The Influence of Big Data Implementation towards Business Models in Different Sectors

Master Thesis

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TU Delft

The Influence of Big Data Implementation towards Business Models in Different Sectors

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TU Delft

Preface

This thesis is the final part of my journey in completing my master program in Management of Technology at TU Delft. Even way before starting this program, I was already in doubt of which program should I pursue. I was contemplating whether I would go with a more technical program that follows my bachelor education, or more on the management side. After some considerations, I finally chose MoT. I learned a lot of things, especially in viewing technologies from a different perspective, as what I want to pursue in the first place.

In starting this thesis, I found difficulties in selecting a topic that is feasible. Some ideas came into mind, but none of them can actually be realized. In the end, this thesis falls into my choice, of course with the support from my supervisors who kindly guided me. Before working on this thesis, I knew almost nothing about Big Data, as I was not familiar with terms related to IT in general. It opens my view on how Big Data can actually contribute to many industries, and how organizations can benefit from it.

There are some people whom I would like to thank, especially considering my challenge with all sorts of novel things. I would like to express my gratitude to Dr. Claudia Werker, my first supervisor, who gave me guidance and encouragement in completing my thesis. I was struggling at the beginning in the search of a suitable and feasible thesis topic, and she kindly guided me to develop one. I would like also to thank Dr. Scott Cunningham, who gave me very clear and guiding feedback that allows me to realize parts that need improvements. I would like to thank Prof. dr. Marijn Janssen for willing to be the chairman of the committee. He kindly gave constructive feedback, even to the tiniest details. Finally, I want to thank both my parents, who support me financially and constantly gave support morally whenever I feel like I lose my motivation. Thank you for your prayer.

I would also like to thank those who were willing to be interviewed for this thesis. Thank you for sparing your time so that this thesis can be completed. I am also grateful to be able to learn a lot of what is actually happening in various sectors.

A lot of effort has been put into this thesis, and yet this is still far from excellent. However, I hope that this thesis would still be able to give contributions, and can be developed further in the future.

Bonifacius Adrianto
Den Haag, 2017

Executive Summary

Background & Research Objective

The emergence of Big Data has drawn a lot of attention from many organizations, due to the potential value they can capture from it, however, organizations also have difficulties creating value from Big Data (Akerkar et al., 2015). They need to adapt their way of doing business when trying to incorporate Big Data, by adapting their business model. Different sectors can contribute to different ways for organizations to deal with this utilization, due to some differentiating characteristics. Based on this, a research question can be devised:

How does different industrial characteristics influence the business model component change when implementing Big Data?

This study aims to identify the relationship between industrial/sectoral characteristics and business model when implementing Big Data, in order to find out how different industrial/sectoral characteristics lead to the change in business model component(s) of firms when implementing Big Data.

Theoretical Framework

Four concepts are discussed, which are innovation system, Big Data, business model, and sector characteristics. These concepts serve as the core of this study, provide the direction of the study, and can help explain what is found empirically. Firstly, the concept of innovation system is discussed. This serves as a context in which the implementation of Big Data in various sectors and industries can be fitted. There are a number of elements that make up innovation system, which are products, actors, knowledge and learning processes, technologies and inputs and demands, interactions between actors, and institutions. These elements, in fact, are reflected in the business model of an organization, or the logic of how a business works or runs. The differentiation between systemic and autonomous innovation is also explained, to enable the discussion of whether the impact of utilizing Big Data in an innovation system requires a partial change or even a complete change.

Big Data is the second concept under discussion. Its characteristics in terms of volume, velocity, variety, and veracity allow organizations to exploit their potential. It is essential to realize the value that Big Data can give, considering the inability of many organizations to create value out of their huge amount of data. In general, there are a number of values that organizations can have, such as predictive analytics, data management, productivity, efficiency, and improvements in decision-making (Akerkar et al., 2015; Cunningham & Thissen, 2014).

As Big Data can be widely implemented across different sectors, the uptake of it can vary. In the previous study (see Papachristos, Cunningham, & Werker, 2016), it can be characterized in terms of the transition rate, the dominant players who implement it, and the openness of

data in the sector. This depends on a number of aspects, such as economic, social, ethical, and legal. In the study, some sectors could be categorized alongside those three characteristics, however, the categorization was based on the expectation of the sector rather than the real situation of the sector. Therefore, this empirical study can reveal whether the categorization is in agreement with the reality. Some mismatches in the findings can lead to the fact that some sectors are not ready to implement Big Data.

The use of Big Data, and consequently the supporting technology for it, needs to be supported by the necessary choice of business model or the changes to the business model. Some advantages are gained by adapting business models, such as increased efficiency and quality of business operations, flexibility in terms of physical space and temporal space, and thus flexibility in organizational arrangements. Some business model frameworks are discussed, and the Canvas framework seems to suit the study best because of its familiarity, being practice-oriented, and the centrality of value in the framework.

These four concepts serve as the core of this study, provide the direction of the study, and can help explain what is found empirically. Interview questions for data collection are also derived from these four concepts.

Research Approach

This study is an explorative and qualitative study. Three sectors are chosen, which are oil & gas, manufacturing, and health. They are chosen because they have the potential to create value out of Big Data. Data is firstly gathered through interviews with key people from different sectors and is then presented and analyzed in light of the existing literature.

Findings & Analyses

Oil & Gas

The rate of transition in the oil & gas sector is found to be slow towards utilization of Big Data. The sector has generated a huge amount of data since the 1970s, but it is only recently that a lot of value has started to be created out of those data. The implementation is still considered to be in the early stage. The transition is different from what was expected, and can be contributed to by technical complexity, the emerging renewable energy regime and the declining oil prices. The implementation of Big Data in the sector is dominated by both big and small players – big players have the financial leverage to spend on big investments in infrastructure and capabilities, and they are also dependent on a number of vendors, in which some are small players, such as SMEs and start-ups. Small players offer services, for example, in handling Big Data and very specific technology and applications as part of Big Data utilization. The hegemony is found to be the same as what was expected. The regime of data openness in the sector is found to be closed. It is revealed from the cases that data is seen as strategic, and business value is created out of these data or the processes that generate the data. This finding agrees with what the transition was expected to be.

It turns out that in the oil & gas sector, companies are affected in almost all aspects of their business model. All aspects, except the customer segments, are affected by the utilization of Big Data, which might be contributed to by the specificity of the business, so that only certain customers demand the product (i.e. oil & gas). The aspects that have major impacts are activities, and partnerships. Activities are affected in a number of areas, including maintenance and exploration; partnerships are affected as to engage with players who can help in handling Big Data-related activities.

Manufacturing

The transition rate towards utilizing Big Data in this sector is considered to be slow. Companies started interconnecting their machines around 10 years ago, but they are still establishing the know-how of fitting Big Data into their business in order to maximize the value creation. They view their information management system to be highly important, however, the problem is that there is no solution yet in the market that helps companies implement Big Data in a way that it can ensure their information management system will not be disrupted. The implementation of Big Data is dominated by big players who have interconnected their machines; others are still trying to establish how Big Data can fit into their business or even have a "wait-and-see" strategy to try to understand things. The regime of data openness in this sector is closed. The data involved is private company data, or data from their network, customers, and service organization. It is not shared outside their network, as it can be a strategic threat towards themselves.

Companies in this sector are affected in almost all aspects of their business model. The result shows that all aspects, except the customer segments, are affected by the utilization of Big Data. Major impacts can be seen in the activities, resources, and value propositions. Some areas of affected activities include product development and marketing, where manufacturers are able to have higher efficiency, better overall process and better product delivery. Improvements in the machines can be considered as a change in the resources, since physical assets are included in resources. The implementation of Big Data opens up a new opportunity for a new business model, focusing on a subscription service. Customers can pay for the right to use the machine and experience services included in the package. It is seen as more attractive to customers, especially the smaller players, and also improves the revenue stream of the machine producers.

Health

The transition of the sector towards Big Data is found to be relatively quick. Efforts started since 2007, and the technology of sequencing and the supporting infrastructure has kept evolving since then. There is, however, a difference between the industry side and the academia side, due to different accessibility to resources. The implementation of Big Data in the health sector is dominated by the big players. At least the top 30 universities that specialize in medical and health research are putting investment into Big Data, although to

different degrees. The regime of the data in the health sector is a closed regime and the data being used is patient data, therefore, there are very strict data governance rules to ensure the security of the data. This is seen as a major concern that hampers the utilization of Big Data to grow further.

Organizations are affected in almost all aspects of their business model – the result obtained shows that all aspects are affected, except the customer segments. This can be contributed to by the specificity of the business of organizations and the experienced incremental improvements that can be directly beneficial to existing segments. However, there is a vision to have expansion in the segment by offering service in sequencing. The resources aspect turns out to have the largest impact regarding Big Data utilization. Without resources like the software, hardware, and servers, any analysis involving Big Data cannot be performed. Next to resources, partnership is also vital in realizing projects, in particular in managing the infrastructure of the data. There is a potential for a new business model, which focuses on providing service in sequencing. This is attractive for research organizations as they can employ it as their cost recovery model. Another potential business model is providing a security solution, as data privacy and security are seen as vital issues in the sector.

Implications for Organizations

Large companies realize that Big Data can help them to deliver better value and offer more value, for example, the direction towards a new business model in the manufacturing sector. The service-based offering that is being planned will be beneficial for actors, including producers and customers. Resources does not seem to be a big issue in large companies, as they usually have sufficient financial leverage for investments in assets. However, human resources remain a problem, since talent is needed to handle activities related to Big Data. A way to solve this is to partner with experts in a specific area and engage with them to acquire capability in the respective areas. Overall, large companies should be aware of areas in their business model that needs adjustment, since often they focus too much on one area and neglect other important areas.

Small and medium enterprises (SMEs) need to find a way to overcome the existing challenge. For them, building innovation capacity is important in order to gain value from Big Data, as especially in sectors where processes are complex and thus capability is really necessary to innovate, building partnerships are beneficial for SMEs. Partnership might be beneficial to help support research and financial capability. Narrowing down the focus might be advantageous, as displayed in the health and oil & gas sectors. A very focused small player can still create competitive advantage within the sector and can still be a threat even to larger companies. SMEs can also have an entirely new business model by using data as the key resources, such as data-as-a-service and analytics-as-a-service. SMEs can capture this opportunity of the value that data can create by providing services according to their core

capability. An example can be seen in Company D in the health sector, who intend to provide an analysis service in the near future.

