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Encourage risk and optimise the competitiveness of the Norwegian petroleum industry through a government digitalisation platform

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Preface

First, I would like to thank David Häger for a rewarding discussion that inspired the work for this thesis. The openness and willingness to help will leave me forever grateful.

Next, I would like to thank Ole Morten Isdahl for listening to my ideas and giving useful feedback throughout the work on the thesis.

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Abstract

Digital transformation is changing society as we know it. Business models for companies delivering consumer products has been changing for years, and we are seeing an increasing focus to do the same in traditional industries. National strategies for digital transformation were explored and the platforms established by the governments were investigated. The strategies originated from large economies like the USA, China, Germany, Japan and Sweden, involving broad spectre of different economies. The national strategies were found to build on the strengths of the traditional industry, with a focus on supporting and strengthening the small and medium enterprises in the countries. There was also found to be a strong focus on international cooperation, even between nations that may be considered competitors within the same industries. After exploring these national strategies and platforms, it is concluded that Norway should make an effort to mirror the initiatives taken by these countries. There should be a focus on a national platform to both facilitate for national cooperation and support to SMEs, while also being a gathering point to unite a Norwegian industry for international cooperation. As the petroleum industry is one of the most important industries in Norway, efforts should be made to strengthen the competitiveness of this with regards to digital transformation.

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Nomenclature

API	Application Programming Interface
BCG	Boston Consulting Group
BDA	Big Data Analytics
CM25	Chinese Manufacturing 2025
IIC	Industrial Internet Consortium
IIoT	Industrial Internet of Things
IT	Information Technology
NCS	Norwegian Continental Shelf
OG21	Oil and Gas in the 21st century
SMEs	Small and Medium-sized Enterprises

1 Introduction

1.1 Motivation

Digital technology has been transforming the world as we know it for years now. Digitising and digitalisation of processes has gone from making menial tasks easier to changing the way we interact and how we consume goods from the market. Some industries have embraced the digital transformation and how they change business models. A popular example is Netflix, and how they went from being a mail order DVD business to providing on-demand streaming over the internet. As a result, the business is thriving. On the other hand, you have Blockbuster, an old giant in the entertainment business. Blockbuster failed recognise the digital trends in the market, and this eventually led to its downfall, not being able to compete with businesses like Netflix. We may observe the transformation of other business segments as well through digital technology. Airbnb has changed the interaction of customers and hospitality providers, disrupting the hotel business across the world. Similarly, Uber has caused major disruptions in transportation throughout the world by connecting customers and drivers together using technology. Soon, we may see even larger changes in the way we are transported, through automated vehicles like cars and busses. Even the food business is seeing changes due to technological advancements. Services like Uber Eats, Foodora and Wolt are connecting customers, couriers and restaurants, bringing the restaurant experience to people's homes and creating new business opportunities.

The digital transformation of the society is increasingly being embraced by traditional industries. World leading economies are disrupting their old ways of working to be at the forefront of new technology, to not be the Blockbuster of industry, but rather the Netflix. In recent years, we have also seen the petroleum industry start to put efforts in to join the digital transformation.

1.2 Defining and limiting scope

The current digitalisation trend is broad and spans over a multitude of business areas and industries. It is likely it will erase traditional boundaries between industries as we know them today. Aspects discussed in this thesis could likely be considered for several industries. The main focus of the thesis is the Norwegian industry, and specifically the petroleum industry. An industry that has

traditionally had a conservative approach to disruptive changes. Why change what is not broken? This thesis aims to answer the following question:

> *How does Norway's effort to digitally transform its' industry compare to the strategies and platforms of other nationalities?*

2 Literature review

This chapter will give a brief introduction to the history of the Norwegian petroleum industry, followed by a summary of the strategy by the Oil and Gas in the 21st century. Next, industry 4.0 and some of the most important technologies to realise the next industrial revolution will be gone through, before presenting some national strategies and digitalisation platforms from some of the leading economies in the world. Finally, two frameworks to digital transform a business are presented.

2.1 Brief history of the Norwegian petroleum industry

Norwegian petroleum history can be traced back to 1959, when gas was found in Groningen, the Netherlands (Regjeringen, 2016). This led to a belief that there could be hydrocarbons in the North Sea. In 1963 the Norwegian government came with new regulations where it was decided that the State was the owner of any natural resources on the Norwegian Continental Shelf (NCS). Authorization to award licences for exploration and production was held by the government. In 1965, Norway reached an agreement to divide the continental shelf according to the mid line principle with Denmark and Great Britain, and shortly after the first round of licensing was announced.

The first exploration wells were drilled in 1966 by Esso (Smith-Solbakken & Ryggvik, 2017). In 1969, Phillips Petroleum found the first viable oil field, which was named Ekofisk. Development of the NCS was dominated by foreign companies in the start, but the Norwegian government wanted to establish a Norwegian petroleum industry. An important step towards this was the founding of Statoil in 1972, where the state initially was the sole owner. In the beginning the company was awarded a 50 per cent share in all licences. In 1974 Statfjord was discovered, where Mobil was to be the main operator, but they were also to train Statoil to eventually take over as operator. The Norwegian petroleum industry grew steadily from here, where Statoil became the most dominant operator on the NCS. Today, the petroleum industry is Norway's most important industry.

The major drop in oil price in 2014 (see Figure 2.1) was a major crisis for the Norwegian petroleum industry. Years of high oil prices had seen the activity on the NCS in rapid growth (Blomgren, 2017). Statoil announced in February 2014 that they needed to cut cost, which affected both Statoil and the service companies in the industry. Numbers from 2016 showed a decline of over 38 000 employees in the industry after the crisis.

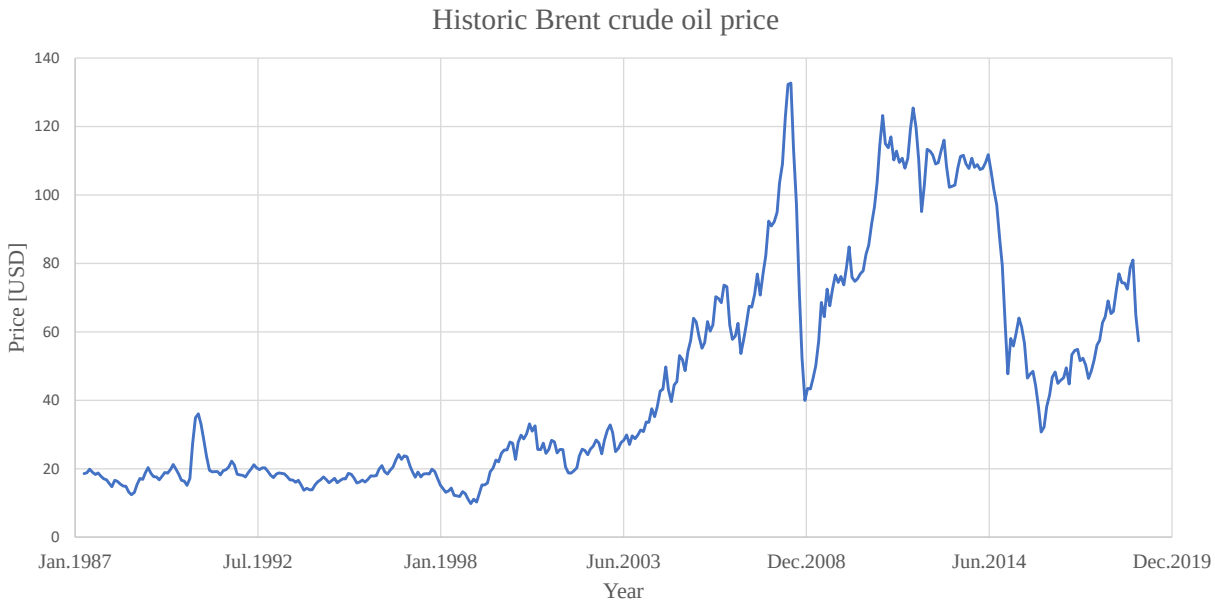

Figure 2.1 A graph showing the historic monthly average price of Brent crude oil (U.S. Energy Information Administration, 2019)

This recent oil crisis has sparked an increased interest in digitalisation, or digital transformations, in the petroleum industry. The petroleum industry is not only facing a higher pressure to reduce costs, but the negative effects to the environment from hydrocarbon are increasingly brought to focus in politics and media. Digitalisation is seen as one of the tools that may help tackling some of the challenges that the petroleum industry is currently facing, especially to reduce cost and to reduce CO2 emissions.

