at the same time keep monitoring financial performance, they can use the Balanced Scorecard framework. The Balanced Scorecard framework is a management system that provide managers and executives with a comprehensive view and measurement of their organization's complex environment. It highlights the value creation in the organization, both past performance and future growth, and how to achieve its goals. The framework measures the organizational performance across four balanced perspectives; financial, customer, internal business processes and learning and growth (Kaplan and Norton, 1996).

The Balanced Scorecard framework is especially effective to use when transforming the organization to meet future demands and capabilities. By setting targets at each perspective and link them to the long-term strategy, they can measure the growth and performance of the organization in a balanced view, instead of just the financial performance. This allows them to understand the cause and effect each perspective has on the overall business performance. The financial performance determines the organization's success based on past performance. However, a solid financial performance in one period does not guarantee future success. Financial performance is improved by customer relationships, such as customer satisfaction, quality, service, price, and brand. These are values defined by the customer perspective, and must be included in the organization's strategy. The internal business process perspective identifies how the organization creates and deliver value through customer management processes, innovation processes, operation management processes, and regulatory and social processes. It is a view on how the management operate the organization, and affects both the customer and the financial performance. Lastly, the learning and growth perspective provides the perspective of intangible assets, such as human capital, information capital and organization capital. It highlights the importance of skills, knowledge, organizational culture, and leadership, and shows how it affects the organization's ability to carry out internal processes (Kaplan and Norton, 2004).

Figure 4-28 shows the Balanced Scorecard framework represented in a strategy map that visualize the cause and effects each perspective has. Such visual representation is powerful because it highlights the complex, business critical value creation in ever layer. If a company wants to transform towards the digital economy, they must provide the customers with novel services. To do that they need to innovate and change internal processes, like experimentation and scale. But to do that, the organization needs adequate skills and competences, together with a change in organizational culture and leadership to drive the transformation.

The Balance Scorecard framework shows that focusing on short-term financial performance only, will hinder long-term growth and value creation. It shows that training and development is a key

value creation for the organization, and not just a cost that can be removed in times of crisis, without understanding the long-term consequences.

The framework is also effective to understand and learn if the strategic decision made is successful or not. By monitoring and measure the performance of each perspective, managers can review status if goals have been met. The financial perspective will always determine the ultimate success of the underlying strategies, which enable them to take measures and change direction if needed. Since the business environment is going to be more complex and uncertain, the Balanced Scorecard gives the company an organizational readiness to navigate in an environment with constant change (Kaplan and Norton, 1996).

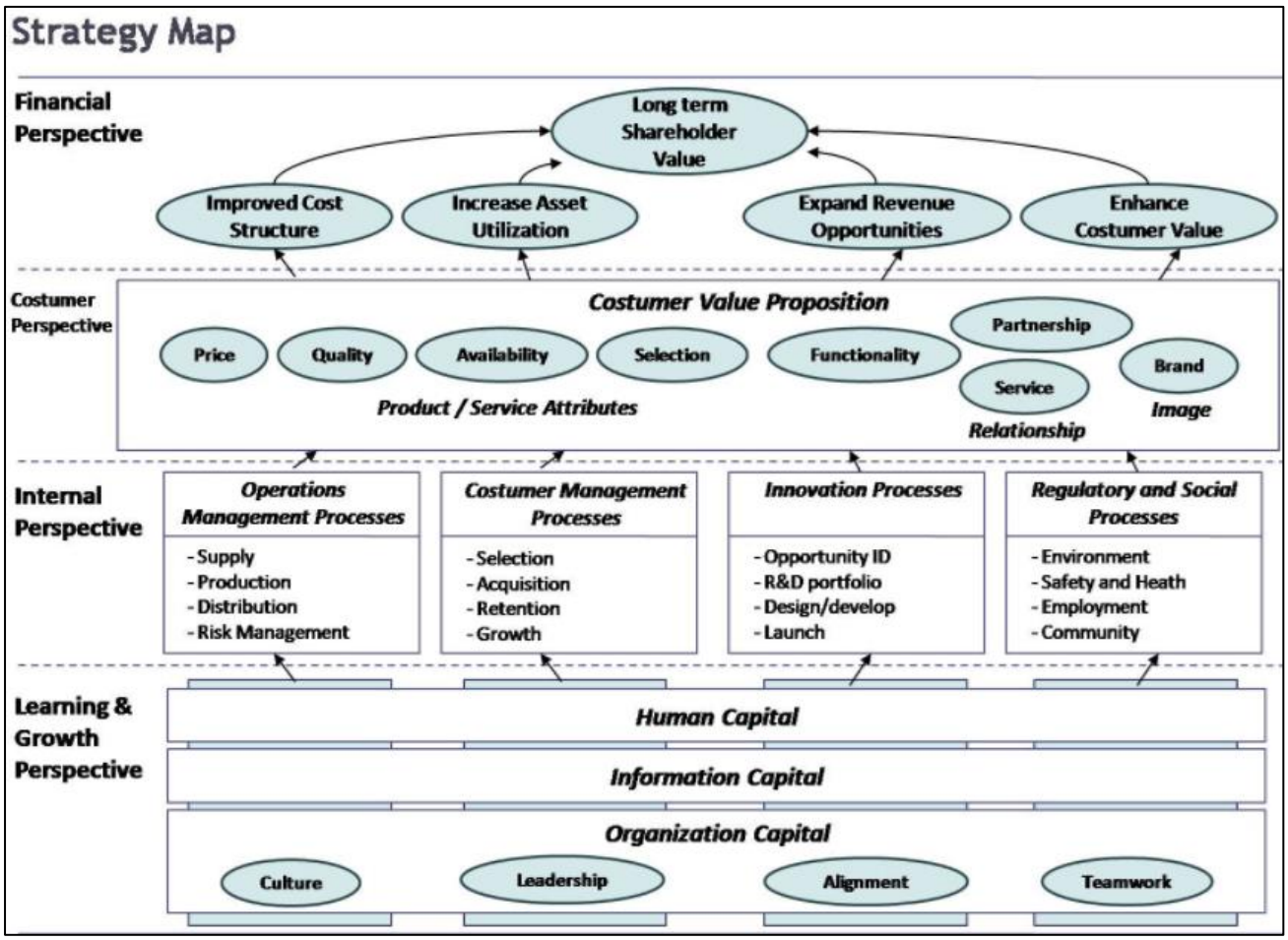

Figure 4-28 Strategy map representing how an organization creates value (Kaplan and Norton, 2004).

3.2.1.5 Securing leaders with the vision necessary to lead a digital strategy, and willingness to commit resources to achieves this vision.