Support from the government on the uptake of Big Data might contribute to the growth of a sector, for example, opening a shared data center specifically for research institutions, could help research organizations to overcome the barrier in resource-related problems that hampers their research. Governments can also be supportive in terms of regulation, where unnecessary costs like administrative costs can be omitted. Regulations can also address problems in privacy and data security, so that Big Data implementation can still grow and give benefits to organizations without compromising data security and privacy.

Conclusions, Contributions, and Future Research

The sectors can be characterized according to their transition rate, dominance of implementing players and openness of data regime. Some factors that influence the characteristics include how Big Data can be applied in sectors, what challenges sectors face in the implementation and how far on the progress of implementation is. Furthermore, this study shows that certain business model aspects change depending on how the sectors are characterized, and more importantly the causes that contribute to the characterizations.

Firstly, Big Data can create a lot of potential value. Some significant added value from Big Data can be seen in the ability to have better forecast, process improvement, and increased efficiency of operations. These lead to optimization of overall process and reduction in cost. Secondly, sectors can be characterized by how they act towards Big Data implementation. This is influenced by several factors, including how Big Data can be applied in sectors, what challenges sectors face in the implementation and how far on the progress of implementation is. There seems to be a mismatch between the expectation of how a sector implements Big Data and the reality. Within each sector, there are factors that influence how the sector is characterized with regards to Big Data implementation. Thirdly, the impact of implementing Big Data on business models is established. Value proposition, activities, and resources are three aspects of business model that experience the most impact. These 3 aspects will lead to changes in other aspects of business model. In addition, only customer segments remain unaffected. This is caused by the specificity of business and incremental improvements on the existing products and process. Improved efficiency and optimized process resulted in improved relationship with existing segments and do not directly lead to the expansion towards a new customer segment. An added value in a product for a segment might not be the same for other segments. Instead, they remain as a possibility in the future to grow the business further once organizations are able to fully understand and exploit the potential of Big Data, as indicated by some actors in the sectors.

Conceptually, this study contributes by bringing together innovation system and business model, particularly in technological changes that take place and subsequent adjustments in

business model by organizations. The exploration of sector characteristics as differentiating aspects is also shown through this study. Practically, this study can help firms and organizations who are planning to implement Big Data, so that they can understand more about the potential that they can capture from Big Data. Organizations who are facing difficulties in implementation or facing different results that expected can also reevaluate themselves, especially in their business model, on which aspects they should focus more and further reflect them into their strategies.

Some improvements can be made for future research. First, the interviewees can be enriched by adding different organizational roles in a particular sector and different backgrounds of an interviewee within an organization, so that a comprehensive view of a sector can be obtained and thus give better insight into impacts on various business models. Second, extremely contrasting sectors can be selected based on the characteristics (e.g. fast transition, big players, and open regime, in comparison with slow transition, fragmented players, and closed regime). It still, of course, needs to be compared with the real sector situation since the characterization of the previous study was an expectation of how sectors use Big Data. Third, efforts can be done more on the operational level, such as establishing a roadmap for implementation, best practices of implementation for organizations, and a balanced scorecard to evaluate and plan the implementation in organizations. This can provide a clearer link between the findings and the actions and strategies of what organizations can do.

Table of Contents

PREFACE **5**

EXECUTIVE SUMMARY **7**

LIST OF FIGURES **15**

LIST OF TABLES **15**

1. INTRODUCTION **16**
1.1. Background 16
1.2. Objective 17
1.3. Research Question 17
1.4. Expected Conceptual & Practical Contribution 18
1.5. Outline of The Report 18

2. THEORETICAL FRAMEWORK **20**
2.1. Innovation System 20
2.2. Big Data 22
2.2.1. Characteristics of Big Data 23
2.2.2. Added Value of Big Data 23
2.3. Characterization of Sectors 24
2.4. Big Data and Business Model 26
2.4.1. Importance of Business Model Innovation during Big Data Implementation 26
2.4.2. Incorporating Big Data into Business Model 27
2.4.3. Selecting Suitable Business Model Framework 27
2.4.4. Limitations and Usability of Canvas Framework 28
2.4.5. Initial Expectation of Impacts on Business Models 29
2.5. Conclusion of The Chapter 31

3. METHODOLOGY **32**
3.1. Research Approach 32
3.2. Case Selection 33
3.3. Data collection 34
3.4. Data Analysis 35

4. BIG DATA IMPLEMENTATION & IMPLICATIONS TOWARDS BUSINESS MODELS: CASES FROM 3 DIFFERENT SECTORS **37**
4.1. Oil & Gas Sector 37
4.1.1. Sector Characteristics 40
4.1.2. Big Data Implementation 42
4.1.3. Severity of Impact 44
4.1.4. Impacts on Business Model 44
4.2. Manufacturing Sector 47
4.2.1. Sector Characteristics 50
4.2.2. Big Data Implementation 51
4.2.3. Severity of Impact 53
4.2.4. Impacts on Business Model of Manufacturing Companies 53
4.3. Health Sector 55
4.3.1. Sector Characteristics 58
4.3.2. Big Data Implementation 59
4.3.3. Severity of Impact 61
4.3.4. Impacts on Business Model 62
4.4. Summary of The Findings 65

5. ANALYSIS & IMPLICATIONS FOR ORGANIZATIONS 67
5.1. THE UTILIZATION OF BIG DATA IN SECTORS 67
5.1.1. The Transition Towards Big Data 67
5.1.2. The Hegemony of Big Data 71
5.1.3. The Regime of Big Data 73
5.2. IMPACTS ON BUSINESS MODELS ACROSS SECTORS 75
5.2.1. Oil & Gas Sector 75
5.2.2. Manufacturing Sector 76
5.2.3. Health Sector 77
5.2.4. Commonality and Differences Between Sectors 79
5.3. IMPLICATIONS FOR VARIOUS ORGANIZATIONS 84
5.3.1. Implication for Large Companies 84
5.3.2. Implication for SMEs 85
5.3.3. Implication for Research Institutions 87
5.3.4. Implication for Government 88
6. CONCLUSION & FUTURE RESEARCH 89
6.1. CONCLUSION 89
6.2. RESEARCH CONTRIBUTIONS 93
6.2.1. Academic Contribution 93
6.2.2. Practical Contribution 94
6.3. LIMITATIONS OF THE STUDY 95
6.4. FUTURE RESEARCH 95
6.5. REFLECTIONS ON THE RESEARCH PROCESS 96
REFERENCES 98
APPENDIX I INTERVIEW QUESTIONS 103
APPENDIX 2 BUILDING BLOCKS OF CANVAS 106

List of Figures

Figure 1 The outline of the report 19
Figure 2 Categorization of cases according to the trends (Papachristos et al., 2016) 24
Figure 3 A visualization of the research approach for this study. 33
Figure 4 A typical value chain of oil & gas industry (Pitatzis, 2016). 37
Figure 5 A depiction of the main findings and their relations 80
Figure 6 A visualization of Canvas business model, where value proposition is central in the framework (Osterwalder & Pigneur, 2010). 106

List of Tables

Table 1 Modified Canvas Business Model framework used for this study. 29
Table 2 Interviewee from different sectors 34
Table 3 Findings in the oil & gas sector 38
Table 4 Comparison of characteristics in oil & gas with previous study. 42
Table 5 Findings in the manufacturing sector 48
Table 6 Comparison of characteristics in manufacturing sector with previous study. 51
Table 7 Findings in the health sector 56
Table 8 Comparison of characteristics in health sector with previous study. 59
Table 9 Summary of the findings in each sector 65

1. Introduction

This first chapter will present the background of conducting this study, as well as the objective and research questions that serve as the core of the study. The structure of the report will also be explained.

1.1. Background

Nowadays, there is an increased use of data, due to more data sources being available. Each day, the use of data can reach 2.5 exabytes globally, and is expected to double every two years (Morvan, 2016). This is made possible thanks to the innovation in technologies over past decades. An enormous amount of data can now be generated, for example, through interconnection of devices and sensors. Not only is data generation possible, but also storing it is made possible. Having the data and the ability to handle the data, a logical question that follows would be what to do with these data. Only having the data without making something out of it would be a waste of time and cost. Therefore, firms that have a great amount of data have to be able to make use of the data by analyzing it and creating added value from the data. It turns out that creating added value from data is a major challenge for many organizations (Akerkar et al., 2015). A study suggested that only about 4% of companies across industries have the capabilities to create value through Big Data (Bertocco & Padmanabhan, 2014). This emphasizes the need to scrutinize how Big Data can create value towards organizations and companies who implement it.

Big Data is a term that is coined from the immense amount of data being involved in all kinds of activities. It entails more than just creating such an amount of data through devices and sensors; it also utilizes data to obtain added value from it. Implementing Big Data into business means that there are various aspects of the business that need to be adapted. These aspects can be seen through the business model. By adapting the business model, firms / organizations can implement Big Data in a more efficient way (Loebbecke & Picot, 2015). In addition, it enables organizations to capture opportunities through the added values created by Big Data, such as predictive analytics, personalization of services, and data management. Specifically, there are some components in the business model that can be adjusted when implementing Big Data.

The impact of Big Data on the business model has actually been demonstrated by Muhtaroglu et al. (2013). However, although they took examples from a number of sectors, they did not directly compare the impact across different sectors. The uptake of Big Data and problems that organizations face differ across sectors (Vega-Gorgojo, Fjellheim, Roman, Akerkar, & Waaler, 2016). The business model, as a way of explaining how business works, reflects how a certain business is affected by utilizing new technology. In an environment that keeps changing, organizations need to adapt their business model as a way to capture new value and opportunities that Big Data can give, and thus ensure a profitable operation. In the

introduction of new technologies into a particular sector, certain conditions might be changing, in particular how a sector reacts to the new technologies. It is, however, not necessarily the same change throughout various sectors. In some cases, only a number of aspects of the business model need adjustment, and in other cases, a lot of their components need adjustments (Lammerant, de Hert, Beamonte et al., 2015). Therefore, this study aims to delve deeper into this core problem, by looking into various sectors, and trying to characterize them. There have been many sectors where Big Data has been implemented or are suitable for Big Data to be implemented, such as health, oil & gas, and manufacturing. By comparing these different sectors with their respective characteristics, the difference they make to business models can be revealed.

The different impacts can be reflected through different components of the business model used, and how these components are changed or adapted accordingly. By looking at different business models across different sectors, which components are affected under which condition can be compared and contrasted (i.e. characteristics of sectors). This cross comparison can lead us towards identifying the relationship between characteristics of industries / sector and business model component change, specifically within the context of Big Data implementation.

1.2. Objective

The objective of this study is to identify the relationship between industrial/sectoral characteristics and business model when implementing Big Data, in order to find out how different industrial/sectoral characteristics lead to the change in business model component(s) of firms when implementing Big Data.