2.2 Oil and gas in the 21st century (OG21)

As the focus of this thesis is the Norwegian petroleum industry, the strategy put forth by Oil and gas for the 21st century (OG21) should be the starting point. OG21 was established by the Ministry

of Petroleum and Energy in 2001 (Regjeringen, 2014). It is a collaboration between operators, universities, research organisations, service companies and the government to develop and implement national technology strategy for the Norwegian petroleum industry. From the foundation in 2001, OG21 has released a national technology strategy every fifth year, with the most recent being in 2016 (OG21, 2016).

2.2.1 Strategy, vision and objectives

The strategy put forth by OG21 will contribute to the following (OG21, 2016):

- Efficient and environmentally friendly value creation from the Norwegian continental shelf for several generations.
- Development of world class petroleum expertise and industry enterprises.

Following this, the overall vision of OG21 is: "Technologies and innovation for a competitive Norwegian petroleum sector" (OG21, 2016). This vision reflects the underlying goal of the OG21 to secure the competitiveness of the Norwegian Continental Shelf and the Norwegian based supplier industry through the development of technology. OG21 has five strategic objectives that will support the vision:

1. Maximize resource utilization
2. Minimize environmental impact
3. Improve productivity and reduce costs
4. Develop innovative technologies
5. Attract, develop and retain the best talents

In the OG21 strategy document from 2016 (OG21, 2016), the digitalization needs for the industry is identified as follows: "Enabling automation, autonomy and ICT-technologies for all petroleum industry disciplines. The technology needs reach across data acquisition, data management, data quality, data integration, decision support and data security." The document also highlights the increased focus on digitalization in other industries, and a need and opportunity to learn from these industries.

2.3 Digitalisation

This subchapter will clarify the terms *digitisation*, *digitalisation* and *digital transformation*. In Norwegian literature, white papers and information from different industries the term digitalisation is often used, while in international literature the term digital transformation usually refers to the same thing.

2.3.1 Digitisation

The Oxford Dictionary of English (2010) defines the word digitisation as: "the conversion of text, pictures, or sound into a digital form than can be processed by a computer". The definition of digitisation is pretty straight forward, it is simply the transformation of a media from the physical domain into the digital domain. Efforts to digitise the petroleum industry can be traced back to the early 60s, where efforts were made to digitise the data from well logs (Gordon, 1962; Tixier, Eaton, Tanguy & Biggs, 1965).

2.3.2 Digitalisation and digital transformation

The Norwegian definition of digitalisation reads: "to facilitate for generation of digital data, and to manage and utilize this data" (Dvergsdal, 2016). There is no set standard of what is and is not digitalisation or digital transformation. What is included in the digital transformation of a business will vary between different companies and different industries, and it is imply the use of digital technology to change how a business works or operates. One of the earliest examples of an industry that started their digitalisation is the telecommunication business. The development of a digital network for cell phone signals started as early as 1982 by the Groupe Spécial Mobile (GSM), from which the network got its name, a group established by CEPT (Conférence Européenne des Administrations des Pstes et des Télécommunications) (Eberspächer, Bettstetter & Vögel, 2008, p.5). The new network was implemented commercially in 1992 and was a huge success. By 2008 the GSM network had a market share of over 81%. The new digital network greatly increased the capacity of data that could be transmitted, allowing for features like Short Message Service (SMS) and mail on cell phones. The GSM network transformed the telecommunication business, paving the way for new technologies such as handheld devices like smartphones and tablets, and the long

awaited 5G technology is seen as an essential part to realise the digital transformation of our society.

2.4 Industry 4.0

Industry 4.0 is a term first presented at the Hannover Fair in 2011 (Drath & Horch, 2014). The vision is that the use of cyber-physical systems (CPS) and cyber-physical production systems (CPPS) will lead to similar disruptions in the industries as the previous industrial revolutions did, see Figure 2.2. The first industrial revolution started in 1784 with the use of water- and steam powered engines. This led to manufacturing being moved from private homes into factories, resulting in a significant increase of production levels. The second industrial revolution followed in the start of the 20th century, with the use of electricity to create assembly lines. The first use of assembly lines was in the slaughterhouses in Cincinnati, Ohio, but the most famous example of assembly lines revolutionising an industry is probably the production of the Ford Model T in the US. The third revolution was ushered in by the first programmable logic controller (PLC) in the 1970s (Kagermann, Helbig, Hellinger, & Wahlster, 2013). This made it possible to use electronics and information technology (IT) to automate the manufacturing processes. The fourth industrial revolution will build on the technologies used in the third one, where everything will be connected to the internet, which was made possible by the introduction of the IPv6 technology.

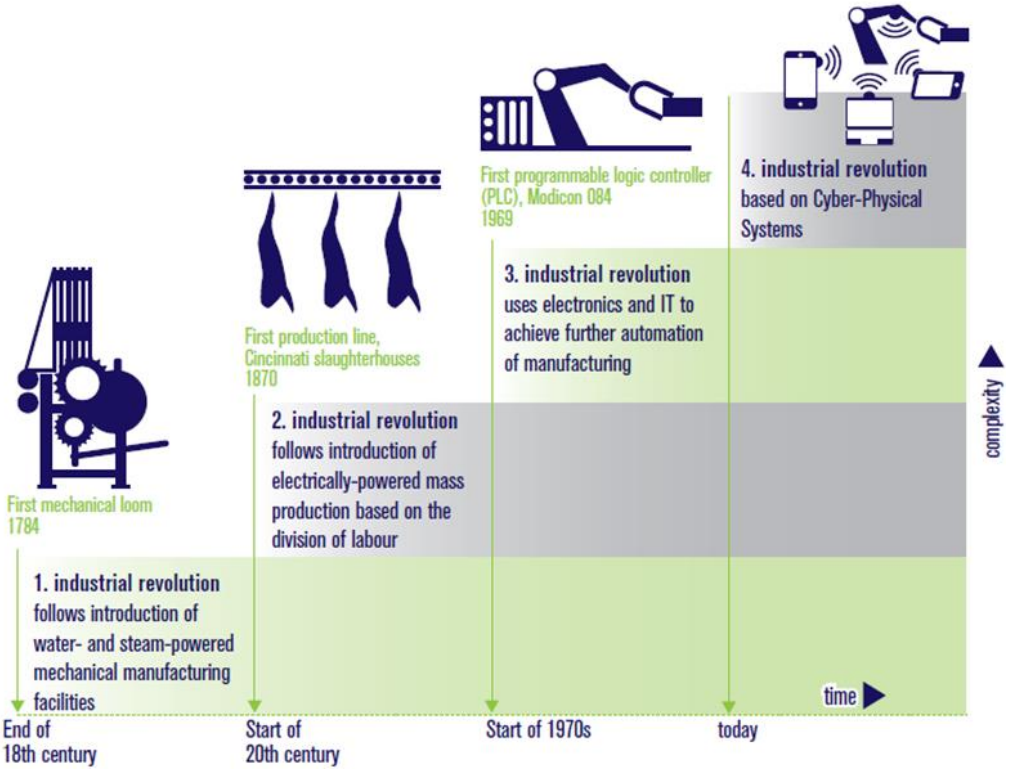

Figure 2.2 The different industrial revolutions as presented by Kagermann et al. (2013).

In 2013 a working group, funded by the federal ministry of education and research in Germany, released the final recommendation for implementing the Industry 4.0 (Kagermann et al, 2013). It envisions the use of smart factories where production can be tailored to each customer's needs. Furthermore, dynamic business and engineering models will make changes easier throughout the production process. Industry 4.0 is also seen as a tool that will help solve challenges we are currently facing, like resource and energy efficiency, urban production and demographic changes. Germany aims to remain a global market leadership by integrating information and communication technology (ICT) while simultaneously creating a market for CPS technologies and products.

The Boston Consulting Group has identified nine technologies that they believe will be the building blocks of Industry 4.0 (BCG, n.d.), an overview of these technologies can be seen in Figure 2.3.