The last point that is differentiating digitally maturing organizations is their ability to securing leaders that have the vision necessary to drive digital efforts. These leaders have clear ambition and management skills to lead the organizational transformation. In addition, digitally maturing organizations are also demonstrating willingness to commit time and resources to achieve this vision. They understand that achieving digital maturity does not happen accidentally, or become one by just saying it. Achieving digital maturity is a transformation process that requires hard work

and commitment to change existing mindsets and the status quo. Figure 4-29 shows that digitally initiatives are about two to three times likely to be successful when there is dedicated investment, support and leadership involved.

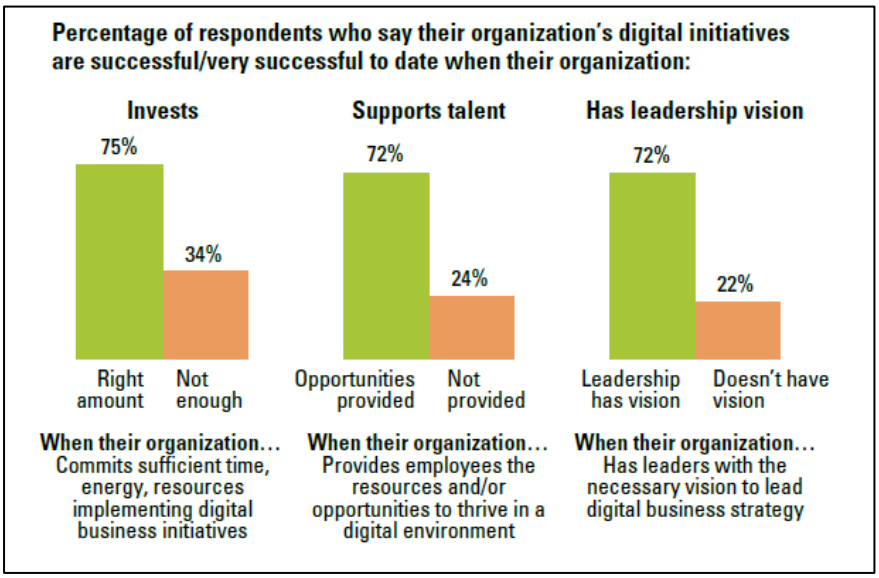

Figure 4-29 Digital maturity is achieved through commitment, investment and leadership (Kane et al., 2017).

At DNV GL, where they established *Digital Units teams* for each business unit, they are dedicated to pursuing digital initiatives. Each team have a *Digital Manager* who is responsible for driving the projects, establish cross-functional relationships, and propose initiatives across the organization. The digital manager at DNV GL, said in our interview, that one of the main challenges driving digital initiatives is to challenge the conservative mindset of doing business as usual. When proposing novel ways to perform job tasks and create value, people may feel discomfort, and friction may occur. The key to succeed, the interviewee stated, was to communicate and demonstrate the efforts early on. By involving stakeholders and include them in the iterations, they are far more likely to accept or be positive to the changes. If employees participate in the transformation, they are more likely to understand the reason behind it, and what their roles and responsibilities will be going forward. Involvement will also reduce the feeling of being imposed from top management, which increase the uncertainty and mistrust towards the change. When employees can be part of the decision-making process, they will feel more valuable and recognized for their knowledge and experience.

The approach from DNV GL to pursue digital initiatives compares to what Frankel (2008) describes as value creation for organizations in the post-industrial age. He advises that to accomplish new value creating organizations, they should establish reforming teams made up of representatives from all work groups affected by the transformation. The benefit by doing that is harnessing the tacit knowledge that exist within an organization, and combine it with new ideas and market feedback to evaluate the effectiveness of the existing organization. At the same time, the organization can identify potential changes it needs to take to respond to a changing market and business environment. Such approach tends to result in a dynamic organization that respond to

change more effective, and make the workforce feel more recognized and increase job satisfaction. Frankel (2008) emphasises that the most important factor of creating value in an organization is to recognize that the combine knowledge of the whole organization and its members is always better, more complete, more up-to-date, and more incisive than any member alone.

In my interview with a Managing Director for an Oil and Gas service company, he recognises that change management is key going forward. Leaders with the ability to understand what is happening in their business environment, respond and act upon the changes, is vital for any organization. They must be technologically competent and capable to communicate about changes effectively.

As the industry is moving towards an uncharted terrain with high complexity and rapid technological innovations, organization must be constantly aware and have the readiness to change. Frankel (2008), argues that management requirements in the post-industrial age is changing from less management of people towards effective management of change. Since the business environment change rapidly, managers must stay alert and respond to market changes, social changes, technological innovations, regulatory changes, change in financing and so on. He calls it *"Futures Oriented Management",* where the underlying concept is to understand that past events are not natural extension of the future. Organizations cannot simply extrapolate past trends towards a changing future. They can learn from the past and past mistakes, but projecting the future based on the past is a mistake itself. Management in a future-oriented organization must continuously adjust and improve the business environment, and anticipate a change in direction if needed. This requires leaders that are open to ideas from its workforce, and encourage initiatives from every level of the organization. Leaders must develop strong interpersonal skills and have technological literacy to resonate with the workforce. They must continuously evaluate the business environment, identify threats and seize opportunities.

For organizations in the digital environment, having strong leadership and willingness to invest time and resource is key to adapt and be successful. When organizations have experienced success with digital initiatives, they are also more like to continue in the same path and initiate more digital efforts. Success tends to foster more success, as Figure 4-30 shows that digital maturing companies are planning to continue increase their investment in digital business initiatives. When the organization already have the readiness and acceptance for change, it is easier for the management to build on this momentum and keep working toward further maturity. For the less digitally maturing companies, there is an alarming gap growing as they are less willing to commit and invest in digital initiatives. It shows the important of transforming the organization to make it adaptable and ready for changes, otherwise they risk falling behind and be unprepared when they eventually have no choice.