1.3. Research Question

Following on from the objective, the following research question serves as the core of this study:

How do different industrial characteristics influence the business model component change when implementing Big Data?

To help in answering the main research question, some sub questions are formulated:

1. *What added value can Big Data give towards business?*
   Big Data implementation gives some added value of benefits towards the business operations. A literature review would be able to answer and explain this added value, particularly whether it is generalized or specific to a certain condition or situation. In addition, it can also be revealed through interview, where the value can be sector-specific.

2. *What trends are characterizing sectors in implementing Big Data? How do those differ across different contexts?*
   As reported in Papachristos et al. (2016), there are underlying trends that can make a certain sector different to another. This difference can influence how Big Data can be implemented and what value it will bring about. Therefore, identifying these trends can be helpful and thus meaningful for selecting different sectors that can deliver clear empirical evidence towards the theory within this research, as well as differentiating across sectors. Interview will be used to help establish how sectors are characterized.

3. *How does the impact on business model differ across the cases observed empirically?*
   After gathering the data by means of interview, there might be some useful information obtained, or even some patterns that can be observed. Considering the different nature of the sectors, it is likely that the impacts will not be identical. It is then meaningful to analyze them and find several points of contrast between the cases, and even draw on some patterns and relationships that can be generalized.

1.4. Expected Conceptual & Practical Contribution

This research can contribute conceptually towards the knowledge in business model adaptation / innovation. As mentioned previously, by identifying the relationship between industrial/sectoral characteristics and business model component innovation, this research can enable us to understand how to adjust the business model, given a certain condition and situation (i.e. characteristic of sector). In addition, there has never been any investigation regarding how the characteristics of industries relate to business model. This study tries to bring together aspects that can differentiate various industries and the subsequent improvements of business model, particularly when implementing Big Data.

Practically, this research can be useful for firms that are implementing / planning to implement Big Data in their business operations. It can provide a guideline on which parts of their business models they have to pay more attention to and adapt accordingly. They can base this decision on the sector that they are involved in. This way, they can anticipate the implementation not to harm their already established business operations and help them to improve even further by making use of the benefits and opportunities created by the implementation. The result of this study can, to some extent, be generalized to other industries, by looking at the similarities of industry characteristics of those studied in this research.

1.5. Outline of The Report

In this report, this chapter will proceed with the research question and sub-questions as the core of the study. It will then be followed by the literature review to ultimately establish a framework on which to base the analysis of the data obtained. Next, the methodology of the research will be addressed to provide clarity on how to conduct the study and achieve the

objective. In chapter 4, the empirical results will be presented on different sectors, based on the result of the conducted interviews. Then, in chapter 5, the empirical result will serve as a basis for analysis and discussion, according to the objective of the study. The report will be concluded with the conclusion and future research. An overview of the outline can be seen in Figure 1.

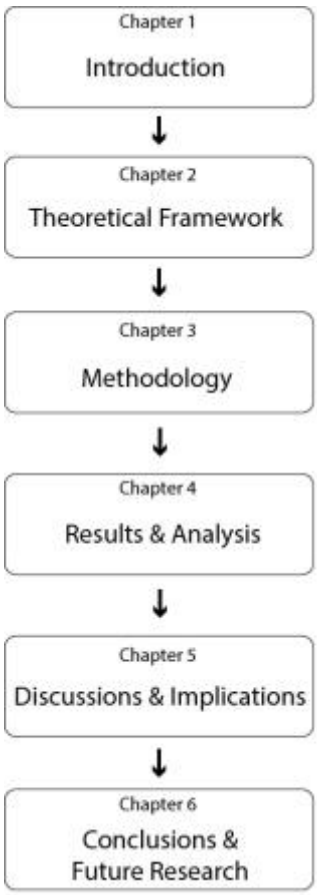

Figure 1 The outline of the report

2. Theoretical Framework

In this chapter, a number of concepts are discussed, which are innovation system, Big Data, business model, and sector characteristics. These concepts serve as the core of this study, provide the direction of the study and can help explain what is found empirically. Big Data, as a technology, is being implemented in a lot of sectors; it is the core of an innovation system that moves towards the direction of utilizing data to create value. Understanding the innovation system and its elements is thus important, as it gives an indication of which aspects are crucial in running a business and organization, which is further reflected in the business model of an organization, with its various components. Understanding how a sector is characterized regarding Big Data is also important, as it helps to explain how these characteristics can lead to a certain impact on business models.

2.1. Innovation System

An innovation system is a system where a number of elements support each other so that innovations can be made. The emphasis lies on the interactive nature of the actors (Malerba, 2002). The elements within an innovation system are the actors, the relation between the actors, and the governing institutions (Werker, 2001). With this systemic view, the focus lies on innovation, and the learning process (Edquist & Hommen, 1999).

To limit the boundaries, much literature has addressed a way to focus the analysis of an innovation system. One way is to see it based on the sectors, commonly known as a sectoral innovation system (SIS) (Malerba, 2002). The approach takes the root from a technological system (TS), which focuses more on the technology and the industry involved (Malerba & Breschi, 1997). The SIS has more concrete and specified elements in comparison to the more general innovation system previously discussed. An SIS consists of products, actors, knowledge and learning processes, technologies and inputs and demands, and interactions between actors and institutions. The SIS approach by Malerba emphasizes the importance of the knowledge and learning processes, technologies and inputs and demands, and the interactions between actors (Malerba, 2002). The main point in the view of SIS is that in different industries and sectors, it is characterized differently in the way that the organizations are competing and running their businesses. In one industry, it may be that it is dominated by a few large firms and they are highly competitive, while in another industry, it may be dominated by a large number of small firms, and the competition is much less fierce. This feature of SIS can be related to how a sector is characterized.

Discussing the innovation system further, the constituents or elements that make up an innovation system, or SIS in particular, have been mentioned above: products, actors, knowledge and learning processes, technologies and inputs and demands, and interactions between actors and institutions. As an actor within a sector, an organization or firm should be aware of and understand these elements. Regarding actors, an organization should

understand who the players are in their sector. Not only should they consider their competitors, but also those within their network that are dispersed along the value chain, such as suppliers, collaborator / partners, and clients. By understanding these actors, an organization can strategize themselves to be engaged with those that can help them to run their operations and businesses, i.e. to develop their technologies and products, in order to fulfill the demand in the market. They can utilize the knowledge that they do not have to have benefits, for example, improvement of their processes and products. These interactions between actors are what make up an innovation system and its dynamic nature, and are what an organization needs to run their business and survive. These elements, in fact, are reflected in a business model, or the logic of how a business works or runs. From that point on, organizations can derive the necessary strategy to improve their business from the business model that they have. A more in-depth discussion about the business model will be discussed later in this chapter.

Another element that makes up an innovation system is the technology. The uptake of a technology in an innovation system determines how the innovation will proceed. A differentiation was made by Werker (2001), where innovation can proceed autonomously or systemically with regards to the existing innovation system in the sectors. By autonomous, this means that the uptake of the technology – and thus the innovation – will affect a part of the existing innovation system. By systemic, this means that the innovation will affect the whole existing innovation system. A similar distinction was made by Teece (1996), who made the relation between autonomous and systemic innovation, changes in technology, and the capability that an organization has. The interdependence of technological change determines whether an innovation is systemic or autonomous, and it is matched with how capabilities exist in organizations. Big Data can affect the innovation system within a particular sector, whether it partly affects or systemically affects the existing innovation system. How the innovation system of a sector is affected by Big Data depends on a number of aspects, which are none other than the constituents of the innovation system. It includes the interactions between actors, the supporting technology (e.g. infrastructure), and the innovation regarding the Big Data itself. Through this study, the findings reveal whether Big Data implementation is affecting a sector partially or totally across sectors. In relation to the technological requirement, to match with the locus of capability, firms also need to adjust their business, so that they can access the necessary capabilities.

Learning

It is also worth mentioning discussion about learning within the innovation system. Learning can be associated with the technological innovation of an organization (Yam, Lo, Tang, & Lau, 2011). This results in the improvement of knowledge and capability needed to develop the technology further. As one of the building blocks of a sectoral innovation system, learning has huge implications towards how innovation can proceed within a sector. It involves the uptake of knowledge to be transformed into something with an added value, and ultimately to trigger

innovation. Knowledge is presumably not the same across different organizations in a sector, in the sense that not every organization can access and gain knowledge equally easily (Malerba, 2002). In addition, it was mentioned previously that innovation is central in an innovation system (Edquist & Hommen, 1999). While innovation can be considered as a form of learning process, it can result in improved knowledge and skills to be able to further develop the technology (Yam et al., 2011). It can then be interesting to reveal whether it is true in reality, whether the difference is significant, and whether the impact is also significant.

Relating to Big Data, learning can imply two things. First, there is the learning to implement the Big Data itself. In order to make use of Big Data, organizations need to understand it from two perspectives, the technological side, and the management side. The technological side includes the know-how of generating data, processing data, and using data. In addition, infrastructure and maintenance are equally important. This will lead to the innovation of process that the organization has. Second, there is the learning to improve and innovate on the process an organization has by making use of Big Data, for example Big Data analytics. It implies the use of available data to improve their business and operations. Learning can be quite a challenge when an organization is new to Big Data, both in terms of having a much larger dataset and in terms of the capability to process it to be meaningful. The technical know-how might be acquired from collaborative partnerships, or events like conferences, but to apply it contextually is another thing, where they have to consider what resources they have (e.g. hardware, software, and human resources / experts), and their experience regarding Big Data. While learning can be a challenge for organizations that are implementing Big Data in their activities, it is worthwhile for them to pay attention to it. Perhaps the most important result that comes out of the learning process related to Big Data is the added value that it can give towards the organization. The inability of many organizations to create value from Big Data (see Bertocco & Padmanabhan, 2014) implies that it needs a deeper understanding of how it should be facilitated. This can thus lead to the need to connect the concept of Big Data and how an organization can adapt their business to implement it.

Having discussed the concept of an innovation system as the starting point, it will then be followed with discussion of Big Data as a technological trend that has started to be implemented by various organizations across various sectors in recent years.