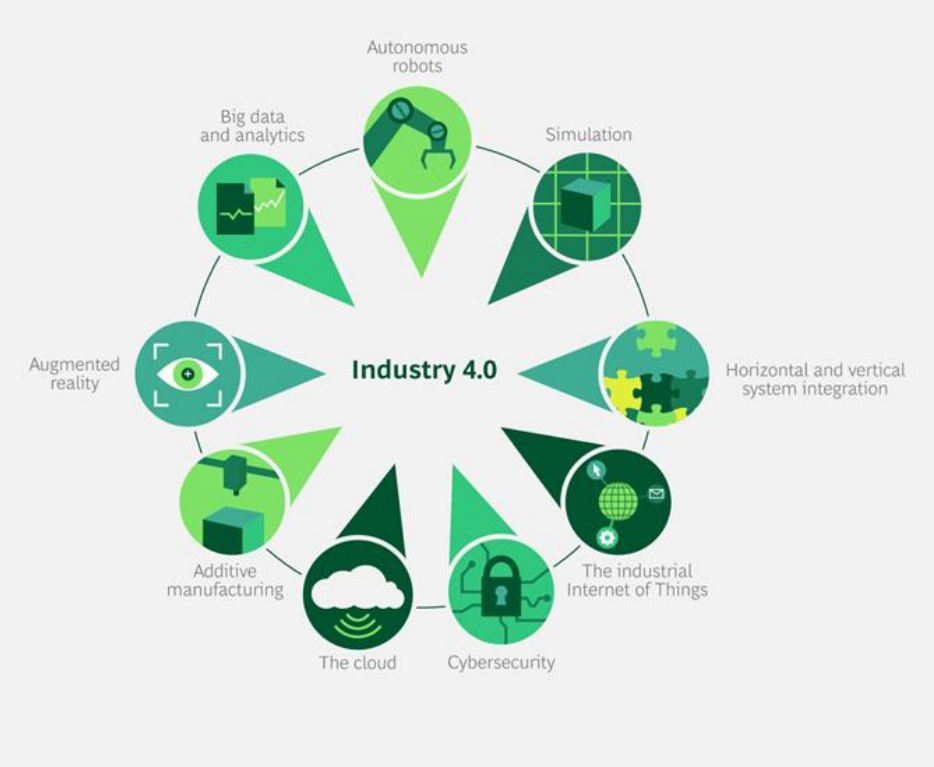

Figure 2.3 The nine technologies that are transforming industrial production, as presented by BCG (BCG, n.d.)

2.4.1 Big data and predictive analytics

Big data and predictive analytics are terms that are used to describe techniques that manage data generation defined by high volume, velocity and variety (Gunasekaran et al., 2017). In addition to volume, velocity and variety, the characteristics veracity and value may also be added, where the terms are referred to as the 5 V data-related dimensions (Wamba et al., 2016). The rate of data generation is increasing like never before (Santos et al., 2017). More and more devices and sensors are interconnected through what is called the internet of things (IoT) (Frank, Dalenogare, & Ayala, 2019). Big data and analytics are seen as some of the building blocks enabling the creation of cyber-physicals systems, which is essential for the realisation of Industry 4.0. The source of data created by networks of sensors embedded in things like smartphones and cars are seen as an enabler for companies and factories to the era of big data (Santos et al., 2017). Big data analytics has already been seen to increase revenue for companies (Wamba et al., 2016). Two examples of use in industries are Amazon and GE, where Amazon uses BDA to generate personalised purchase recommendations and GE plan to use BDA to improve efficiency of gas turbines.

2.4.2 Autonomous robots

Industry 4.0 will bring on a new level of sociotechnical interaction between all stages in manufacturing (Kagermann et al., 2014). An essential piece to make this happen is autonomous robots, where they are able to control themselves, may react to different situations, may configure themselves, are knowledge-based and are equipped with sensors. Autonomous systems are seen as essential to make the CPS and smart factories of Industry 4.0 work (Darth and Hoch, 2014). Automated robots are one of the main components of the previous industrial revolutions, and further development of these in to autonomous robots will be an important building block of Industry 4.0 through increased interconnectivity.

2.4.3 Simulation

Explanatory models will be required to manage the complex systems introduced in Industry 4.0 (Kagermann et al., 2014). One way of obtaining these models are through simulations. The increasing pace of digitalisation and expanding networks will see an increase in actor- and sensor data (Lasi et al., 2014). This will drive new technology and enable simulated output from the digital world (Hermann et al., 2016). One such technology is the creation of a digital twin of the physical product (Qi & Tao, 2018). The digital twin will act as a simulation of the finished product in the design phase, where it will be a representation of the vision of the product while simultaneously having the constraints of the real world. The digital twin will follow the whole lifecycle of the product and be continuously updated with data from the physical product. This allows for simulations to be run when testing the product for new environments and gives a detailed representation of status of the product. On the NCS, both Equinor and Aker BP are currently exploring the possibilities of digital twins (Equinor, n.d.; Loen, 2018). For Equinor, Johan Sverdrup will be the first field in production with a digital twin of the field, allowing for continuous update of the model using sensor and real time data from the field. Kagerman et al. (2014) raises concerns about the need for qualified engineers in SMEs, where the role of the engineers often can be more specialised, and the need to provide these with tools to keep up with the changes.

2.4.4 Horizontal and vertical system integration

Horizontal and vertical system integration are also seen as essential parts to realise Industry 4.0. In this context, Kagerman et al. (2014) defines horizontal system integration in the context of production and automation engineering and IT as "the integration of IT systems sued in different stages of the manufacturing and business processes that involve an exchange of materials, energy and information both within a company and between several different companies". Vertical system integration refers to the IT systems at different hierarchical levels, ranging from actuators and sensors up to corporate planning levels. The goal of both horizontal and vertical system integrations is ultimately to deliver end-to-end solutions.

2.4.5 The industrial internet of things

The term industrial internet of things may be a bit confusing. In the US, the fourth industrial revolution, Industry 4.0, is often referred to as the Industrial Internet of Things, a name given by GE (Drath & Horch, 2014). While in the context of Industry 4.0, it is a sub-category of the industrial revolution where machines and goods in the manufacturing processes are able to communicate with each other. It is seen as one of the main enablers to achieve the interconnectivity required (Kagerman et al., 2013). Kagerman et al. (2013) calls it the internet of things and services, where everything is connected through the internet and combines to create smart factories. These factories will be able to track products throughout the value chain and the products themselves will be able to control their own manufacturing and be able to recognise wear and tear throughout life cycle once completed.

2.4.6 Cybersecurity

While cyber-security already is an important factor for any company today, it will be even more so when different managerial and manufacturing processes are connected through the web. Cyber-security is an important focus point identified by Kagerman et al. (2013), where the goal of these security measures is to increase confidentiality, integrity and availability of data and operations.

A recent case that illustrates the importance of cyber-security very well is the virus attack on Norsk Hydro in March 2019 (Brekke, 2019). Norsk hydro was attacked by a ransom virus that encrypted

some of their data and required a payment to decrypt the data. This led to the employees not being allowed to log on to their network, and most of the production was run in manual mode, wherever they were able to so. The media speculates that Hydro might have experienced losses up to 350 million Norwegian krone.

2.4.7 The cloud

Connectivity to the cloud is seen as an essential requirement for the CPS to function properly (Drath & Horch, 2014). Cloud computing will enable powerful and accurate data and service through integration with the web (Lu, 2017). All the technologies that form the foundation for Industry 4.0 function closely together, and one enables the use of the other. The internet of things and interconnectivity it supplies is an important service to enable the use of the cloud. The cloud will unlock large capabilities of analysing data, and paves way for new technologies like machine learning, and incorporates well with big data analysis. Cloud computing enables coordination and integration of geographically dispersed activities (Götz & Jankowska, 2017).

In the Norwegian petroleum industry, some of the big operators are already showing clear intentions to embrace this technology. Equinor signed a partnership agreement with Microsoft, where they aim to work closely in developing new technology (Equinor, 2018). Similarly, Aker BP is working closely with Google and Cognite in developing cloud-based services in the petroleum industry (Aker BP, 2018).

2.4.8 Additive manufacturing

Additive manufacturing was formerly known as 3D printing (Thiesse et al., 2015). It is also seen as one of the corner stones for the next industrial revolution. Additive manufacturing will provide several advantages over conventional manufacturing, offering increased flexibility and efficiency. Additive manufacturing will provide many new benefits, like being able to generate objects that was impossible before. This also includes preparing the tools required for the production, in addition to the production. Another is the substitution of human labour through automation, allowing for efficiency increases. It will also allow for a higher customisation of products, where the products may be made to order by the customer.

2.4.9 Augmented reality

Augmented reality uses computer generated information to enhance the real world (Paelke, 2014). This is done through the use of either handheld devices, like smartphones and tablets, or through specialist glasses, where a camera is used to project graphical interfaces to the user's screen or glasses. Technology advances within handheld devices has made this technology viable in recent years, even though there has been research done on it for decades. Augmented reality is seen as essential to empower the workers in industry 4.0 (Gorecky, Schmitt, Loskyll, & Zühlke, 2014). It will allow the worker to interact with the CPS in a world where the worker has taken a more supervisory role over the automated production.