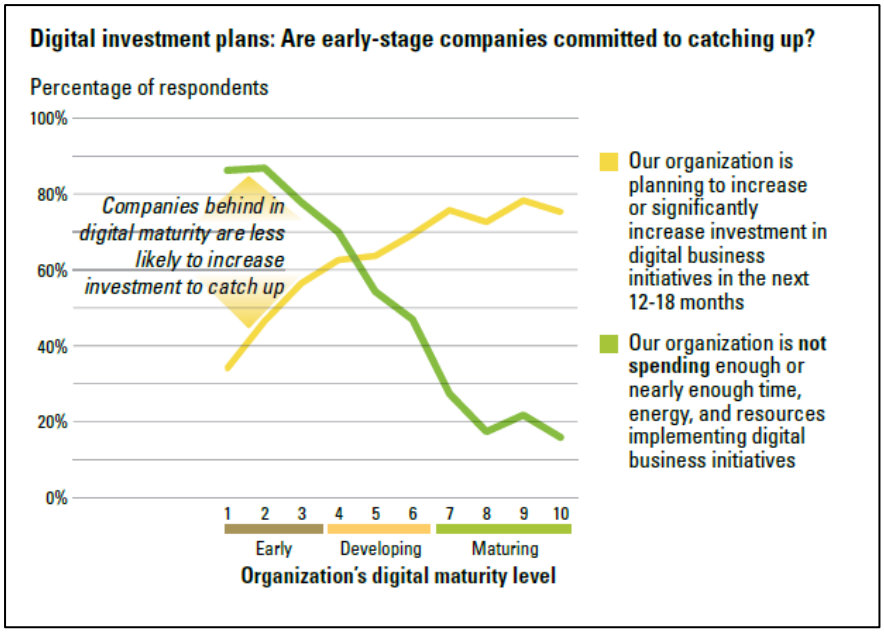

Figure 4-30 Continuing digital initiatives (Kane et al., 2017).

4.5 Stakeholders

Every organizations that exist do so by coexisting with different stakeholders that may have a direct or indirect influence over the organization. Stakeholders can be internal or external, and serve a function towards the organization. Internal stakeholders are generally the employees working in different business units, and serve the organization by performing different functions to achieve its goals and mission. This can be the sales team, technical department, human resource department, financial department, legal department, and so on.

External stakeholders can be more complex, as they exist outside the organizational boundaries. Every organization must deal with the external environment, since it affects the organization by possessing as a threat or an opportunity. In modernist perspectives, organizational environments are defined by three elements that affects the organization; the interorganizational network, the general environment, and the global and international environment (Hatch, 1997).

The interorganizational network consist of suppliers, customers, competitors, partners, unions, regulatory agencies and special interest groups. These are stakeholders that exist within the close environment of the organization, as a network of a complex web of relationships. Stakeholders in the interorganizational network are prone to direct influence from the organization.

The general environment consists of forces from external sectors that can influence the interorganizational network both as opportunities and threats. Organizations must deal with the general environment normally without being able to influence the progress, speed or impact of those forces. They can only manage how they understand, respond and adapt. The general environment is divided into different sectors and includes social, cultural, legal, political, economic, technological and physical.

The financial crisis in 2008 is an example of an economic force from the general environment that organizations had to dealt with to survive. Another example is social issues, such as mass migration or an ageing demographic. If we look at external forces that has influenced the Oil and Gas industry, we have the recent drop in oil price which caused a crisis in the industry. Another issue is the growing public concern about the environment, where there is strong social and political discussion about moving towards renewable energy sources.

The digital transformation, which this thesis is about, is an external technological force, which organizations must understand and respond to. There is little they can do to influence the development of the technological innovations, and can only adapt its own organization to survive. Figure 4-31 shows a visual representation of the interrelationship between the general environment, the interorganizational network and the organization.

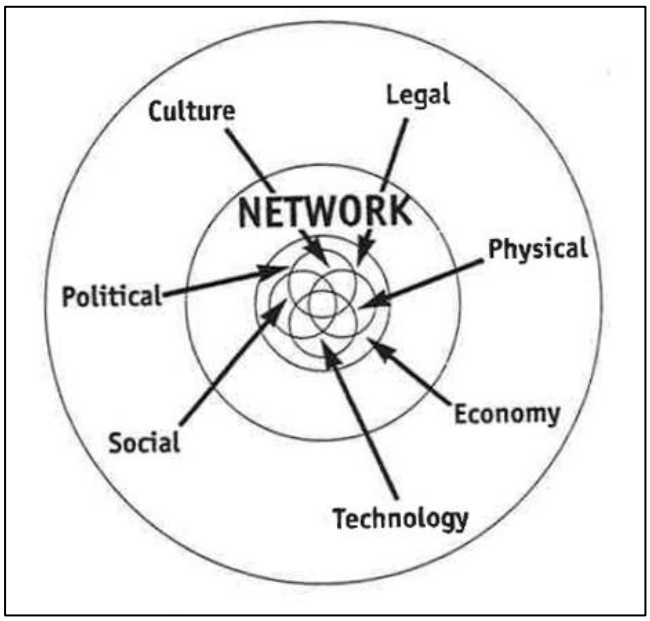

Figure 4-31 Interrelationship between the general environment, the interorganizational network and the organization (Hatch, 1997).

The third element of organizational environment is the global and international environment, which are factors and entities that span cross national boundaries or is organized in a global scale. The United Nations, the International Monetary Fund, the European Union, and international firms are examples of actors in the international environment which can influence an organization or its network. Today, we see the largest technology companies such as Google, Facebook, Apple and Amazon have gain immense power of the world, and are influencing consumer behaviour, socioeconomic factors, political issues, media, and technological developments. When those companies initiate or develop a new product or solution, the rest of the world seems to respond and follow their lead. Google is among the technology companies that is leading the development of cloud computing, data analytics, and artificial intelligence, and has become a central stakeholder for many industries.

In modern days, organizations must navigate and coexist among various stakeholders with different level of influence. Their business environment is complex and dynamic, and stakeholders can change their roles on how they influence the organization. The digital transformation is going to further complicate the business environment, and there is likely to be a reshuffle and emergence of new stakeholders. The following subchapters will try to assess the changes based on the covered materials and the perspective from the industry.

4.5.1 New entrants

The digital environment is expected to bring new stakeholders into almost every industry. As covered earlier, the technological innovations are reshaping the value creation and business models across industries. During times of uncertainty where the industry is facing a paradigm, the business environment is fragile and open for threats or opportunities. Depending how your view is.

In my interviews, all the respondents are coherent about the emergence of new entrants. The Managing Director at the service company, believes many small start-up companies will challenge large corporations, especially within digital platforms. Digital technologies are opening the path for new entrants to enter their market, but the uncertainty is which form it will take. They can emerge as direct competitors, partners, suppliers or even as a customer. The biggest threat is a new entrant that completely disrupt the existing market, which forces the incumbent companies to play catch-up in order to survive. We have already seen this in other industries, from Uber in the personal transportation sector, and from Airbnb in the accommodation sector. For the incumbent companies, there is not much they can do to prevent the emergence of new entrants. They must stay alert and constantly sense their business environment, and prepare the organization in advance.