2.2. Big Data

Big Data is often referred to as “a huge amount of data”. A lot of companies are able to create a lot of data, thanks to different possible data sources, both internal and external of the company. However, it entails more than just the amount of data involved, and creating it. It is also about how to make use of the data so that it gives added value to the company and the business. A definition of Big Data can be stated as data that are complex, multiple, huge in size, and hard to process using conventional methods (Akerkar et al., 2015; Özköse, Arı, &

Gencer, 2015). Vega-Gorgojo et al. (2016) alternatively define Big Data as a trend, in particular "… of massive data acquisition and data utilization that is changing the way knowledge is produced, business conducted and governance enacted". This difference in formulating Big Data definition, although not exactly counter to each other, can be seen as a different way of viewing Big Data. While the first one emphasizes the technical aspect and the nature of data involved, the second definition pays more attention to how Big Data can give impact towards knowledge, business, and governance. Although both definitions can be used at the same time, the latter certainly has more relevance towards this study, as the business model – as the way the business logic is explained – is of importance in this study.

2.2.1. Characteristics of Big Data

Big Data is a newly emerging trend, characterized by three aspects: volume, velocity, and variety. In terms of volume, there are a lot more data to deal with, reaching the magnitude of an exabyte (i.e. 1 billion gigabytes) (McAfee & Brynjolfsson, 2012). With this number of data, firms can do a lot, including improving their business activities, and operations. In terms of velocity, this concerns the speed to create data, as well as accessing the data, for example, real-time data. This velocity aspect enables firms to be able to quickly make accurate decisions and be more agile (McAfee & Brynjolfsson, 2012). In terms of variety, a lot of data sources are now available to collect, and are all scattered and unorganized. It is therefore up to the firms how to make use of this variety of data in order to improve their business, or tackle some problems that they are facing. There has been an addition to these aspects, which is veracity, also known as the fourth "V". This concerns the reliability and accuracy of the data utilized (Özköse et al., 2015).

2.2.2. Added Value of Big Data

In implementing Big Data, there are a lot of benefits being created, and thus giving added value. These values encompass different relevancy across different sectors, and applications. Cunningham and Thissen (2014) delineated three main and fundamental values that are seen as beneficial when implementing Big Data: improvement in decision-making, enhanced control and automation of complex system, and increase of value of information. These values are extracted from different kinds of Big Data implementation across various business cases. For example, improvement in decision-making is more relevant in businesses that are characterized by low margins and high competition within industry, and increased value of information in industries such as healthcare and science-related. Therefore, in implementing Big Data, a value might be more apparently beneficial in one particular sector than another.

Another perspective can be obtained from the study of Akerkar et al. (2015), where they described opportunities for added value on personalization of services, predictive analytics, data management, productivity, and efficiency. Nevertheless, Big Data can provide numerous opportunities for added value towards business. This is where organizations tend to fail to create value out of Big Data for their business. Organizations should be able to adapt their

business models to reflect the changes experienced in their operations (Loebbecke & Picot, 2015). By comparing implementation across sectors, the difference in the added value might also be revealed, and thus hints at how business models are affected.

2.3. Characterization of Sectors

Specific to Big Data implementation, a previous study suggested a way of differentiating various sectors. There are three trends that form expectation of how a sector will be affected when Big Data is being utilized, namely the rate of transition, the hegemony of the players, and the data regime (Papachristos et al., 2016). These trends correspond to several external forces – which are regarded as external uncontrollable events – that result in a number of unintended consequences and impacts. To give an example, the forces that may accelerate the transition are dominant players in IT infrastructure, and policies on closed and proprietary data, while those that may hamper the transition include climate change and natural disaster. These correspondences, however, do not truly reflect the current situation in sectors. Rather, they reflect the expectation on how sectors will respond to the introduction of Big Data in various applications.

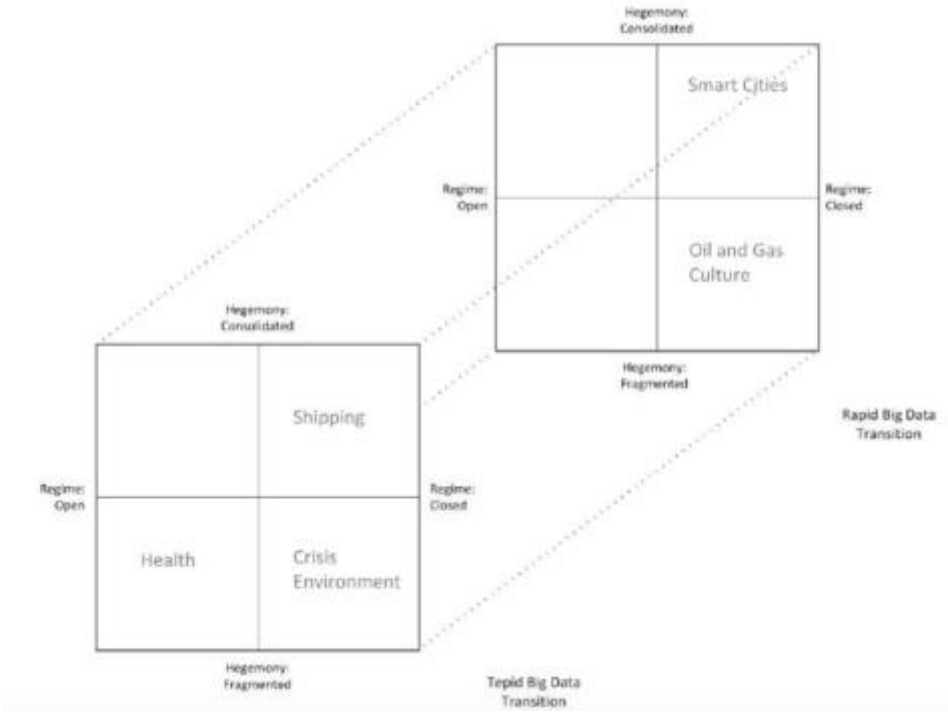

Figure 2 Categorization of cases according to the trends (Papachristos et al., 2016)

The trends are the Big Data transition, Big Data hegemony, and Big Data regime. Transition is characterized by the rate of transition towards Big Data implementation; whether it is fast or stalled. It can contribute to a lot of factors, and it can be related to the challenges that occur when implementing Big Data, whether it is a technical challenge, management challenge, or even institutional challenge. The rate of transition is important, since it reflects how capable

Big Data is to disrupt the existing ways of doing business and to provide a solution to societal problems (Papachristos et al., 2016).

A note to be made on the rate of transition is that one can argue that indicating the transition to be slow or fast is subjective, without any specific indicator. However, this rate of transition of a sector shows the condition of a sector, which means that with regard to Big Data utilization, a sector has a number of aspects that can accelerate or hamper the utilization. These aspects have been discussed in some of the literature, for example the social, ethical, and legal aspects (Garcia et al., 2014). In addition, it seems like assigning the characteristic suggests that there is a starting point and an end point to the utilization. While there certainly is a starting point, it may or may not be the case for the end point. Technology will keep evolving along a certain trajectory, supported by necessary research, discovery, and needs from the users (Castellacci, 2008). In that sense, there would not be any end point to the utilization, or there is not any way to define what is an end point. With regards to that, it is useful to define an end point to provide clarity. From the perspective of the author, an end point here refers to when an organization finds that Big Data is involved in all their activities where it is possible to implement it, successfully creates value from Big Data towards their business process, and when Big Data plays an important role in the continuity and growth of their business and operation.

Regarding hegemony, the sectors are characterized by either control by several big players, or by many players in a diverse marketplace. The uptake of Big Data can thus be dominated by either the big players, or by various players. It is mainly influenced by two forces, the concentration of power, and where the decision-making process is situated.

With regime, a sector is characterized by how open the data is. A sector might be characterized by the data being publicly available, or in contrast, might be privatized to organizations. As reported in the research by Papachristos et al. (2016), many are in favor of the closed, proprietary regime, where data is privatized. An important reasoning is that Big Data can be a crucial resource for innovation, and competitive advantage. Organizations are willing to exploit Big Data to create benefits, and it can be an incentive for them to invest in Big Data. Asymmetry of openness might also be a possibility to take place within a sector; different trends might occur for different sectors (Papachristos et al., 2016). This fact triggers the study to investigate how these differences influence the business model. In particular, the trends were established based upon expectations of actors in their respective sectors. It remains to be seen whether the current situation matches, whether there are initiatives and plans toward the expectation, or whether it is completely contradictive.

Some sectors in this research can be found in the previous study, which are health, and oil & gas (Papachristos et al., 2016). It was expected that the health sector could be characterized as a sector with slow transition, fragmented hegemony, and open regime. Looking at the oil

& gas sector, the previous study suggested that the implementation is expected to be a quick transition, fragmented hegemony, and closed regime. In this study, this characterization can be revealed through empirical findings. The manufacturing sector, was not studied previously, although an attempt to characterize the sector was also done. The manufacturing sector was characterized as a sector with a quick transition, fragmented hegemony, and closed regime. The findings in this study will give a new insight towards how Big Data is implemented in the sector. It has to be noted that the characterization was done based on building scenarios as a vision on how the sector will use Big Data. It is more of an expectation rather than a factual condition of the sector, therefore, the characterization remains to be confirmed through findings.

Sectors that tend to be favorable towards the utilization of a technology might be facing more opportunities (Castellacci, 2008). Thus, a combination of characteristics might imply to a certain degree how value can be benefited. Business can therefore be adjusted to help the organization enjoy the value, by taking into account how the sector is shaped in terms of transition, players, and data openness. By focusing on the business model, it might help to explain the adjustment to be made.

2.4. Big Data and Business Model

The business model can be defined generally as the logic of how a company operates their business (Osterwalder & Pigneur, 2010). More specifically, Amit and Zott defined the business model as a depiction of content, structure, and governance of transactions in order to create value through making use of business opportunities (Amit & Zott, 2001). There are various frameworks of business model that are used. One of the most often used is Canvas, which consists of nine different components: key partnerships, key activities, key resources, value propositions, customer relationship, channels, customer segments, cost structure, and revenue streams. These components are actually based on four perspectives that are seen as important in business logic and how it works. These are value proposition, financial aspects, activities, and customers (Fritscher & Pigneur, 2010). In this section, the importance of adapting the business model and its relation with Big Data will be explained further.

2.4.1. Importance of Business Model Innovation during Big Data Implementation

Having the ability to utilize Big Data towards their business can help firms to gain advantages (Muhtaroğlu et al., 2013). In addition, the use of Big Data, and consequently the supporting technology for it, needs to be supported by the necessary choice of business model or the changes to the business model, as the business model can act as a moderator of employing technology (in this case Big Data, and its supporting technology or infrastructure) towards an improved performance (Baden-Fuller & Haefliger, 2013). In particular, adapting their business model can bring firms a number of advantages. First, it offers flexibility in terms of physical space, and temporal space, and thus flexibility in organizational arrangements (Loebbecke &

Picot, 2015). Second, it increases efficiency, and quality of their business operations (Lammerant, de Hert, Vega-Gorgojo, & Stensrud, 2015; Loebbecke & Picot, 2015). This can be reflected in their business model and to what extent they change theirs. In some cases, only a number of components of their business model needs adjustment, and in other cases, a lot of their components need adjustments (Lammerant, de Hert, Beamonte, et al., 2015). After all, a well-developed business model can help organizations to capture value from their technological innovation (Teece, 2010).