2.5 National strategies for digital transformation

This subchapter is dedicated to presenting some national strategies for digital transformation in some of the largest economies in the world, and also from Norway's closest neighbour, Sweden.

2.5.1 Germany and Plattform Industrie 4.0

As mentioned in the start of chapter 2.4, Industry 4.0 originated in Germany, and Plattform Industrie 4.0 is official name of the initiative of the Federal Ministry for Economic affairs and Energy and the Federal Ministry of Education and Research in Germany for implementation and execution of the platform (Plattform Industrie 4.0, 2019). Plattform Industrie 4.0 brings together over 150 organisations, with the governmental branches mentioned previously are at the head, where they discuss issues surrounding industry 4.0 and its' role in digital transformation, see Figure 2.4 for the complete structure of the platform. In its' current iteration, the platform works towards realising three objectives:

1. Developing visionary concepts and solutions to implement Industry 4.0.
2. Stimulating digitisation in industry through national and international cooperation,
3. Supporting SMEs in turning ideas into practice.

The first objective is covered by the six working groups, where they work to address topics like standardisation, cyber-security, legal frameworks, education, digital business models, etc. The

second objective is also important, especially for the fields of standardisation, cyber-security and legal framework, where international cooperation with some of the world's largest economies are central. The third objective has been worked with since the initial introduction of Industry 4.0, where Kagerman et al. (2013) underlined the importance of supporting SMEs. This remains a focal point in the latest iteration with a focus on providing information and networking services to SMEs to help managers find the right services to implement Industry 4.0 solutions.

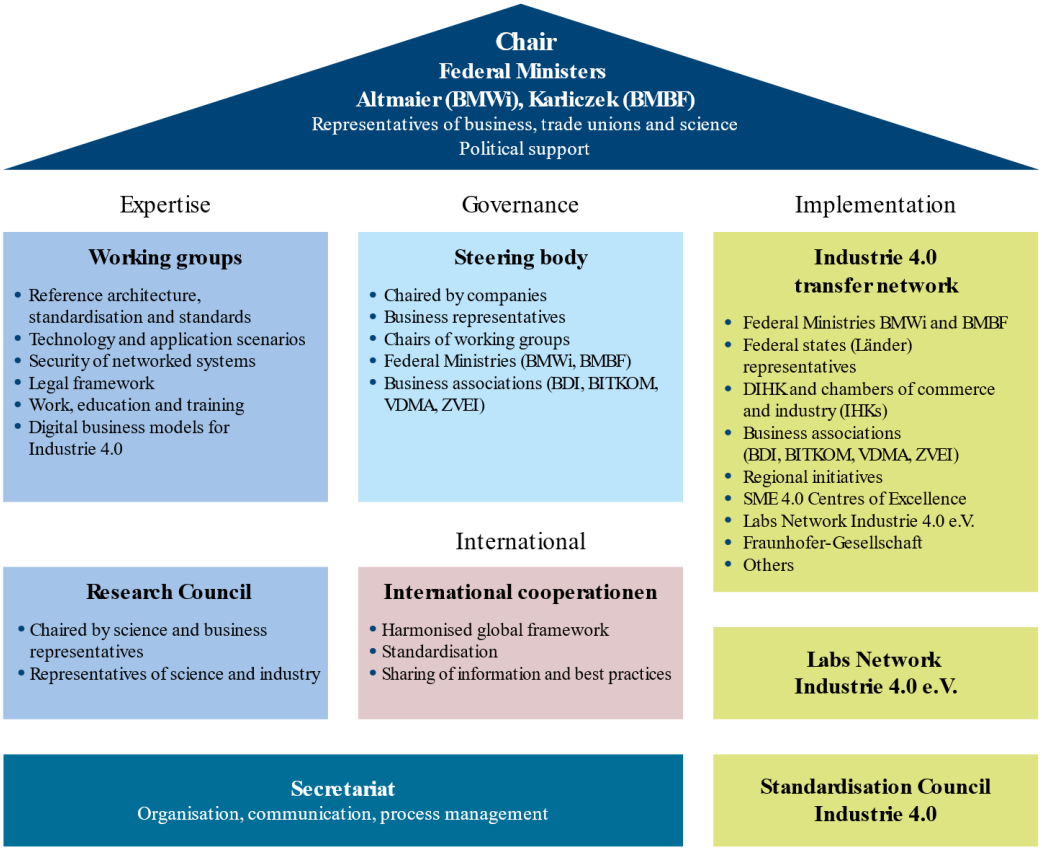

Figure 2.4 The working structure of Plattform Industrie 4.0 (Plattform Industrie 4.0, 2019).

At the end of 2018 the Federal Ministry for Economic Affairs and Energy released a national strategy for the German industry, called "National Industrial Strategy 2030" (BMWi, 2018). This strategy aims to secure and reinstate Germany as leader in technology and the global economy. The strategy will strengthen and keep a competitive edge in the areas where German industry already excel. The strategic document highlights several challenges, one of which German industry's lead in technology and quality. A major concern here is that countries with lower wages and production costs are catching up in terms of technology and quality. Another concern is the

financial backing of innovative start-ups by American companies, which eventually lead to these companies moving to the US and becoming USA-based. The strategic document also refers to studies about the future of jobs, where they say that the numbers of jobs will increase as a result of the digital transformation, but a large number of jobs will be affected and possibly perish. It is also highlighted that these new jobs may not be created in the country where the old ones were lost. As such, it is important for Germany to get a leading position in the digital transformation to retain these jobs.

2.5.2 USA and the Industrial Internet Consortium (IIC)

While the Industrial Internet Consortium (IIC) does not represent a national strategy from the USA, it was founded by major technological companies from the US and will be included here as an example of a strategic approach to the industrial revolution originating from the USA. The IIC was founded by the American companies AT&T, Cisco, General Electric, IBM and Intel (IIC, 2014). IIC is an organisation that evaluates and organises existing standards, where the goal ultimately is cooperation between membership organisation to reduce duplicate efforts. Membership count had grown to 56 in June 2014, and as of today there are over 250 member organisations from 31 countries in the IIC (IIC,2018). Much like the Plattform Industrie 4.0, the IIC consist of a steering committee governing over several working groups (Diab, 2017), their interactions can be seen in Figure 2.5.

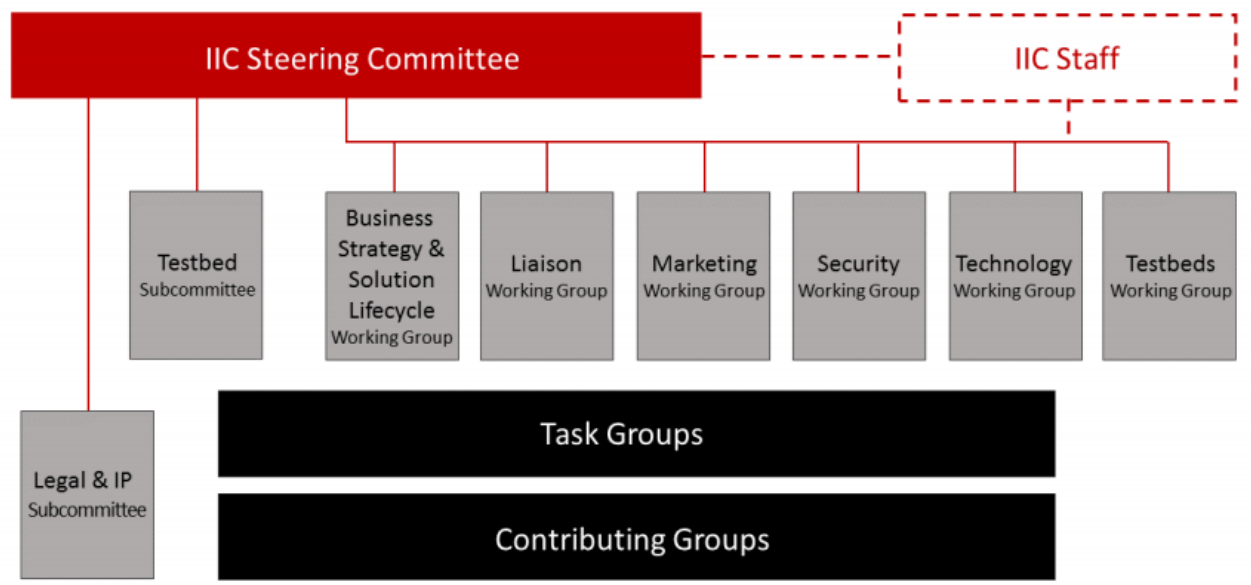

Figure 2.5 Overview of the organisational structure of the IIC (Diab, 2017)

The Business Strategy & Solution Lifecycle working group released a framework to help businesses adapt to the Industrial Internet of Things (IIoT) (IIC, 2016). The framework highlights the importance of collaboration between companies and the new skills in the era of IIoT and businesses needs to comprehend and embrace the new changes, where strategy and goals for the IIoT adaption are seen as essential to balance the risks of being a market leader and a late adopter. Much like their German counter part, IIC are concerned with smaller businesses that might not have the expertise, or the ability to acquire the expertise, required to implement IIoT technologies. The importance of a collaborative networks like IIC or Plattform Industrie 4.0 are then underlined, where there is also a possibility to develop skills that are useful across different industries and might introduce a business to new opportunities. The 1st of April 2019 IIC announced a closer collaboration with Plattform Industrie 4.0 (IIC, 2019).