The digital environment is also contributing to intertwine existing interorganizational networks from different industries in terms of competing for resources and sharing marketplace. Since the digital transformation is occurring in every industry, they must compete for the same digital talents and competences. A computer scientist will be needed as much in the health sector, as in the Oil and Gas industry, which will result in an expanding network of stakeholders to deal with.

In addition to more competitors for talents, the digital environment is also enabling new partnerships. In a digital platform, where various industries participate by sharing asset data and analytic services, companies can form partnership that crosses former industry boundaries. A service provider in the Oil and Gas industry may collaborate with a service provider in the maritime industry to combine their data and abilities, which can result in enhanced insight into industry assets. The Digital Manager from DNV GL believes that forming such partnership and collaborate with asset data and analytics is going to become a widespread practice. Since data analytics and machine learning algorithms gets better with more relevant data, both parties will benefit. In addition, more eyes on the data will increase the data quality, and extract more insight from different perspectives.

4.5.2 Reshaping and enhancing relationships

The digital transformation will not only introduce new entrants to an existing interorganizational network. The change in value capturing, the change in demand for new skills and abilities, and the changing nature of performing work tasks and job functions, will also reshape relationships among incumbent stakeholders in a business environment. Many competitors may need to collaborate, suppliers and customer may form partnerships, and stakeholders that once was considered as peripheral or secondary may become a central actor in the interorganizational network.

The computer scientist, at the Oil and Gas operator, states that digital business is also reshaping the relationships internally in the organization. Since the digital environment requires more cross-functional collaborations, job silos must disappear to succeed. That means forming relationships and collaborate with internal stakeholders that was not considered business critical in the past. As mentioned before, front-end service engineers and technician must collaborate with data scientist and data analysts if they wish to succeed with novel data-driven approach towards maintenance management. In addition, sales representatives must be involved to understand the new concept in order to effectively communicate with customers. One of the key factors of transforming the company towards a digital business is to include the whole organization in the transformation. The traditional approach of separating business units and support functions within an organization, where digital initiatives are delegated to the IT department is outdated, and will make it hard to change the core business strategy.

Externally, the industry is already reshaping the relationship among customers, suppliers and competitors. Alliances is formed to provide more integrated services and reducing the overall cost as well. This year, Statoil has together with the supply industry formed a partnership that aims to reduce cost and increase efficiency towards maintenance and modification. Their initiative, *Modifications, Maintenance and Operation – Joint Industry Project (MMO-JIP),* is an arena to create common improvements, shared learning and increased standardization in work execution. When the supply industry accounts for more than 85% of the project hours, there is certainly huge cost saving potentials. In addition to the industry partnership, they have also included an academic institution by collaborating with Høgskolen på Vestlandet. The goal of collaborating with an academic institution is to promote future research and master theses within the fields of digitization and low carbon emissions (Statoil, pers. comm., Nov 21, 2017).

In the UK, Oil and Gas producers have started to collaborate to establish a shared online trading platform for managing tools and spare parts. As a consequence of the dip in oil prices, the industry searched for measures to reduce maintenance and operational cost. The result was to form an industry partnership by trading sizeable inventories to reduced cost associated with storage and maintenance of materials. In a warehouse located in Aberdeen, they have set up a pool of spares ranging from nuts, screws, valves and compressors, and consists of more than 200,000 items. The shared inventory is catalogued and managed through common online platform, and has helped the companies to reduce lead time and inventory cost for spare parts (Oil and Gas UK, 2016).

Enhancing collaboration with academic institutions is going to be vital during the digital transformation. *The Future Jobs report* from the World Economic Forum (2016) recommends closer collaboration between the industry and academia to, not only develop and reskill the current workforce, but to prepare the future workforce on the necessary skills and ability requirements in a digital environment. In their survey, they found that due to the accelerating pace of technological developments and changing skill demands, there are already large mismatches between the actual supply and the demand of key work-related skills. To prevent increasing this gap in the future, the industry must start with stronger collaborations with academia and the educational sector to identify and develop future skill demands.

Another important stakeholder to involve stronger in the digital transformation is the regulators and authorities. The Oil and Gas industry are strictly regulated, and changing the approach towards maintenance management and operational performance is not something that is easily done. When introducing innovative approach and methods to maintenance management, changes the risk picture. For regulators, such change introduces uncertainties, which is not appreciated. The interviewee representing the Oil and Gas operator highlights that involving regulators is important to enable them to understand and accept the new methods. He recalls previous cases where innovative technologies have been introduced, but due to the lack of understanding from the regulators, the implementation had to be postponed. He emphasises that in order for digital innovations to be accepted, the regulatory framework has to follow the development and be updated along with the changes.

4.5.3 Introducing "The crowd"

One of the most significant impact the age of computers and the internet has made in the worlds is connecting billions of people around the world to a common digital arena. This digital arena, also known as *the web,* is free for anybody to enter and participate in, and does not discriminate against any background, whether it is level of education, cultural, social, ethnical or geographical[3]. With the constant increase of computing power and the reduction of costs, the power and capabilites of the web and digital technologies is becoming democratized. Meaning it is accessible for the common user of the internet. This development has led to more innovation is being done by *ordinary* people on the web, and the knowledge and capabilities of the collective people online, *the crowd*, is starting to challenge established experts and core institutions.

The potential value that exists in the crowd is starting to become more recognized. In their book *Machine, Platform, Crowd: Harnessing Our Digital Future,* the authors McAfee and Brynjolfsson (2017), have dedicated a third of the book about the power and capabilites that the crowd offers. The uniqueness of the crowd is that it is large, offers several perspectives and is quickly updated about new knowledge. Those attributes make the crowd equipped to solve almost any challenges, even as complicated as sequencing the human genome.

[3] The web itself does not discriminate, people online do. Access to the web is free but depends on adequate infrastructure.

In 2013, a pioneering researcher in competitions involving the crowd, Karim Lakhani and his team, conducted a study on how the crowd could find a way to faster sequence the genomes of large numbers of white blood cells. The benchmark, which was set by researchers at Beth Israel Deaconess Medical Center, could annotate 1 million sequences in less than forty-eight minutes with 77% accuracy. Sequencing the genome is carried out by computational power, using algorithms to solve the task. Lakhani and his team converted a segment of gene annotation into a general algorithmic problem, and posted the challenge on Topcoder, an online platform for computationally intensive problems. The platform had, at that time, a community of approximately 400,000 developers around the world, who enjoyed solving though challenges. The competition ran for fourteen days, with over 122 people or teams submitting algorithms to solve the problem. Majority of the algorithms were less accurate than the benchmark, but eight submissions from the crowd were able to reach 80% accuracy, which was the estimated maximum for the applied data set. Those who were at least as accurate as the benchmark, did it so at the average of eighty-nine seconds, way faster than the researchers at Beth Israel Deaconess Medical Center. The most astonishing factor of it all was that the participants were not academical or had no experience with industrial computational biology. Only five said to have experience with R&D or life sciences. In addition, the total prize money offered during the contest was $6,000 (Lakhani et al., 2013).