2.4.2. Incorporating Big Data into Business Model

From the literature, there can be an expectation of how Big Data can impact business models. A previous study suggests that there are various ways of incorporating Big Data into the business model (Schroeder, 2016). Big Data can be used as a basis to inform many business decisions and management processes. This is aided by engaging data in various components of a business model, as have been found in various organizations. Although rarely seen to be very radical, organizations slowly incorporate all the data that they have into their existing business model.

Another suggestion is that Big Data can be incorporated as a way of offering consultancy and advertisements. This can be found within organizations that offer expertise, for example, in IT infrastructure, automation and control of process, human resources and organizations, and security. This can be seen in two ways. First, an organization can offer such expertise as their core of business, which serves as consultation and provides solutions to industrial players. Second, an organization, which is an industrial player, can consider those consultancy organizations and solution providers to be their partners. By being in partnership with these organizations, it enables them to incorporate Big Data and also capture value in their business. The influences can be found throughout a lot of aspects in their business model, starting from resources, value proposition, customer relationship, and many others. A similar way of thinking can be found in other examples, such as the incorporation of Big Data as a way to provide tools, such as cloud servers, hardware, high speed computers, and software.

These various types of business model show that implementing Big Data gives opportunities in a number of ways. Through capturing the value that Big Data creates, organizations can offer more through what they are currently doing, or are planning on doing. By looking at the business model aspects, it can tell us how the impact takes place and in what way.

2.4.3. Selecting Suitable Business Model Framework

There are various business model templates available that have been coined. Canvas is used as a starting point because of its familiarity and being practice-oriented, without compromising much on the substance of a business model (Ching & Fauvel, 2013). In addition, Canvas puts value as a central notion in the framework (Coes, 2014), which is in line with how

Big Data can contribute value towards businesses. The Canvas framework is one of the most common templates to be utilized by organizations, however, it is not the only business model framework in existence. There are other frameworks that have been established by various authors, such as STOF (Bouwman, Faber, Haaker, Kijl, & De Reuver, 2008), VISOR (El Sawy & Pereira, 2013), and CSOFT (Heikkilä & Heikkilä, 2010). What differentiates these frameworks is the focus they are emphasizing. STOF, for example, emphasizes the service that an organization provides. CSOFT, which stands for customer value, service, organization, finance, and technology, is a customer-centric framework, which focuses on the segmentation of customers (Heikkilä, Bouwman, Heikkilä, Solaimani, & Janssen, 2016). VISOR, on the other hand, has a very specific application for businesses with a digital platform. It is represented by the Interface and Service Platform as two of the major elements in the framework. Considering these various options, Canvas can be seen as being more versatile for use in comparison to the others. Its applicability is proven to be suitable for many kinds of industries and sectors. In addition, it can be suitable for both businesses that are traditional and those that are more digital-based (e.g. Muhtaroğlu et al., 2013).

2.4.4. Limitations and Usability of Canvas Framework

Since Canvas takes the perspective of an organization, it is generally a comprehensive framework for the operations of the focal organization, however, it fails to comprehensively take into account the ecosystem of the focal organization. Some aspects of the ecosystem have already been included in the Canvas, such as partnerships, customers, and suppliers. A common point that a lot of authors have mentioned about the downside of Canvas is the competition aspect that is not addressed (Ching & Fauvel, 2013; Coes, 2014; Euchner & Ganguly, 2014; Kraaijenbrink, 2012; Maurya, 2012).

Another shortcoming of Canvas is its applicability. It is usually applied to profit-oriented organizations (Coes, 2014). In reality, however, a lot of organizations, including research organizations and municipality projects, are starting to adopt the Canvas model and modify it to their needs (e.g. Universalia, 2013 and Yang, Khamit, & Mohammed, 2008). The difference is simply in their focus, and these organizations are still creating and delivering value to fulfill their purposes (Osterwalder & Pigneur, 2011).

The incremental adjustments that have been attempted in the Lean Canvas or Value Model Canvas might be seen as important in order to make the Canvas more efficient and consistent, and might as well be adopted for this research. However, since this study is focusing on Big Data's impact on the business model and revealing it through interview, it is more important to be concerned about the familiarity of the interviewee towards the building blocks as concepts related to the business and operations. Therefore, some adjustments of merging blocks together as done by some researchers will not be used in this research. However, the comprehensiveness of Canvas will still be considered, by incorporating the competition block as an additional element of Canvas for this research. Table 1 summarizes the aspects that will

be used in the study. In this block, the competitors and their values will be addressed, to understand in what way the competitors are ahead of the focal organization, or behind the focal organization. In other words, the completeness and efficiency of Canvas, and the familiarity of Canvas are a trade-off in this case, however, without fully compromising both aspects.

Table 1 Modified Canvas Business Model framework used for this study.

Business Model Components	**Description**
Key Activities	The main activities conducted within the organization
Key Resources	The resources used to conduct the activities
Value Proposition	The value that the organization wants to deliver
Customer Segment	The segment / group of customers that the organization aims at
Customer Relationship	The way an organization maintain their relationship with customers
Partnership	The partners the organization is engaged with
Channels	The way the organization reaches their customers
Revenue Stream	The main sources of revenue for the organization
Cost Structure	The main costs incurred by the organization
Competitors	The main competitors the organization is facing

While the business model is usually applied to commercial firms, there is a growing application towards research organizations and municipal organizations (e.g. Universalia, 2013 and Yang, Khamit, & Mohammed, 2008). This is due to the need for sustainable activities for these kinds of organizations and decreasing funding received (Universalia, 2013). It basically puts forward the needs of the organization to survive, whatever the value is that they want to create and deliver. These organizations also need to cover their expenses, and to structure their business and sustain it, they need a type of business model. The difference between them and traditional profit-seeking or commercial firms is in their focus (Osterwalder & Pigneur, 2011).

2.4.5. Initial Expectation of Impacts on Business Models

A number of expectations of how Big Data impacts the business model can be made, based on a number of literature. These expectations will be incorporated into the analysis section later, to be compared with the findings in the sectors.

In the oil & gas sector, there appears to be a need for analytical talent (Bertocco & Padmanabhan, 2014). The people employed for IT-related functions are usually not very specialized, although there is an increasing demand and expectation for talent to keep up

with the latest trends of IT, such as cloud and open-source software, and also for them to be able to solve problems and create new opportunities rather than just having analytical skills. Therefore, companies can be expected to adjust their business models in areas related to human resources, such as the resources and partnership aspects. They can equip themselves internally by hiring talented people with skills, and externally by collaborating with and outsourcing talent. Overall, there is an expectation of Big Data to have an impact on the resources and partnership aspects of business models in the oil & gas sector.

In manufacturing, the expectation is that there is a change in the necessary capability and competences of the people. There is an increasing demand for experts that are able to handle Big Data and are able to provide the right technology within a specific business context (Vermeire, Torfs, Van der Straeten, Vanderlinden, & van den Kerkhof, 2017). It remains a concern, and therefore industry players are expecting talent to appear more. There is also an expectation by the players to create a sustainable and open ecosystem which will consist of a number of players with different specializations (Vermeire et al., 2017). There will be an increasing intensity of collaboration within that ecosystem, where knowledge will be shared openly. The mentioned expectations imply that not only do they expect the regime of the sector to be open, but also the collaboration and partnership aspect of business models to be affected. Partnership will be a crucial aspect that organizations need to adjust, in order to ease their transition towards the implementation of Big Data. Another study highlights the current ongoing focus of research in manufacturing (O'Donovan, Leahy, Bruton, & O'Sullivan, 2015). A number of findings can be highlighted from this study. First, it is shown that, using the number of publications as an indicator, most researches are more focused on theory, while it is still lacking in areas such as platform (i.e. system with hardware and software for application execution), methodology (i.e. approaches to solve problems), and tool (i.e. well-defined software utilities to address problems). The finding from this study indicates that there is a gap in those areas, which are expected to be explored in the near future. It also means that those are the areas in manufacturing that are still under-developed and need to be adjusted in the business. Second, it is also found that the focus of the application is mostly in process and planning, which is related more to the operational and execution levels. Within this application area, there is still a lack of focus on the methodology and tool. Therefore, there is an expectation of a considerable impact on the area of resource and activities, since these two aspects of business model can address process and planning. Another area is the focus of the research on the data analytics. Basically, manufacturing companies are focusing more on the predictive analytics, as they find this to be beneficial for their operations in terms of accuracy of decision-making. It is a capability that manufacturing companies expect to have, and thus improve their whole process and value proposition towards their customers. However, they are still far from prescriptive analytics, which allow them to have suggestions of actions based on data. Overall, considering the findings in some literature, there is an expectation of Big Data to have a considerable impact on the activities, resources, value proposition, and partnership aspects of business models in the manufacturing sector.

In the health sector, there is an expectation that the data complexity and amount will increase over time, as there is an increase in the understanding of living organisms (Costa, 2012). There should be sufficient and capable infrastructure, such as the hardware, software, and servers that can support the research. Therefore, it needs to be addressed within business models in order to ensure researches are not interrupted and insights can still be obtained. In the longer term, more applications of analytics can be done using the data from sequencing, for example, the diagnosis and prescription, which some also refer to as genomic medicine (He, Ge, & He, 2017). Data from sequencing can be integrated with the patients' electronic health records, which can result in a more accurate and comprehensive diagnosis and prescription. Overall, there is an expectation of Big Data to have a considerable impact on the activities and resources aspects of business models in the health sector.

2.5. Conclusion of The Chapter

Throughout this theoretical framework chapter, the concepts used for this study are discussed in relation to the objective of this study. The aim of this chapter is to discuss a number of concepts that can provide direction to the research, since the research is explorative in nature. Some issues discussed in the concepts will come back later in the report and will be used to analyze and discuss the findings. Expectations on how sectors will implement Big Data and what the impacts on business models are, have been discussed in this chapter. These expectations can later be compared with what is found in the evidence and will be discussed regarding how the agreement or the discrepancy can take place. Some implications can further be derived for organizations, especially on how they should treat the implementation of Big Data in their business.