2.5.3 Japan and society 5.0

Contrary to Germany and the Plattform Industrie 4.0, Japan does not have a national strategy that revolves around its industry, but a strategy that puts the individual in the centre, which they have named Society 5.0 (JapanGov, n.d.). The Japanese government envisions the use of the same technologies that prevail in Industry 4.0 and the IIoT to form the newest iteration of its society. The first for iterations of the society was the hunter-gatherer society (1.0), agrarian society (2.0),

industrial society (3.0) and the information society (4.0). We find that the industrial society, Society 3.0, build on the same technologies as the second industrial revolution, and likewise the information society, society 4.0, relied on the same technologies as the third industrial revolution. Just like the fourth industrial revolution builds on the technologies in the third industrial revolution, Society 5.0 will build on the technologies from Society 4.0.

As a step towards realising Society 5.0, however, the Ministry of Economy, Trade and Industry (METI) in Japan has released a concept framework called "Connected Industries" (METI, 2017). They have identified five fields where their efforts will be prioritised. First, automated driving and mobility service. This field is seen as an essential part of realising Society 5.0 through reduction of car accident, better traffic flow, less environmental load, and increased mobility for individuals with historical low mobility, like elderly and other vulnerable individuals. The effort will also strengthen the important automotive industry in Japan. Second, the field of manufacturing and robots. Just like Germany, Japan aims to strengthen value creation in the fields where they already excel. There are some important points here, that underlines the similarities to Plattform Industrie 4.0, like work towards international standards, cybersecurity, cooperation, human development, and especially the desire to facilitate for SMEs to introduce digital technologies to their business. The last three fields are biotechnologies and materials, plant/infrastructure safety management, and smart life. Common denominators for all the field are the desire to work on international standards, data cooperation and cybersecurity. International cooperation is valued highly, and cooperation with European countries, Asian countries and the US are underlined as important efforts to achieve international standardisation.

2.5.4 China and Made in China 2025 (MIC25)

In 2015 China released their ten-year strategy as a road map for the Chinese manufacturing industry, called Made in China 2025 (State Council of People's Republic of China, 2017). The strategy aims to transform the Chinese manufacturing to better handle the pressure of cheap labours from other emerging economies while simultaneously close the gap to the more advanced technological economies like Japan, Germany and the USA. In their strategy, the Chinese government highlights ten industries where efforts should be focused. Ultimately, the goal of the plan is to facilitate for innovation and research while building green and smart industries, and to

also increase the quality of domestic brands and products. China has historically been a major producer of consumer goods, but the equipment used to manufacture these has usually been brought in from foreign countries, and China now aims to not only provide this equipment domestically, but to also export it. The Chinese strategy is heavily influenced by the German Industry 4.0, and both countries have shown willingness to share ideas and equipment to usher in a new era in manufacturing. Just like Plattform Industrie 4.0, the Chinese companies are encouraged to cooperate to help SMEs to integrate new technology solutions, as a goal to optimise supply.

2.5.5 Sweden and Produktion2030

The Swedish government agency Vinnova launched a strategic innovation programme named Produktion2030 (Vinnova, n.d.-a). The goal of this programme is to develop the Swedish industry, where it acts as a national base of research, innovation and training. Currently, over 250 companies, research agencies and organisations support Produktion2030 (Produktion2030, n.d.). A strategic agenda has been released by Vinnova, outlining the vision for the Swedish industry and recommendations for long term efforts to realise these (Vinnova, n.d.-b). Sweden aims to build on the already competitive manufacturing industry that has made a shift from mass production over to flexible manufacturing of advanced goods and services. Strong ties between the industry, academia and research institutes are seen as an important asset for the strengthening of Swedish industry. Six key areas are identified in the strategic agenda to strengthen the Swedish production in 2030. These are: environmentally sustainable production (1), flexible manufacturing processes (2), virtual production development and simulation (3), human-centred production system (4), product- and production-based services (5), and integrated product and production development (6). The agenda also identifies five key instruments to structure the programme of production around: research and innovation projects (1), knowledge and technology transfer to SMEs (2), education (3), mobility (4), and internationalisation (5). These instruments are similar to focus points identified by the other national, or consortium, strategies. Of particular interest is the focus on involving SMEs and enable them to participate in the high-tech production and the focus on internationalisation. Cooperation has been identified as a key value driver by many of the strategies, and this holds true for the Swedish one as well. The agenda highlights the need to focus on developing cooperation in research and innovation to strengthen Swedish industry.

2.6 Digital transformation strategy

In 2015 MIT Sloan Management Review and Deloitte performed a study on global digital businesses and their transformation strategies (Kane, Palmer, Phillips, Kiron & Buckley, 2015). The study included a survey of over 4 800 business executives, managers and analysts from worldwide businesses. Interviews with businesses were also conducted to supplement the survey. The study focuses on evaluating the digital maturity of organisations, and how the organisations differ from one another at various maturity stages. Kane et al. (2015) asked the businesses to assess their own maturity level, ranging from 1 to 10. The different levels were sorted in to three different maturity levels; early, developing and maturing, as can be observed in Figure 2.6. For businesses in the early and developing maturity levels, one of the top barriers were found to be a lack of a clear strategy for the business digital effort. The survey showed that digital mature companies were more than five times a likely to have a clear digital strategy. It also showed that digital maturing companies were more likely to encourage risk taking.

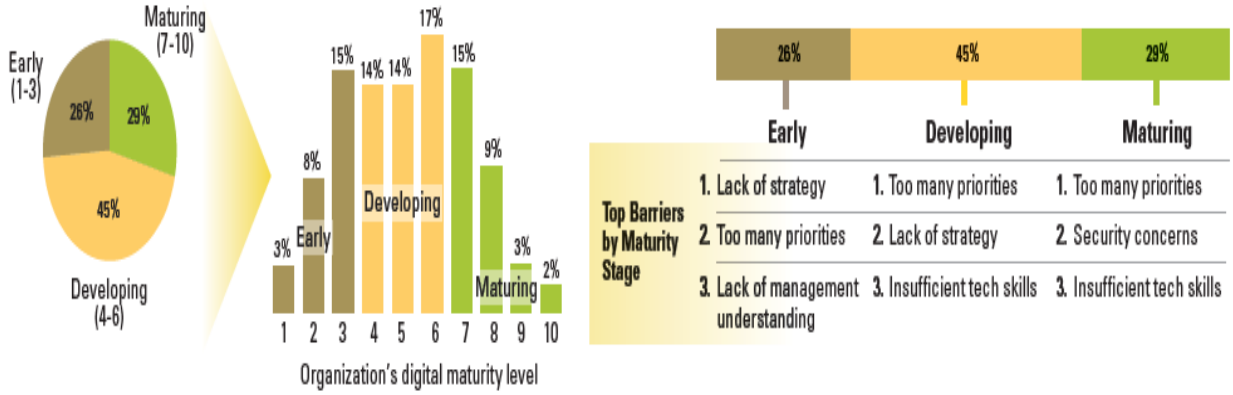

Figure 2.6 Maturity assessment of company and identification of barriers at different maturity levels (Kane et al., 2015)

Further findings showed that only 15% of the companies in the early stages of digital maturity had an established digital strategy (Kane et al., 2015). For more mature companies, on the other hand, the number increased to 81%. The employees knowledge of the digital efforts in the companies were also seen to increase in the more digital mature companies. An important finding in the research of Kane et al. (2015) is how the companies in the early stages of digital maturity often find themselves focusing on the implementation of specific technologies, instead of focusing on

implementing a digital strategy. The more digital mature companies use technology as a means to reach their strategic goals. Close to 90% of the respondents in their survey attributed the digital transformation of the company to a digital strategy.