Many companies are starting to realize that tapping into the power of the crowd can help solve many problems they struggle with. More online communities, such as Topcoder, are emerging, and companies are posting different types of challenges. This includes competitions within design, application development, algorithms, analytics, and many more. The winners are offered a prize money depending on the impact and scale of the challenge. McAfee and Brynjolfsson (2017), states that the advantage of using the crowd is the diversity in perspectives. Sometimes are knowledge and expertise from other faraway discipline often what is needed to solve complex problems. In addition, the sheer size of the crowd makes it more likely to be more up to date with technological innovations that changes rapidly.

Another emerging trend we are seeing with the use of the crowd is help with financing, also called crowdfunding. In both, business and personal aspects, crowdfunding has become a popular source of financing. Companies or start-ups are using it to cover the cost of prototyping new products or developments, and at the same time identifies market interest and potential customers. In a personal domain, crowdfunding can be used to get help financing health related issues, educational costs, disaster relief, political campaigns, travels or anything that people wants to contribute their money with. Crowdfunding creates a new channel of financing that spans around the world and includes ordinary people that previously were not reachable or even thought about as a contributor.

The digital environment is introducing the crowd as relevant stakeholder in any domain. For organizations, including the crowd as a stakeholder in their interorganizational network can be wise and yield great benefits in solving complex problems or help with financing. Harnessing the power of the crowd can give competitional advantage to a limited cost.

4.6 Risks, challenges and opportunities

The digital transformation that is happening is complex, ambiguous and possesses many uncertainties. For companies in any industry, this can be perceived as a threat or an opportunity, depending on how they approach the changing environment. Organizations that views the transformation as an opportunity, may be quicker to harness the value that emerges and strive in a new business market. For organizations that see it as a threat and oppose the changes, are in the risk of staying behind and be left in a market that is destined to end.

Identifying the extent of risks, challenges and opportunities that exist or will emerge, is to substantial for this thesis to cover. There are many unknown factors involved, and as the industry is moving toward digital maturity, new challenges and opportunities will emerge. However, following is a summary of some key risks, challenges and opportunities that I believe is important and have covered in the thesis so far.

4.6.1 Risks and challenges

- Understanding the changing environment – First and foremost, organization must understand and sense that their external environment is changing. If they become too inward looking or complacent about their position in the market, there is a risk that they miss out on emerging markets that can disrupt the existing ones. Such mistake can be devastating for companies that do not see that their market is about to disappear or getting greatly reduced. Those companies become the victims of a creative destruction. Failing to act, or acting to slow will also have negatively compounding affect. If actions are taking to slow, organization will miss out on the already scarce supply of adequate talents and competences in a digital environment. Developing skills and competence internally takes time, and is a long-term investment. They risk missing out on forming vital partnerships, and establish a network of collaborating stakeholders. Eventually, they either disappear or lose their position in the industry.

- Understanding the concept of digital transformation – Not only does organizations understand that their environment is changing, but they need to understand what is changing. Understanding the digital transformation, and the value and capabilites it brings is vital for success. Believing that the digital transformation is something related to the IT department or just an incremental improvement, and not a transformation of core business strategy and value creation, may have the same resulting consequences as not understanding the changing environment. To succeed in a digital environment, it is vital to change the organizational culture, and empower the workforce to pursue digital initiatives. The digital transformation requires organizations to work in more cross-functional collaborations, and abolish existing job siloes. In addition, understanding the digital transformation is important to identify which skills and abilities is needed going forward.

- Attracting and developing talents – One of the main challenges that emerges in a digital environment is to have the necessary skills and competences in the organization. That means attracting digital talents and developing the current workforce to become digital literate. For the Oil and Gas industry, this is perhaps even more challenging as the industry still recovers from huge investment cuts and personnel lay-offs. Making new hires or starting with substantial reskilling programs may still be too soon for many companies, as they may still struggle with short-term financial objectives. Talent acquisition and development is a costly concern that normally has a long-term perspective, which can make many decision-makers reluctant. However, disregarding this issue is a long-term pitfall for future success. Adding to the challenge of attracting and retaining digital talents is the growing concern about the future of the industry, since the recent oil price crisis and the social focus on greener energy, have given the industry an unfavourable public image.

- Changing organizational structure and culture – Change management is hard to perform in any organization. One of the key success factors of achieving digital maturity is changing the organizational structure and culture where the workforce is empowered and understand that working in silos in no longer sustainable. There needs to be a shift in mindset and approach in terms of leadership, job functions, and risk aversion. Managers must concede decision-making authority to its workforce, and be open and supportive of digital initiatives and experimentations. Organizational changes are perhaps one the most challenging part of the digital transformation, and requires commitment, time and resources to succeed.

4.6.2 Opportunities

- Creating new value and business models – Innovative technologies that are emerging pose both as threat and opportunities for businesses and organizations. Failure to understand, or being reluctant and dismissive on how innovative technologies can impact existing business models and markets is certainly one of the biggest threat. On the other side, seeing how novel technology can create new value, reshape existing business models or enabling access to new markets may yield great rewards. The companies that understand that the digital transformation is changing the core business model, strategy and value creation, are in the front seat when the business environment is changing. One common factor that all companies shares, whether they are market leaders or in a challenger position, the digital transformation is an equal opportunity for everybody and nobody can claim to be an expert in the field. A paradigm shift means moving towards the unknown, and the companies that are quick to react and view it as an opportunity, rather than a threat, can become the market leader in a new business environment. Rolls Royce, is an example of company that harnessed the value of novel technology, and changed their core

business model and strategy to move from a struggling position to a market leading position.

- Becoming a modern and resilient organization – To succeed harnessing the value from the digital transformation, means also changing the organization to adapt to a new business environment. Organizational structure, job performance, leadership approach and work relationships are some aspects organizations must change to achieve digital maturity. Companies must commit and invest time, energy, and resources to succeed in changing their organization. But the reward of doing that may yield long-term benefits and make the organization agile and resilient to a constant changing environment. The digital transformation is an external technological factor that impose the need for change. Such change can also be initiated by other external forces, like social, political, economic, cultural, legal or physical factors. If the organization acquires a new mindset and culture towards change and has the ability to adapt to a changing environment, they are more likely to cope and survive the next big transformation, regardless of which sector it may arise from. Such success will give the company an organizational readiness and resilience in a long-term perspective.