3. Methodology

In this chapter, the methodology employed for this study is explained. The whole research approach will first be explained, to emphasize the reproducibility aspect of the study. Next, the selection of cases and sectors will be explained, along with the reason why the choices have been made and how they can help explain the research question posed. Data collection is also presented, which explains the steps taken to retrieve findings. The chapter ends with an explanation of how the findings will be analyzed.

3.1. Research Approach

This study is explorative in nature. In general, the research will proceed in an inductive qualitative manner, with a methodology called grounded theory, which is suitable for the study, since the concept of Big Data is still relatively unexplored, let alone the relation between Big Data and the business model of an adopting organization. The aim of this study is to understand how Big Data will have an impact on business models of different organizations situated in different settings (i.e. different sectors). Firstly, after the research focus and questions are established, the literature review will be performed, in order to further decide the direction of the study. This is done through looking at some key concepts, such as Big Data and its implementation, the uptake of Big Data on various sectors, and potential impact on the business model. The constructed interview questions will evolve around these concepts. Subsequently, it will be followed by data gathering, by means of interview. Three sectors will be selected for this research and further explanations on how the selection will be conducted are provided in the following section. After data is obtained, it will then be analyzed and ultimately be a basis for building theory. Some cross-case patterns can be highlighted, and some relationships can be established based on the incoming data. The findings will be analyzed in light of the existing theory and literature. A visualization of the flow can be found in Figure 3.

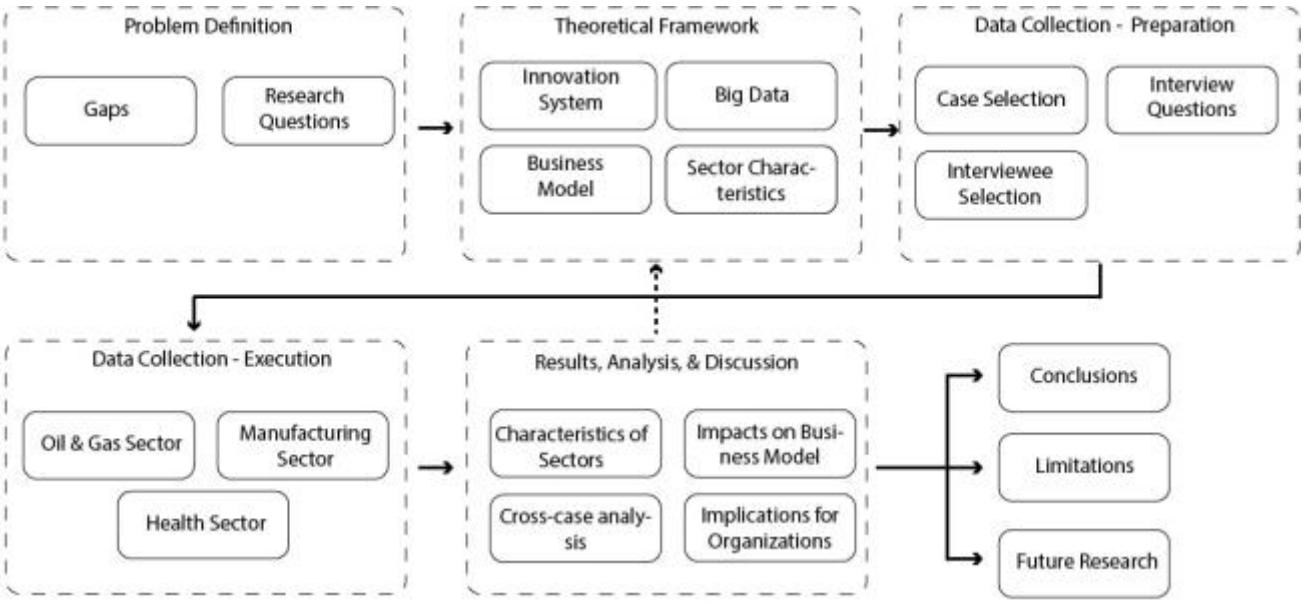

Figure 3 A visualization of the research approach for this study.

3.2. Case Selection

Case selection is important as a starting point to determine who will be interviewed. It is often regarded as theoretical sampling, where the selected cases fulfill the purpose of "illuminating and extending relationships and logic among constructs" (Eisenhardt & Graebner, 2007). The case selection is largely based on the established categorization of sectors in the literature, in order to produce a more robust categorization rather than exploring and establishing a new method. As mentioned previously, Papachristos et al. (2016) attempted to categorize the case studies of BYTE project into these three trends, which means eight possible scenarios from the combination of the variation of these forces. Further, it was reported that the categorization was able to group the seven case studies into five different scenarios, according to the trends that characterize each of them.

Among all industrial sectors that start implementing Big Data or have implemented Big Data, three are chosen for this study. These are oil & gas, manufacturing, and health, which are chosen because of their relevancy to Big Data implementation. The oil & gas, and health sectors have been found to be two of the potential sectors for Big Data implementation, and have been used as case studies in a previous study (Vega-Gorgojo et al., 2015). It is proven to have a lot of value for organizations, which is a good starting point towards seeing impacts in the business model. For manufacturing, potential can be found when Big Data is implemented, with examples of added value, such as improvements in capturing data in the machines and automation, leading to less waste produced and less human intervention with the machine, thus decreasing risks (Garcia et al., 2014). It was also included in the extension of the characterization based on seven case studies of Big Data (Papachristos et al., 2016).

3.3. Data collection

In collecting the data, a semi-structured interview will be performed. This is to ensure that the required information can still be obtained through the interview, however, without completely obstructing any potential new and relevant information from the interviewee. It is therefore suitable for the chosen methodology of the study. The prepared questions were based on the discussed concepts in the previous chapter, consisting mainly of four parts: introduction and general, Big Data implementation, impact towards business model, and characteristics of the sector. Additional questions can be asked spontaneously during the interview, in response to the answers from the interviewees. This enables the author to understand more of what the interviewees said and obtain additional information that might be useful. A more detailed list of the prepared questions can be found in Appendix I Interview Questions, as well as how to derive them from the concepts discussed in Section 2.

On average, the interviews were conducted for one hour, although some interviews were conducted for less than one hour due to technical circumstances. The interviews were conducted via video conferencing software, and were recorded. Some transcripts were fully made and can be found in the appendix, but one is an exception, due to a confidentiality matter. In all circumstances, the credentials of all interviewees and organizations are anonymized.

The full list of the people from different organizations that were interviewed can be found in Table 2. From each sector, two interviews were successfully conducted. In the oil & gas sector, both interviewees come from commercial-oriented companies with different roles. The first one is from an oil & gas company that does exploration, drilling and refining, while the other is from a company that provides infrastructures for an oil & gas production company. In the manufacturing sector, both interviewees come from the same organization, which is a research organization. However, both of them have different responsibilities, and different levels of involvement towards the operational level of research, although both are fully involved in Big Data-related projects. Due to these different positions, different perspectives can be retrieved. The last sector, health, is represented by two interviewees from the same organization. They come from a research institute, and are part of academia. Both of them, however, come from different backgrounds, and have different roles and responsibilities in the organization. This enables a different perspective on how they see Big Data affecting the organization.

Table 2 Interviewee from different sectors

Company	Sector	Description	Interviewee	Position
Company A	Oil & Gas	Commercial-oriented oil &	Person A	IT manager

		gas company. Activities including exploration, drilling, extraction, and refining.		
Company B	Oil & gas	A commercial company providing IT solutions for oil & gas companies	Person B	Senior Manager
Company C	Manufacturing	A research organization focusing in manufacturing technologies and manufacturing processes improvements.	Person C Person D	Project Manager Project Manager
Company D	Health	A research institution focusing on DNA research related to health issues	Person E Person F	Researcher Bioinformatician

3.4. Data Analysis

After data is obtained through interviews from various sources, it will be utilized for further analysis and ultimately for building theory. To do this, the results of the interviews need to be transcribed. The interviews were recorded, so the transcription can be made easier by listening to the recordings. The interview results are then transcribed in order for the data to be analyzed. After the interview results are transcribed, coding will be done on the transcription. Statements or insights from interviewees will be assigned according to which topic areas they belong. This process of coding enables a more systematic result to be presented, and therefore can be easier to use for analysis.

The analysis proceeds with looking at each sector present, using the existing literature as the basis. The analysis will be focused on the implementation of Big Data by the representative organization of the sector, the impact of Big Data towards their business model, and the overall sector characteristics with regards to Big Data. Afterwards, a wider view can be made by comparing sectors to each other, to see whether the findings are different and what

contributed to the differences. Subsequently, the result of the analysis can be used further to develop theories regarding Big Data implementation, as mentioned in the research questions.

4. Big Data Implementation & Implications Towards Business Models: Cases from 3 Different Sectors

This chapter focuses on the findings obtained from the previously conducted interviews. The aim of this chapter is to reveal what is happening in the respective sectors regarding Big Data, and what impacts organizations experience in their business model. The data will firstly be presented according to the respective sector it belongs to, in order to understand what is actually going on within each sector, what is the implementation in the organizations and in the sector, and the impact of the implementation towards the business model of the organizations. Statements and findings from the interviews will be referred to the interviewee using what is denoted in Section 3.3, for example Person A, Person B, etc. The same thing will be done when referring to organizations.

4.1. Oil & Gas Sector

The oil & gas sector is one of the sectors where the application of Big Data is highly relevant. The main driver for it is reported to be the need to survive through a crude price crisis situation, which forces companies to reduce costs and uncertainty of investments (Vega-Gorgojo et al., 2016). Big Data can be seen as one major way of helping them. A typical value chain in the oil & gas sector can be found in Figure 4. Big Data can be implemented in all parts of the value chain, starting from upstream to downstream (Hamzeh, 2016). However, this study will focus on the upstream activities in the sector, as the interviewees are involved directly in the upstream area of the value chain.

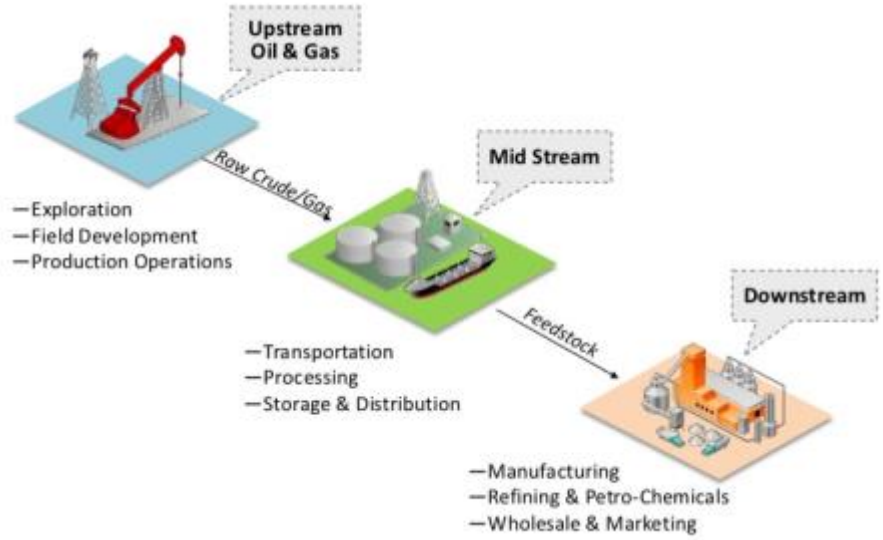

Figure 4 A typical value chain of oil & gas industry (Pitatzis, 2016).