The study performed by Kane et al. (2015) also highlights the importance of talent acquisition and development. Over 75% of the answers digital mature companies think they are able to get the required skills for the digital environment, while the number is only 19% for the low maturity companies. Retention of the talent is also an important point for digital maturing companies, and across all age groups responding to the survey 72% state they want to work for a company that is digitally advanced or leading in their market.

One final point to take from the study performed by Kane et al. (2015) is how the culture of a business is affected by the digital transformation. The survey showed that the more digital mature companies had a culture where risk taking was accepted, while for the less digital mature companies there was a fear of taking risks. A collaborating culture was also found to be important to drive innovation within a company. The combination of cross-discipline collaboration and risk taking, where managers were encouraging experimental use of digital technology, were found to be important aspects of the culture in the digital mature companies.

2.6.1 Digital strategy framework

Bharadwaj, El Sawy, Pavlou and Venkatraman (2013) explores the need for a new way of prioritising the information technology (IT) strategy of a company compared to the business strategy. Here they suggest changing the historic way of defining a company's IT strategy, called aligned view, where the IT strategy has always been subordinate to, and had to align with, the business strategy. To do this, they introduce the term digital business strategy, where the IT and business strategy are joined together as equals. Bharadwaj et al. (2013) identified four themes that they believe may act as a guide for a digital business strategy. The drivers for these four themes are shown in Figure 2.7. The four themes identified were the scope (1) and scale (2) of digital business strategy, speed of decision making (3), and sources of value creation and capture (4).

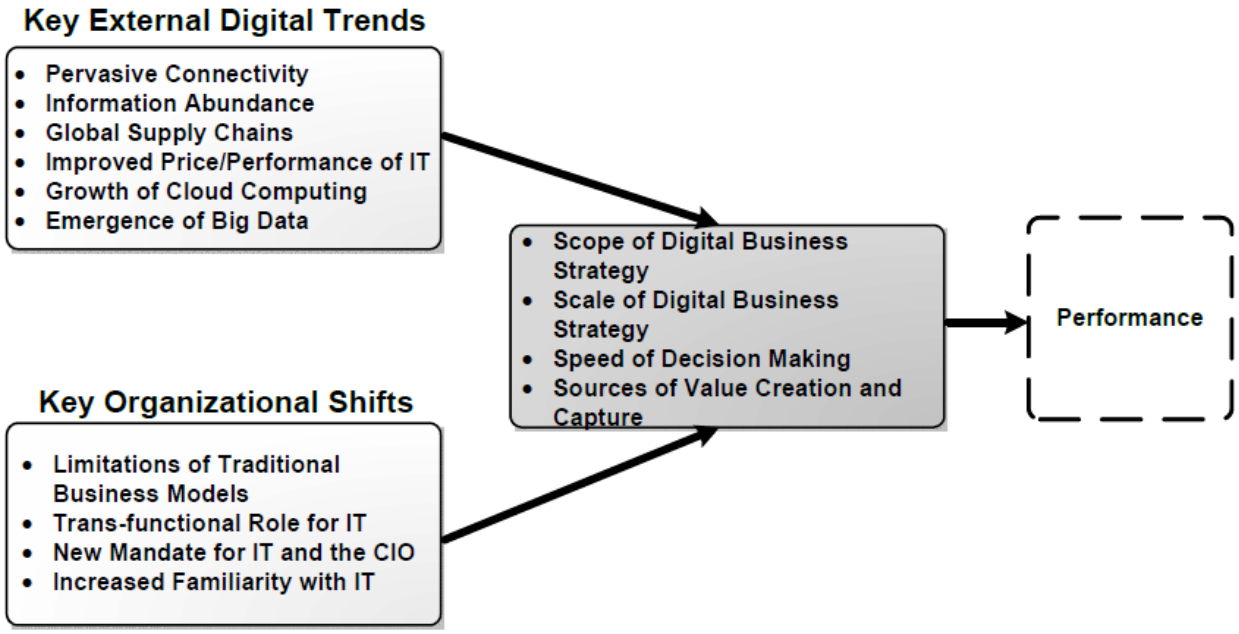

Figure 2.7 A graphical representation of how the four themes for a digital business strategy were generated (Bharadway et al., 2013).

The scope of any business' strategy is important for strategic management (Bharadway et al., 2013). While old IT strategies often had a functional approach, the new digital business strategy should reach further, across both functional areas and IT-enabled processes. As a business becomes more digital, Bharadway et al. (2013) predicts that the digital business strategy will gradually become the business strategy. An essential part of the scope of the digital business strategy is to enable digitising of products and services across business lines, where physical and digital domains become connected. Finally, the importance of the scope to transcend established boundaries in the business is highlighted. As technology is developed, new ecosystems are established and the data amount increases, sharing digital resources among partners and competitors may become fruitful.

The next theme identified by Bharadway et al. (2013) is the scale of the digital business strategy. In this setting, the meaning of scale is the benefit of lower unit cost of products. The importance of not only thinking of scale in the physical domain of production, supply chain or geographic coverage is highlighted, but also to consider scale in the digital domain. A minimum of four different ways of scale in digital business strategy was identified. The first is scale through rapid digital scale up/down as strategic dynamic capability, through the use of cloud services to let the

business quickly adapt to changes. The second is the use of network effects to create rapid scale potential, where the value of a good or service increases the more they are used by individuals. The third is the scale of data and information available, where big data and the internet of things is mentioned, and how the business needs to adapt to utilize and develop this resource. The fourth and final way is scale through alliances and partnerships, where companies should share digital assets and information when it is beneficial. Here, Bharadway et al. (2013) mentions the airline industry and the way they share reservations systems among alliances. Also, they mention how new start-ups rely on application programming interfaces (API) and web services.

The third theme is the speed of the digital business strategy, Bharadway et al. (2013) believes the time factor will become more important in the digital business strategy than it has been before. They present four ways of thinking of speed, the first of which is speed of product launches. An example used here is handheld devices like phones and computers, where companies often launch new products once a year, as hardware is continuously improving. The second way is the speed of decision making. The digitising and access to data gives businesses increased capabilities to speed up their decision making due to increased information flow across different levels of management. The third way is the speed of the supply chain, as an important driver for a competitive advantage. The fourth and final way is the speed of network formation and adaption, seen as the ability of a business to construct networks as a complimentary resource.

The final theme for the digital business strategy is sources of value creation and capture (Bharadway et al., 2013). The key points in this theme is the increased value of gathering information and tailoring products, gaining value by expanding the business model outside the conventional product lines, using networks to coordinate with other companies and the control of digital industry architecture. A common factor in this theme is to leverage the use of information, technology and infrastructure to increase value for the business.

2.6.2 Digital transformation model

Parviainen, Thinen, Kääriäinen and Teppola (2017) performed research on the digital transformation of companies. They identify three different impacts for digital transformation, as seen in Figure 2.8. The goals of digitalisation may be to increase efficiency by improving internal

procedures and working methods, pursue new external business opportunities, or to disrupt the business entirely.

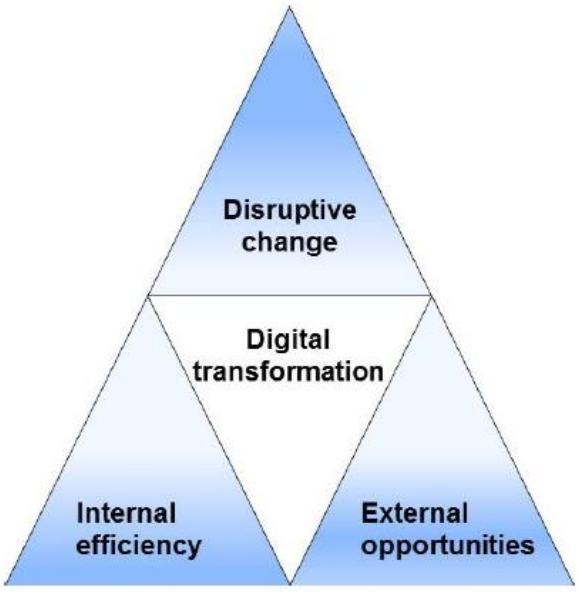

Figure 2.8 Impact of digitalisation as presented by Parviainen et al. (2017).

Through four different case studies, Parviainen et al. (2017) developed a conceptual framework to use in the digital transformation of a business. The framework is not for one specific industry but intended to be used as a general guide to digital transformation. The framework uses a four-step approach to the digital transformation, following the plan-do-check-act principles. An illustration of the framework is shown in Figure 2.9, which underlines the cyclical nature of the framework, and digitalisation in general, where continuous improvement is important.