- Upskilling the workforce – Investing and implementing digital technologies in the core business requires adequate digital skills and competences. It will also require changes in other core work-related skills, such as socials skills, cognitive skills, content skills and complex problem-solving skills. For companies to succeed in a digital environment, they need to invest in both acquiring such talents and developing the internal workforce. Doing so tends to be a capital-intensive concern, but it is also a value creating investment that yields long-term growth and benefits. When digital technologies become a core part of the business performance, the whole organization must become digital literate. That helps lower the bar for the organization to initiate new digital efforts and innovations. The development of digital technologies is viewed to only be in an early stage, and when technologies such as artificial intelligence, autonomous vehicles and robotics matures and fully entering the industry, further business innovations is needed. Having a workforce that is already digital literate and competent, will give the organization a competitive edge.

- Forming new relationships – The digital environment is set to reshape and introduce new stakeholders in the interorganizational network. New entrants are emerging as business start-ups or from other industries that was previously not relevant. Again, this can be viewed as a threat or an opportunity. Certainly, some new stakeholders will challenge incumbent companies and compete for market shares. That is inevitable, especially in a disruptive environment the digital transformation is creating. But it also creates opportunities for companies to form new relationships among its stakeholders. Collaborating with competitors, suppliers, and customer may yield benefits for all parties and strengthen the industry from external threats. Collaborations with stakeholders from

other industries can also be beneficial, as providing other perspectives and insight can solve exiting problems or improve efficiencies. Digital platforms are also introducing *the crowd* to help innovate, solve complex problems, or acquire funding for product developments. Using the crowd as central actor in core business activities were not on many company radars just a few years ago. In the digital environment, they can become a valuable source of perspectives and value creation. Forming stronger partnership with academia and public institutions is a collaboration that is going to be more important. Educating and training the future workforce is necessary to cover the demand of future job skills and abilities. Even jobs that do not exist today, but will so in the future, is necessary to identify and prepare for.

4.7 Business model canvas

To summarize the analysis, I have identified key focus points for the digital business environment, and arranged them in a business model canvas. The business model canvas is visual representation tool of an organization's strategy and business model, and helps identifying and map value proposition, customer perspectives, revenue streams, cost structure, key activities, key resources, and key partners (Osterwalder et al., 2010). Figure 4-32 shows a business model canvas based on some key factors that has been covered and identified in this thesis.

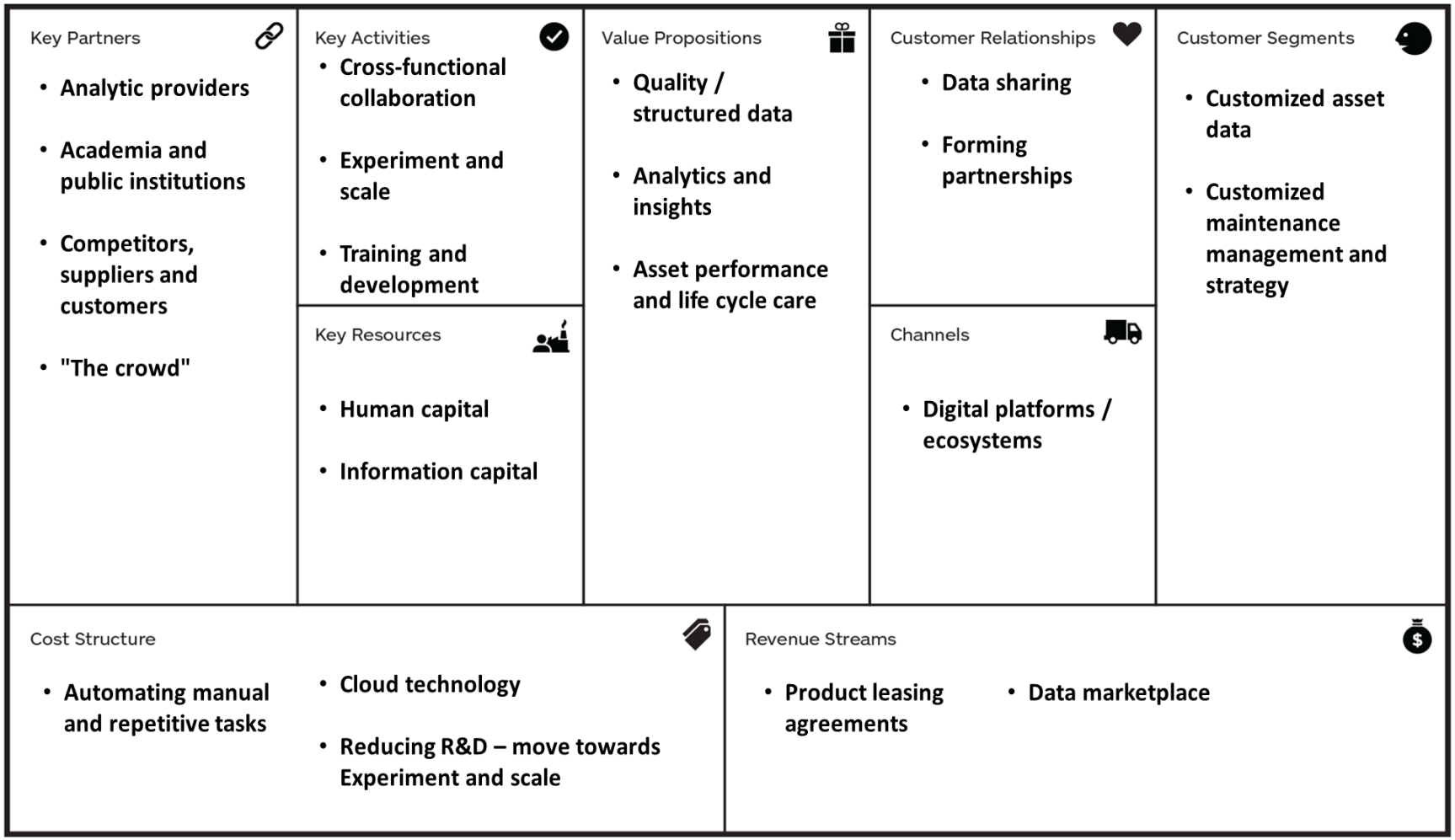

Figure 4-32 Business model canvas

5 DISCUSSION

This chapter aims to provide a summary and discussion about the subject and the findings of the thesis. It offers the researcher's point of view about the work and reflects on the observation and the result of the analysis. Included are also a description of challenges about the work and recommendation for future research.