The oil & gas sector is represented by Company A and Company B. Company A is one of the major oil & gas companies in the world. Company A is traditionally involved in the oil & gas

sector, however, they are also focusing on the renewable energy area. Their major operating field is spread throughout a number of geographical areas, including the North Sea, North America, South America, UK and Africa. Person A, an IT manager in the company, provided insights into how Big Data fits into and affects the company and the sector.

Company B is a company providing IT solutions in the energy business, with oil & gas clients as one of the areas. They also provide infrastructure for energy conversion like power plants. Person B, as an interviewee for the oil & gas sector, comes from Company B and holds a position as one of the managers.

Some information that was intended to be asked could not be obtained, either due to confidentiality reasons that interviewees were concerned about, or due to the limited time that interviewees had.

Table 3 Findings in the oil & gas sector

Concepts	**Sub-topic**	**Company A**	**Company B**
		Person A	**Person B**
Implementation	Application	Generation, acquisition, analysis, and usage of data	• Provides clearer picture of what is happening in the process • Simulation of future possible scenarios and how process can be improved
	Benefits	• Understanding how equipment and combination of equipments act • Integration of service data with producing installation data and intelligence out of it • Better maintenance, predicting regularity, leading to optimized production	• Process optimization • Better process controlling • Cost reduction • Better scheduling • Better delivery capacities • Both in terms of quantity and quality
	Challenge	• Integration of different sources, formats, and resolution	To create an ecosystem in the industry so that

		• Investment timing and allocation for infrastructure • Country-specific regulation constraints	information and data exchange is free flowing
	Progress	• Varies across the value chain, in general still developing • Prediction maintenance and equipment utilization is getting mature • Early development in production optimization and regulating production	Big Data is hugely influential in what is offered
Sector Characteristics	Transition	Slow	Slow
	Hegemony	Big Players	Fragmented (Big & small)
	Data openness	Closed	Closed
Business Model	Activities	Improvement in existing activities	• Better understanding of the machines • Better forecast • Customer's process optimization • Improved supply chain management • Better supply of raw materials
	Resources	• Raw materials remain unchanged • Higher efficiency in extracting oil & gas	• Infrastructure for cloud computing, including option for outsourcing • Software, options for open source
	Value Proposition	• Better value of product, deliveries, and guaranteed quality	• Constant change in the offering, following customers' expectation

		• Better decision of selling products	• In general reduced cost, faster process, real-time control
	Partnership	New vendors, startups, niche players as support in Big Data-related activities	Experts in algorithm, cloud computing, supply chain
	Customer Relationship	• Improved due to better value proposition, leading to optimized price	Improved due to numerous benefits from Big Data
	Customer Segments	• No changes experienced	Looking for new customers
	Channels	-	Start using digital platform, although impact is in different way with traditional industry customers
	Revenue Stream	• No additional stream, but improvement on the existing stream	Growth of revenue due to increased sales
	Cost Structure	• Overall expected to be lower on building cost • Lower investment on installation and construction cost	Clearer parts to reduce cost
	Competition	-	• Some big players in the same direction • Smaller companies are strong in their respective areas

4.1.1. Sector Characteristics

The findings of this study start by presenting the characteristics of the sector. Sector characteristics comprise three different aspects: the rate of transition, the type of players who implement them, and the accessibility / openness of data. In the case of the oil & gas industry, the result indicates that it is characterized by a slow transition towards Big Data, big players who are implementing Big Data, and a closed regime of data openness (Person A and Person B). It needs to be noted that the point of view of Person A and B is different, with the first one more on the exploration and production (E&P) side, and the latter more on the automation and infrastructure solution provider side.

The rate of transition in the oil & gas sector is found to be slow towards utilizing Big Data. A large amount of data has been involved in the industry for a long time (Bertocco & Padmanabhan, 2014). For example, from the E&P side, digitalization of the seismic data for exploration has taken place since the 1970s (Person A). Since then, there has been a slow and continuous effort of development and utilization of data, however, not optimal. Only until recently, is Big Data really considered to be advantageous and to have the potential to give added value towards the business. This is reflected by the progress of implementation across the value chain of oil & gas. Predictive maintenance and equipment utilization are two areas that are relatively advanced in the development, while production optimization and regulation of production are two examples that are at a relatively early stage in the development (Person A). Along the same lines, literature suggests that the implementation is found to still currently be in the early stage (Vega-Gorgojo et al., 2016). On the solution provider side, Company B started offering the service 15–20 years ago (Person B), which means that starting from roughly 20 years ago, there were already needs from the market to have a solution on how Big Data can be incorporated into their production facilities and plants. This is where Company B's role came in fulfilling the needs.

The implementation of Big Data in the sector is dominated by both big and small players, both in the role of E&P, and solution provider (Person A and Person B). It might be rather obvious for big players, because they have financial leverage to spend on big investments in infrastructure and capabilities. In E&P companies, they are also dependent on a number of vendors, whose role is to sell equipment and services to the operator, for example, those for drilling, platform equipment, and weather forecasting (Vega-Gorgojo et al., 2016). In addition, small players can also be seen to move into the utilization of Big Data in the role of solution provider (Person B). The role of small players is similar to that in the E&P ecosystem. The involvement with Big Data is not on how the companies work per se as producers do, but rather they offer services, for example, their expertise in handling Big Data, and very specific technology and applications as part of Big Data utilization. Therefore, it has nothing to do directly with the financial resources that the organization has. The small players in the E&P side have not implemented Big Data, however, they are known to have considered and reassessed their value stream to see and understand how Big Data can fit into their operation.

The regime of data openness in the sector is found to be closed. In both cases, data is seen as strategic and business value is created out of these data or the processes that generate it (Person B). Even more, seismic data typically makes up 70% of the data that an E&P company has (Person A). The volume is high, and these data are important. An E&P company, with exploration of potential wells as one of its major activities, will have no benefit whatsoever by, for instance, making their seismic data accessible. In addition, opening up their data poses a risk, as some issues regarding security threats exist in companies, urging them to tighten their security (Vega-Gorgojo et al., 2016).

Table 4 Comparison of characteristics in oil & gas with previous study.

Sector Characteristics	Expectation from previous study (Papachristos et al., 2016)	Findings from this study
Transition	Fast	Slow
Hegemony	Fragmented	Fragmented (Big & Small)
Regime	Closed	Closed

Looking at the oil & gas sector, the previous study suggested that it is a sector with a quick transition, fragmented hegemony, and closed regime (see Section 2.3). However, the results do not fully agree with the previous findings, as both the hegemony and the regime correspond to the previous study. Both big and small players are found to be implementing Big Data. The regime also shows agreement where data will not be openly shared, however, regarding the transition, the result shows that the transition towards Big Data is slow. This contrasts with the previous study that expected the transition to be fast. The characterization in the previous study was based on scenarios devised by experts in respective sectors, therefore, it can be said that the transition is expected to be fast. However, the current finding shows that it is slow. Both statements do not necessarily contradict each other – the decision of coming up with claiming the transition to be slow is based on taking into account the whole progress of implementation since the beginning when a huge amount of data was generated. It shows that it is only recently that there is an increasing understanding of the added value and that the capability of capturing value starts to build up. In addition, oil & gas is a late adopter sector (Vega-Gorgojo et al., 2016). Interviewees were also unable to really come to a conclusion of whether the transition is fast or slow. In that respect, judgments are based on the available information in the literature and in the interview.

4.1.2. Big Data Implementation

Application

In the oil & gas sector, Big Data is applied in many areas across the value chain. In exploration, it is used to increase the accuracy of drilling and locating potential wells (Person A). This can be done via gathering seismic data and data from a vast number of sensors around the well. Moving onto refinery, Big Data can help producers understand their equipment and how it acts. It basically makes use of a lot of sensors in the machines to understand the process that is running, not only in isolation, but also when machines are combined along the whole process (Person A and Person B). In addition, there is also an application of Big Data for predictive maintenance, where data is collected from the machines in order to be able to understand the best timing and execution for maintenance. Being able to predict the maintenance can help companies to have a better regularity in their production, and thus fewer barriers and problems towards meeting the demand. In general, the progress varies across the value chain, with some areas being more advanced than others. For instance, prediction maintenance and equipment utilization are two areas that are relatively more

developed, and production optimization and regulating production are two areas that are in the relatively early stage of the development (Person A). In the case of Company B, they are also able to simulate future scenarios in order to be able to identify which areas can be improved and how the improvement would affect the whole business (Person B). A number of technologies can also be employed when Big Data is utilized, for example robotics, augmented reality, and drones (Person A and Person B). These technologies help to maximize how an organization can benefit from Big Data.

Benefit

Utilizing Big Data allows operators to experience benefits in a number of areas in the business. Due to the ability to have predictive maintenance, the organizations are able to have better maintenance for their equipment in the process (Person A). Also, an important thing that organizations are able to do is to regulate their production process (Person A), which allows them to match their production capacity with the demand they are getting from the market. This is also agreed by Person B, in which he referred to it as having a better delivery capacity. Not only can they have control over the process from a holistic point of view, but they are also able to have a better process control on a smaller scale between machines and process units. This leads to a better understanding of the whole process, and ultimately to production optimization. It is reported that using Big Data and Big Data analytics can boost production by up to 8% (Bertocco & Padmanabhan, 2014). It will in turn affect the financial aspect of the business, with their overall cost being able to be pushed down (Person A and Person B). For solutions providers, the need for operators to be able to accomplish tasks related to Big Data provides an opportunity for them to come into the gap. Operators mostly do not have sufficient capability to accomplish such tasks, and solution providers can be of benefit by offering their capabilities.