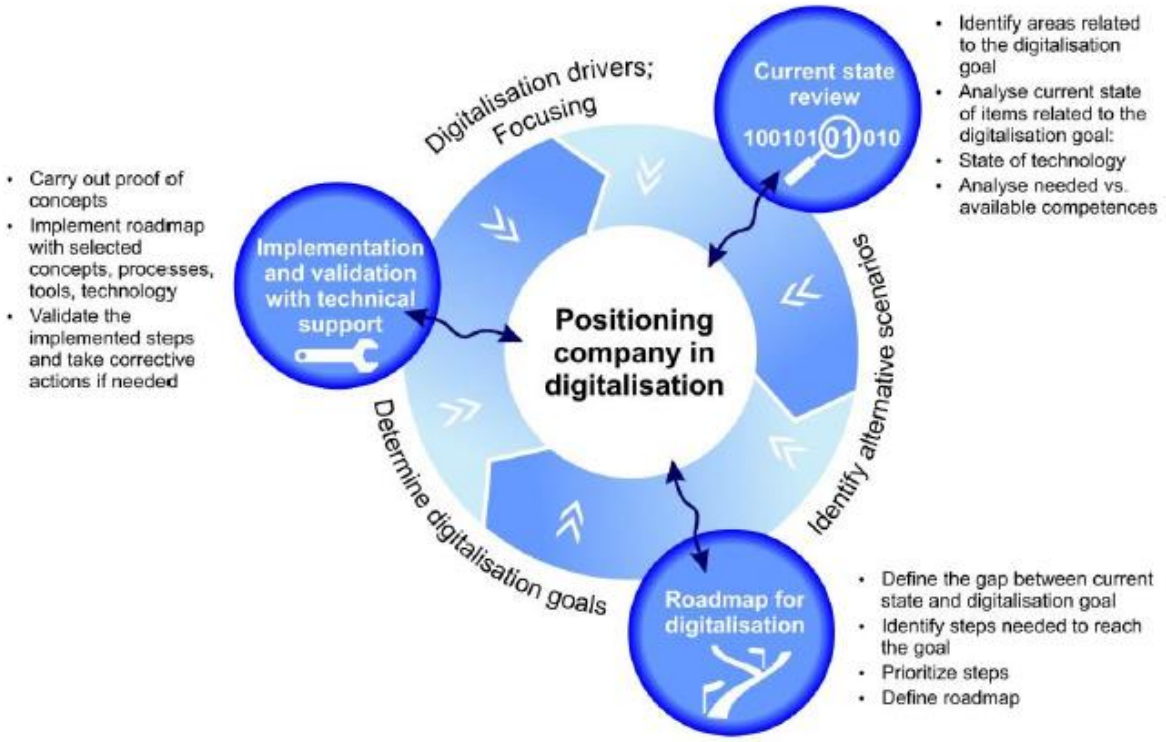

Figure 2.9 Illustration of the model to act as an aid in the digital transformation of a business (Parviainen et al., 2017).

The first step of the framework is to *position the company in digitalisation* (Parviainen et al., 2017). This involves four further steps, where digitalisation- impacts, drivers, scenarios and goals are identified. *Digitalisation impacts* are analysed to identify current and upcoming trends in digitalisation, and how these fit in with the business. The current adoption of the trends by the company should also be analysed. Building on the results from the analysis of the trends is the identification of *digitalisation drivers*. The impact the different trends will have on the company is analysed, and the importance of the individual trends should be defined. The next is to identify the *digitalisation scenarios*, where the different potential scenarios for the company's future are identified and analysed. Then cost-benefit analysis and risk analysis are done for the different scenarios. Finally, the *digitalisation goals* of the company are defined, by analysing the different scenarios and their feasibility for the company. This should result in indicators that situations and improvements may be measured against.

The second step is a *review of the current state* (Parviainen et al., 2017). This step contains two further sub-steps, where one is the analysis and identification of the impacted areas, and the second is the analysis of the situation with respect to goals. Several questions are presented as an example that should be asked and answered to help with this step, where they differ depending on if the goals for the digital transformation is to increase internal efficiency, pursue external opportunities or disruptive change of the business.

The third step presented by Parviainen et al. (2017) is a *roadmap for digitalization*. This step contains four further sub-steps, where the gap between the current state and the goal is identified, the actions to close the gaps are planned, the feasibility and prioritisation are analysed, and a roadmap is created. The *identifying the gap between the current state and goal* sub-step is straightforward and depends on which of the impacts in Figure 2.8 that is desired for the digital transformation. This may include mapping of internal states and processes for improving internal efficiency, to mapping competencies and development work for external opportunities. The further steps in this process involves identifying technology to be used and establishing key performance indicators (KPI) that progress may be measured against. Once the actions have been identified and the feasibility analysed and prioritised, the actions may be organised to a roadmap, where the order, importance and responsibilities for the actions are arranged.

The fourth and final step of the framework put forth by Parviainen et al. (2017) is *implementation with technical support*. The measures from step three is implemented, and as there may be large variations of the results from the previous steps between companies they have not provided a rigid approach for the implementation of the framework. Proof-of-concepts may be implemented in this step in the case of new product development. The importance of change management is highlighted, as a digital transformation of a company naturally involves changes.

3 Discussion

3.1 Digital21, the Norwegian national strategy

In the fall of 2018, the Norwegian minister of Trade and Industry received a proposal for a national strategy for digitalisation by the Digital21 committee, a committee that was founded in the spring of 2017 (Regjeringen, 2018). The strategy suggested 64 measures that would aid in the digitalisation of the Norwegian industry (Digital21, 2018). These 64 measures will aid in fulfilling five main tasks:

1. Establish a knowledge- and technology base and develop new business
2. Secure adequate competence
3. Make data resources available and develop business-oriented infrastructure
4. Ensure cyber security
5. Develop a national framework to stimulate innovation and digitalisation

The strategy also highlights four technology areas that are seen as important for the Norwegian industry: artificial intelligence, big data, the internet of things, and autonomous systems. The strategy acknowledges that Norway can't be the best in everything, and therefore should focus on education, research and innovation. Digital21 is to act across all Norwegian industry and business segments, both private and governmental, and cross over to the other 21- organisations (see Figure 3.1), like OG21 mentioned in chapter 2.2.

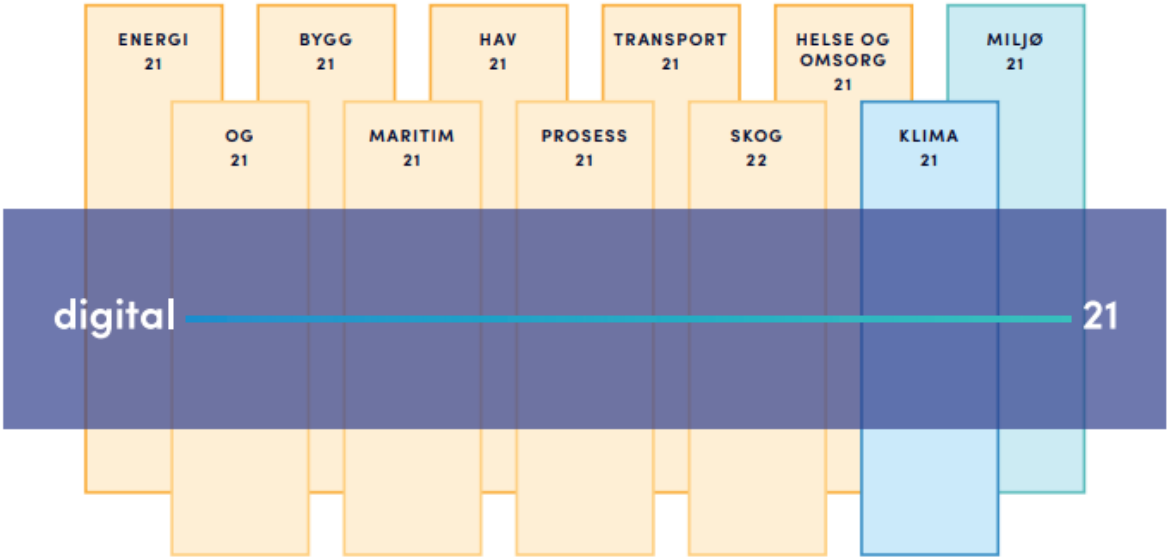

Figure 3.1 Hierarchy of the other 21-organisation (Digital21, 2018)

The Digital21 strategy acknowledges the importance of the government to be involved in the digitalisation of the industry and how important it is to work across sectors (Digital21, 2018).