5.1 Summary and discussion

At the very start of the thesis, when the research subject was discussed and chosen, I had limited awareness about the gravity of the digital transformation. The buzzword *digitization* was frequently mentioned in the media, and I must admit my first impression was, like most, digitizing manual tools. To me, digitization meant going from paper to tablets or other digital tools, and I tend to understand now why I thought that. In the mainstream media, the word digitization is often explained in simple form, and uses many examples about digitizing public services. Like the digitizing of our tax records or introducing a mobile application to purchase our bus tickets. It emphasises on making things more efficient and automated to reduce costs. Such examples are something every one of us will have a personal experience with, and it may create a bias towards the concept of digitization or digital transformation.

At the beginning, I started the research by reading articles and expert opinions about the topic. My initial approach was to focus on the technology side of it, and the capabilites it may bring. News about the progress of innovative technologies, such as artificial intelligence, 3D printing, robotics and so on, were exciting and holds many opportunities for businesses. I understood that innovative technologies could enhance many of the work tasks that we are doing today. But many experts and people familiar with the topic had a different take on digitization, and argued that digitization is less about technology and more about human and organizational changes. I must admit, at first, I struggled with that argument. With all the innovative technologies that are emerging, digitization must be about technology. I realized had to dig deeper into the matter to fully comprehend what they meant, and started by buying books that were relevant. I also attended conferences that were about digital transformation to expand my knowledge, and combined the attendance as part of the research by talking to experts about their perspective and experiences.

The more research and analysis I did about the digital transformation, the more I came to realize the gravity of the situation, and the uncertainties, challenges and threats organizations are facing. I came to the realization that digital technologies are external forces that may initiate fundamental changes to the business environment, and understood what the experts were really saying. Innovative technologies that emerges in the digital environment must be viewed as a tool that initiate changes to job requirements, organizational structure and culture, customer behaviour, and value creation. The totality of an organization's business model is going to be affected. The digital transformation is a global phenomenon and is reshaping the business environment in an unprecedented way. That is why it also has been labelled as a paradigm shift, not only for the industry, but in a socioeconomic and customer behaviour perspective. Digital technologies are unlocking a completely new way to create and harness value, which organizations must adapt to.

I also came to the realization that the digital transformation is vastly complex, and involves many factors and elements that are prone to changes. The scope of this thesis does not justify it all, but I believed the elements covered in the analysis may give an indication on the major challenges organizations are facing, and the breadth and scale of the disruption. It may feel like peeling an onion, the more layers that is subject to change is revealed and analysed, the more layers appear. Capturing every layer is too extensive for a single thesis alone to cover.

Many of the sources used in the analysis might not be exclusively related to the maintenance service industry, as they are quantitative survey reports spanning across countries and involves different industries. In addition, many business cases cited, are taken from other industries not related to the Oil and Gas sector. However, the digital transformation is a global phenomenon, and the same type of changes and disruption is occurring in any industry. That makes the challenges similar and transferrable. Key skill sets and core work-related skills are changing regardless of industry, and digital technologies will require the same type of talents to apply it effectively. The challenges for organizations is attracting such talents, and be able to collaborate cross-functional between existing workers and new digital talents with different mindset. There is an added pressure on management and leadership style, because they need to balance a more diverse workforce in terms of gender, generations, cultural and social beliefs, worldviews, and field of expertise. In the digital environment, many of the older generation employees may feel out of touch or outdated. Even though they may sit in a position of power or organizational authority and expertise, the digital environment requires digital literacy and knowledge the younger generation tend to have more of. Such rebalancing of key abilities is a growing tension many organizations are facing, and requires a leadership approach that can manage both veterans and hungry young talents to foster collaboration between them.

The digital environment favours speed and agility, which requires organization to adapt and change their organizational structure and culture. The technological innovations are happening in an accelerated pace, and organizations must not only understand the changes, but also take measures to implement it and use it effectively. Generally, in large organizations, this is difficult and hard to achieve. Initiating cultural and organizational changes is difficult enough, but this time, the digital transformation requires upskilling of the existing workforce to become digital literate, and adapt to the changing nature of work tasks. They are complex challenges that is happening simultaneously, and with an industry still in recovery mode after the slump in the oil price, such focus may not be the first in line.

In the analysis, I have included theoretical perspectives and frameworks that are relevant for organizational change in a modern age. It includes organizational theory in the post-industrial society (Hatch 1997) and effective management for the future (Frankel 2008) that describes the characteristics of modern organizations. On the other hand, I also think about the capabilities that the digital environment is providing. The progress of technological development has greatly reduced the cost of using sophisticated technologies, and lowered the bar for less capital-intensive entrants to enter the market. Cloud technology platforms offers the same capabilites to anyone,

regardless of size and market share, and digital ecosystems are offering industry data, expert opinions and analytics services that were previously unattainable. Long-term, capital intensive research and development efforts is replaced by quick and cheap experiment and scale. In addition, crowdfunding and crowdsourcing may provide capital and other insights that are valuable and up to date. This have me thinking that what if the large size of the market leaders' organization is actually a disadvantage to them, because they lack the speed and agility to react to a constant changing environment.

Organizations usually become large because of economies of scale and centralizing many functions. Growing the organization and becoming market leaders is, or have been, capital intensive and consists of many business functions. However, with digital technologies such as cloud technology, artificial intelligence and data analytics, many functions can be automated. Key resources and skills can be obtained from partnerships or digital ecosystems. Entering the market and challenge market leaders will not be as capital intensive as before, which gives smaller organizations, or just a team of talents that collaborates, the advantage of being more agile and digital literate. The digital transformation may not only be paradigm shift in value creation and consumer behaviour, but also fundamental change in the size and structure of organizations.

I offer such thought because of the sheer complexity and speed that the digital transformation is introducing. For incumbent organization, there are many important elements and measures to take to adapt to the digital environment. First, the organization and management must understand the concept of digital disruption, and understand the changes to customer demand, changes in technological capabilities and changes in organizational structure and value creation. Then, they need to initiate strategies and change management across the organization. Digital talents and competences must be acquired, and the existing workforce must be up-skilled and developed in digital literacy and related abilities. First then, innovation efforts and harnessing new value and business opportunities can be initiated. All those elements and measures takes time and are hard to achieve. Resistance within the organization are often unavoidable, and short-term financial targets postpone or limits many long-term growth opportunities. For smaller and more agile organizations, there is probably no better time to challenge large incumbent companies that are slow to react to the digital disruptions.

If there is going to be an influx of new entrants in the maintenance service industry in the Oil and Gas sector is uncertain. However, there is no doubt that organizations need to adapt to a changing environment. Threats does not necessarily come from new entrants, but may also come from existing companies within the industry that have adapted to the changes more quickly. Like Rolls Royce did in the jet engine manufacturing industry, when they changed the business model from product offering to the delivery of jet engine performance instead. With the use of connected sensors and data analytics, they reshaped an entire industry and became market leaders. Such change in business model is in fact directly transferrable to the Oil and Gas sector, and we are already seeing steps initiated towards it by some companies.

5.2 Challenges

Like in any project, challenges during the work have occurred in many forms. The first challenge was understanding how to approach the research questions. The scope of the thesis covers many elements of the digital transformation, and it felt necessary to include those perspectives to try describing the complexity of the topic. Given it was an exploratory research, I had to have open mind and be able to steer the work in a new direction as the understanding got better or new relevant information appeared.

Probably the biggest challenge during the work is the constant flow of information that keeps coming with regards to digital transformation. It is a topic that is highly relevant these days, and new articles, breakthroughs in technological innovations, survey reports and business cases keep being published that contains new or relevant information. The challenge was to filter through all the available information and decide the limitation. On one side, I wish to have as updated and relevant content as possible, but on the other side I had to realize that the information is dynamic, and the thesis is a perspective of the current situation. The environment changes rapidly not only for businesses, but also for researchers and academia that tries to understand and keep up with the digital transformation.

The selection and access to interview objects was also a challenging part of the work. I wanted to get the perspective from the individual that was qualified to share relevant information and their organization's approach towards the digital transformation. Finding such individual in large organizations is challenging. With the help from my own personal network and the network of the supervisor, I believed we manage to achieve a suitable selection. The diversity of the interview objects that was accessible, gave me valuable information and insights from different perspectives in the industry.

The work on the thesis has also been done in combination with the daily job. This combination has not always been easy, and has sometimes affected the time schedule. Working on the thesis has been an effort of long hours and have required sacrificing many daily activities. It has been a mental challenge sometimes to keep up the motivation and break through the hurdles of the writer's block.

5.3 Future research

The research methodology applied in this thesis is usually a methodology that forms the basis of conducting more conclusive research. The purpose of this research has been to explore how the digital disruption will affect and transform the maintenance service industry in the Oil and Gas sector. The transformation is relatively in its early stage, and we are yet to witness a full-scale market disruption. The research has covered industrial trends and predictions that are expected to occur by various stakeholders and global survey reports. Business cases from other industries have been compared to draw similarities and possibilities.

Given the breadth and complexity of the topic, the thesis opens for many future research possibilities. The rapid change of the environment and technological innovations may change many

assumptions that are covered in the thesis. Conducting a follow-up research when the digital transformation become more matured in the industry is a potential option to see the outcome of past predictions and expectations. Future research on each of the sub-question covered in the thesis is also an option, to find more in-depth solutions of a specific problem, which includes:

- Further expectations of the digital transformation based on recent data
- Technological capabilites and future innovation
- Competences and skill sets that is emerging
- Changes in business models and organizational structure
- Changes in stakeholder relationship and business environment
- Risk, challenges and opportunities that may arise or be revealed based on new information

The topic covered in the thesis is open for many research options beyond what is covered as well, and given the relevance of it, future research will certainly be expected and welcomed.

6 CONCLUSION

The research in this thesis had a main objective to be answered: *How is the digital disruption transforming the maintenance service industry in the Oil and Gas sector in a 3 – 5 years perspective?* To understand the objective, the analysis covered six sub-questions that the researcher found important to examine, and contributed to form a broad description of the complexity of the topic.

It started by examine the expectations and understanding of what digital disruption really meant. This section was important to include not only to understand how aware the industry is, but also because it contributed to change the assumption of the researcher. The initial assumption about the digital disruption changed from a technology-centric focus towards the implications the transformation has on organizations and its employees. Technological solutions and services is a key part of the transformation, but for organizations it is an external force they must manage and adapt to. Digital technology should be viewed as a tool or an enabler for creating new values, changing business models, changes in skills and job requirements, and reshaping business relationships.

The uniqueness of the digital disruption is the unprecedented changes it creates. It is a transformation that most individuals have limited experience with, and drives the industry towards a paradigm shift in many elements. It changes the nature of work tasks and job requirements, which requires a wide-ranging up-skilling and development of the workforce. Digital competences, such as computer scientist and data analytics becomes more central to the value creation, which changes the organizational structure by requiring more cross-functional collaboration. The organizational culture must be more acceptance of risk and failure towards digital innovation efforts, which requires leaders that empower and support its employees. The industry must also be willing to share or trade asset data to harness the potential value that the digital environment offers. This can be done by establishing partnerships with competitors, suppliers, customers, or a stakeholder that was not considered relevant in the past.

The research explores global trends and business cases to understand the depth and variety of the transformation. It collects the perspective from different stakeholders in the industry to get further insights and knowledge about the status quo and the way forward. However, since it is a research methodology where the objective is to explore and investigate a relative uncertain domain, it is difficult to provide final and conclusive answers. Probably the only certainty is that industry is about to change in many levels, and the research raises more questions than it answers.

The recommendation I take from the research is that the organizations and managers that view the digital disruption as an opportunity instead of a threat, and take measures to adapt to the environment are more likely to succeed when market disruption occurs. The pace and complexity of the transformation requires also a sense of urgency, because failing to react fast enough may come with a compounding set of risks and challenges that is hard to overcome.

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APPENDIX A: INTERVIEW GUIDE DIGITAL DISRUPTION

Expectations and Semantics

1. How does your organization define *Digitization*?
2. What impact do you expect digitization will have on your industry?

Technological solutions and services

3. Which new digital technology will most likely disrupt your industry?
4. Does your organization plan to invest / or already using new digital technology?

Stakeholders

5. Have you identified any new stakeholders in the digital landscape?
6. Has any current stakeholder changed their role due to the digital disruption?

Talent and skill set

7. Have your organization identified competences and skill set needed?
8. Does your organization have the adequate competence and skill set?

Business model and strategy

9. What new values does your organization identify because of digitization?
10. Have your organization set any strategies to harness the value?
11. Does your organization have a clear strategy or process for innovation?
12. Does your organization have a strategy to acquire and retain necessary competences?

Risks and opportunities

13. What main challenges do you expect the organization is facing going forward?
14. Are there any other opportunities that may emerge?