3.1.1 Encourage taking risk

The approach of the Digital21 committee of focusing of some core areas of digitalisation appear to be a risk-averse approach, focusing on only a limited set of technology. The fear of failure has long been a part of the Norwegian culture. As Kagerman et al. (2013) points out, we are at the start of the fourth industrial revolution, and nothing is as hard to predict as the future. The technology we have today may develop in ways we have not foreseen. The study done by Kane et al. (2015) also underlines the importance of having a risk-taking culture for a digital mature company. For Norway to really be at the forefront of the digital transformation, it might be fruitful to encourage and facilitate for a risk-taking nature in technology development. The study by Kane et al. (2015) shows how important a culture can be for the development of a digital mature company. Germany, for example, tackles this buy offering finance support for start-ups, company growth and innovation.

3.1.2 Government involvement

The Digital21 strategy calls for more involvement from the government (Digital21, 2018). While the strategy outlines that the responsibility of the digital transformation should lie with the industry,

it recognises that the government has to be involved to shape the future of the Norwegian industry. They recommend a framework by the government that spans across different sectors, where the government may also be involved through public procurement. This way of thinking is very much in line with the strategies we see coming from most of the leading economies in the world. Germany, Japan, China, and Sweden, where the government is heavily involved and an important driving force for digital transformation of the countries' industry. Only the US stands out as the odd one out, where industrial forces themselves have taken the initiative to establish a framework for digital transformation.

3.1.3 Lack of focus on SMEs

Compared to some of the other strategies presented in this thesis, there appear to be a lack of focus on supporting the digital transformation of SMEs. The strategies for Germany, Japan and Sweden all have a heavy focus on facilitating for the digital transformation of SMEs. The SMEs are seen as an essential part of the industry, and to truly transform the society and industry it is important to support their efforts. This is further compounded through the use of government backed digital transformation platforms, like Plattform Industrie 4.0, Connected Industries and Produktion2030.

3.2 DigitalNorway

The Digital21 strategy often mentions the importance of government involvement and recommends that the government should facilitate for increased technological innovation (Digital21, 2018). Looking at some of the largest economies of the world, Germany, Japan and China, in addition to Sweden, we may observe that the governments here are heavily involved in pushing digital transformation reforms in the nations' industry. Germany have their Plattform Insdustrie 4.0, supported by the Federal Ministry for Economic Affairs and Energy and Federal Ministry of Education and Research. Japan has their Connected Industries framework to help realise their vision for Society 5.0, supported by the Ministry of Economy, Trade and Industry. Sweden are realising their Made in Sweden 2030 strategy through the governmental administrative body Vinnova that is backing the platform Produktion2030.

Norway does not have a platform that directly compares to these platforms in the other countries. The closest thing Norway has is the organisation DigitalNorway. DigitalNoray initially started as an initiative from the industry to increase the digital transformation efforts (Regjeringen, 2017). The Norwegian government announced in 2017 that they would enter into a cooperation with this initiative. As a result, it would be established as a non-profit organisation. DigitalNorway is owned by, or strategic partnerships with, some of the largest companies in Norway (DigitalNorway, n.d.) One of the main thoughts behind DigitalNorway is "To cooperate where we can, to compete where we have to". DigitalNorway will do this through facilitating for Norwegian companies to share knowledge and experience, and to help them develop the networks needed to work with digital transformation.

3.2.1 Cooperation with foreign initiatives

One important aspect that DigitalNorway seems to fall short on compared to the platforms from other countries is the focus on international cooperation, as a united Norwegian industry. The German initiative, Plattform Industrie 4.0, is cooperating with some of the countries that may be considered their fiercest competitors (Plattform Industrie 4.0, n.d.). Germany and China started their cooperation as early as in 2014, even though the emergence of a highly technical Chinese industry may be seen as one of the main competitors to the advanced western industries. Germany is also cooperating with Japan, a cooperation that started back in 2016. Last, but not least, the Plattform Industrie 4.0 is cooperating with the initiative originating from the USA, the IIC. This cooperation started in 2016 and has only grown stronger in the recent years. A major concern for all these countries has been to retain the new jobs created by the digital transformation, to make up for the jobs that may be lost.

It is apparent that international cooperation is one of the main ways to realise the digital transformation. Countries which are competitors cooperate where they can, in line with one of the base ideas of DigitalNorway. It seems fruitful that this cooperating spirit of DigitalNoray should be extended to an international level, where a united Norwegian industry may explore digital transformation and create new job opportunities in Norway, as well as participate in the standardisation of digital transformation.

3.2.2 Lack of transparency of member organisations

Observing the IIC, Plattform Industrie 4.0 and Produktion2030, they are all very open about the participating companies in the platforms. DigitalNorway, however, only lists the owners and strategic partners. To facilitate for further growth of the platform, it may be an idea to be more transparent about the participating companies. This might lower the threshold for companies to take the step to join the platform, when they see companies of similar sizes and business areas participating.

3.3 Strategic framework for SMEs

This thesis presents two different frameworks for digital transformation, one relating to the digital strategy of a company, and the other for the process of transforming the company. While it is not within the scope of this thesis to suggest a framework for digital strategy and digital transformation, they are included to underline the daunting task this may be for SMEs to venture in to. Digital transformation will change the way the businesses think and function, to the point where a digital strategy is fully incorporated and will act as the business strategy of the company. This is a huge task to take on for any company, and increasingly so the smaller the company is. Small companies may have trouble acquiring the expertise needed to perform the digital transformation. It seems prudent to develop a framework for the digital transformation of SMEs, and this responsibility should lie with the national digitalisation initiative. The focus in Norway at the moment is on the implementation of different technologies. As discussed by Kane et al. (2015), however, the focus on implementing single technologies is a sign of less digital mature companies. Therefore, there might be a need to look beyond the current technologies and try to disrupt and change old processes and ways of thinking, through changing the digital strategy of a company.

3.4 The petroleum industry

As Norway's most important export commodity, with oil and gas totalling just over 50% of the Norwegian export in 2018, it is no doubt that a thriving petroleum industry will be important for the Norwegian economy for years to come (SSB, n.d.). The points discussed in the previous chapters are valid for most industries. The strong focus on collaboration we are seeing both from other national strategy and from literature regarding digital transformation aligns well with the

historic values on the NCS. Cooperation and working towards a common good have been the backbone of Norwegian petroleum industry. A united Norwegian industry working towards digital transformation goals will be of great benefit, and the petroleum industry should focus on reducing duplicate efforts on digitalisation of the NCS.

As arguably the most important industry in Norway, the petroleum industry is uniquely positioned to push for initiatives that will both benefit themselves and the national industry. As such, it seems prudent that the industry should work towards a national platform that is able to bring Norwegian interests out to the world, collaborating with other national platforms wherever possible. The petroleum industry will also undoubtedly lose jobs to the digital transformation of businesses, and it is imperative to at the forefront of the digital development to secure the new jobs that are created by it. The speed of the digital development is unlike anything we saw in the earlier industrial revolutions and lacking a national platform that unites the industry and cooperates internationally risks Norway losing out on jobs it may elsewise have gotten.

The strategies of the other countries that were explored in this thesis revolves heavily around the strengths of their current industry. The petroleum industry in Norway is undoubtedly an important contributor to society. With emerging economies from South America, Africa and Asia the energy requirements worldwide will continue to increase, and a strong and competitive petroleum industry will continue to remain important for Norway. It may therefore be prudent for a national platform for digital transformation to build on the strengths of the petroleum industry, even though it is facing increasing pressure from a climate perspective.

4 Conclusion

The current trends from worldwide nationalities with regards to digital transformation of their industries were explored, specifically their strategic approach to digital transformation and how this is channelled through different platforms. The countries examined ranges from a capitalistic country, USA, to a socialist, China. Economies situated between to two extremes of these two countries were also investigated, namely Germany, Japan and Sweden. A common denominator for all the strategies is that they aim to build on the strengths that their industry already possesses, and compound this through the use of digital transformation. The governments of Germany, Japan and Sweden has established national platforms for digital transformation, that both acts as a unifier for the national industry and as a spearhead for international cooperation. Discussing the national strategy and platform of Norway, the following conclusions were reached:

- The government should explore the opportunity to create, or increase support to, a national platform for digitalisation, mirroring the efforts of Germany, Sweden and Japan.
- The national platform should encourage companies to take risks in the digital transformation and facilitate support to so, where there is an increased focus to support SMEs.
- A national platform for digitalisation to unite the Norwegian industry should also be explored with regards to international cooperation, to strengthen the position of Norwegian industry on an international level.
- With the value created through the petroleum industry, the industry and OG21 is uniquely positioned to push for a digitalisation platform to strengthen Norwegian industry as a whole, but also to strengthen the petroleum industry.

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