Challenge

Organizations face a number of challenges in relation to the utilization of Big Data. Firstly, the integration of data from different sources is difficult because there are various data sources, which come in different resolutions, formats, and identifications (Person A). It mainly concerns coupling a 3D model with the engineering data, which if it is realized, will be very helpful for organizations. Secondly, there is the investment challenge. Utilizing Big Data requires organizations to invest heavily in the supporting infrastructure, in order to ensure processes go smoothly and are fruitful. This decision needs to be considered carefully, especially regarding the timing of investment, and the technology they want to invest in (Person A). Regulation constraint is also a challenge, which may not be only applicable during Big Data utilization. Different countries have different regulations, and organizations have to adapt accordingly and make sure that investments, and the application of technology in their process, are not hampered by the regulations. In addition, there is an ultimate goal of having an ecosystem in the industry, so that information and data exchange is free flowing within the network (Person B). This enables a more efficient process within the network of the

organization, and enables organizations to facilitate having a two-sided platform in their business model. It is, however, still not realized currently.

Organizational Structure

Company A relies more on having a partnership with external parties to execute Big Data-related activities, such as condition-based maintenance, and visualization of data. In contrast, Company B, as a solution provider, experiences impacts in their organizational structure. There are roles such as having digital officers in the digital department to be able to handle the needs of customers regarding Big Data-related solutions. Since digital sales are also involved, training is also needed for employees to be able to familiarize themselves with, and maximize the use of, digital sales.

4.1.3. Severity of Impact

Looking at the impacts that Big Data gives towards business, some observations can be devised. First, it turns out that in the oil & gas sector, companies are affected in almost all aspects of their business model. The results from Company A and Company B show that all aspects, except the customer segments, are affected by the utilization of Big Data. The customer segments might remain unaffected because of the specificity of what E&P operators are producing – they only sell raw materials and refined products (intermediates). Only those that are demanding these things are interested. Moreover, E&P operators mostly do business-to-business sales, which justifies why there is not any impact on segments, in terms of the addition of it. Big Data can, however, improve the relationship of the current customers due to improvements in process. The same case can be found in Company B, which is a solution provider. The specific offerings by solution providers leave the customer segments unaffected.

The aspects that have major impacts are activities, and partnerships. A lot of activities that are present throughout the value chain are affected by the utilization of Big Data, starting with exploration, production and drilling, general operations and maintenance, and sales of raw materials. This variety of activities shows that Big Data can be utilized in almost all of the companies' activities and they can reap benefits from it. Partnership is also seen as having a major impact, due to capability and risk reasons. The capability of a company to work with Big Data varies across companies, and in general is still developing. Synergy and collaboration with partners can be seen as beneficial to gain advantages from the utilization. Reducing risk is also one reason for operators to engage in collaborative partnership. The rest of the business model aspects actually follows these two aspects, where value proposition and customers' relationship will be improved, and will result in revenue growth.

4.1.4. Impacts on Business Model

Activities

Changes can be seen in the main activities of the organization when utilizing Big Data. As mentioned before, process optimization can be achieved. This entails various areas, starting from the exploration, production, trading, and supply chain (Person A and Person B). In exploration and production, the use of seismic data is highly influential towards improvements in the accuracy of exploration. It involves a vast number of sensors, which can be located on all the equipment above the sea, subsea, or inside the well (Vega-Gorgojo, Fjellheim, Roman, Akerkar, & Waaler, 2016). These sensors increase the accuracy of drilling, thus preventing accident risks. In operations, Big Data has an important role in changing the understanding of process. How the equipment behaves in isolation and in combination with other equipment can be explored, and results in process improvements. Maintenance is another major impact that the company can experience. Predictive maintenance enables a company to have better regularity of their production, leading to a more optimized process (Person A). Related to this, having a better forecast is also found to be beneficial towards many other aspects, such as supply chain, supply of raw materials, and smoother operations with less downtime (Person B).

Resources

The resources of the organization are affected due to implementing Big Data. Infrastructure for Big Data is seen as a valuable resource for organizations. The use of cloud computing is becoming more important and more widely adopted, as it can replace costly servers and save costs in administrative terms. It also gives better performance as it acts like a network with several connected servers. Outsourcing the cloud can also be an option since it can reduce energy consumption, especially when there are a lot of operations being handled (Person B). Open-source software can also be employed, which can lower costs but also give competitive performance. E&P operators typically explore their own resources for further production. There is not any impact on the resources exactly, but more on how the process of getting the resources is affected. As explained previously, a number of applications of Big Data in exploration can lead to improved efficiency, and better regularity. They can have control over the quality and quantity of what they are exploring and producing.

Value Proposition

Applications and benefits have been discussed previously. These can give a lot of additional value, not only internally for the organization, but also to the value that the organization can offer to the customers. They can understand the process and have better control over it, which can lead to process optimization (Person A). In turn, it contributes to high-quality product, which leads to the ability to fulfill the demand and expectation. In addition, having better predictability will lead to a better price in trading oil and gas, by utilizing all kinds of data related to the materials and having the data in digital form instead of manual, paper-based form (Person A and Person B). It also helps to stabilize the prices in the market and prevent them increasing dramatically.

Partnership

As an E&P operator, Company A experiences changes in their partnership. They are now connected with new vendors, start-ups, and niche players, who specialize in condition-based maintenance and analytics of data. Their role is to support activities related to Big Data, due to their expertise. Vendors also sell equipment and services, for example, those for drilling, platform equipment, and weather forecasting (Vega-Gorgojo et al., 2016). The same situation is found in Company B, where there are new partners in areas like algorithm building, cloud computing, and supply chain that are closely related with Big Data. Since Big Data is becoming an important part of the business, engaging with new, different partners that are experts in Big Data-related areas is essential to develop the business further. The need for talent exceling in Big Data analytics is becoming apparent, and having capabilities in working with Big Data is essential towards competitive advantage in the sector (Bertocco & Padmanabhan, 2014). Therefore, engaging in collaborative partnership, as Company A does, is beneficial and important towards Big Data implementation. In addition, the oil & gas sector is technically challenging and economically risky, with large investments involved (Vega-Gorgojo et al., 2016). Having partners can help them to share the risks involved.

Customer Relationships, Segments, & Channels

The aforementioned benefits of Big Data have an impact on the customer relationships of an organization, which are certainly improving, due to better value proposition and higher product quality. A good example is on trading of raw materials. The obtained oil and gas can either proceed to Company A's refinery or be sold to external refineries. This has always been manually done and paper-based between the operator and refineries. By utilizing Big Data, it can be done digitally and automatically, and thus can enable a real-time view of the prices. All kinds of improvements happening throughout the process of the company also contribute to the improvement of the relationship.

In terms of segments, however, no changes are found – Company A and Company B currently serve the same customers. It is suggested that Company B are looking for new customers, but it remains unclear whether they will serve new segments or stay in the same segments (Person B).

Person B stated that his company is also utilizing a new channel to reach customers. In particular, they have started using a digital platform to make sales. Feedback can also be gathered via the platform.

Revenue Stream & Cost Structure

There is found to be no impact on revenue, in the sense that there is an additional stream. However, there is certainly an improvement on the existing one. The ultimate goal of innovation and improvements is to have revenue growth, and this is what is observed from

both Company A and Company B. The improvements in value offering towards the customers help to increase the sales, and thus the revenue.

Building the platforms and infrastructures for all processes is capital-intensive for operators. It used to involve expensive investment and complex construction, without having too much agility in the building process (Person A), however, it is expected that the cost will be lowered significantly. The process and deployment of installation and construction will be simplified with the available integrated data, and higher efficiency will take place in the process. In the end, it will result in a significantly lower investment. In addition, Person B suggested that because of Big Data, it gives a clearer view to the organization on which areas of their value chain can be changed to reduce costs. Subsequent action can be deployed, whether to optimize the area or completely cut it out.

Competition

As a solution provider, Company B suggested that there are various players who are their competitors. Big players are certainly moving in the same direction as Company B, using Big Data to create competitive advantage, and smaller companies are also seen to be strong competitors, since most of them are very good in their respective areas.

4.2. Manufacturing Sector

This sector is represented by Company C, a research organization that focuses on research around the manufacturing sector; Company C is funded by the government. The focus of Company C is on discreet manufacturing. Two sources were interviewed – Person C is a manager in Company C. His role is basically to define projects together with the companies that are part of their network, translate the companies' needs, and discuss the technological possibilities. In particular to Big Data, he helps identify the needs in the manufacturing process and products, defining Big Data projects, and finding a technological approach using Big Data. The second is a researcher in the field of mechatronics; his role is to define the projects and to follow them up. The sources answered the questions from both the point of view of the company as a research organization, and of a manufacturing company to the best of their knowledge. Some information that was intended to be asked could not be obtained, either due to a confidentiality reason that interviewees were concerned about or due to the limited time that interviewees had.

Table 5 Findings in the manufacturing sector

Concepts	Sub-topic	Company C	
		Person C	**Person D**
Implementation	Application	Capturing information from machines, and use the information to create business value	• Data is still only collected but not utilized yet • Prospect is to interconnect machines
	Benefits	Increase overall efficiency of the process	Different ways • Users of machinery: optimize machines • Machine producers: gain control over the machine, interconnect and gather feedback for further improvement • Component manufacturer: no visible benefit due to what they make
	Challenge	• How to implement without interrupting IT system as the backbone • No room for slight disruption due to very high standard of production	• How to make use of Big Data • What is the most efficient way to implement
	Progress	• No specific information about a manufacturing company, but uneven and very early implementation in the sector	Differently • Some started 10 years ago to interconnect machines but does not advance further • Some start thinking how to interconnect machines • Some wait and see and try to understand

Sector Characteristics	Transition	Slow	Slow
	Hegemony	Big Players	Big Players
	Data openness	Closed	Closed
Business Model	Activities	• Marketing: new revenue models from the technology • Product development: definition of specifications & capabilities differently • Process definitions & operations management • Corrective & predictive actions	
	Resources	Changes in machine as capital assets	Less resource used
	Value Proposition	Quicker production & more control over the machines	• Improve competitive advantage • Move to different business models focusing on service
	Partnership	-	Looking for partners who can provide implementation solution
	Customer Relationship	More efficient & reach faster due to the improvements in the machines and process	• Is affected but do not know the details and to what extent • Improved due to the ability of gathering feedback • Potentially Improved due to new business model
	Customer Segments	No change	-
	Channels	No change	-
	Revenue Stream	-	• A new stream if new business model is employed

			• An improved existing stream if sticking to old business model
	Cost Structure	Costs like energy & raw material consumption will be lower	Lower the overall production cost
	Competition	• Competitor does not change • Competitive advantage, although there are other fixed variables influencing	-

4.2.1. Sector Characteristics

In the case of the manufacturing industry, the result indicates that it is characterized by a slow transition towards Big Data, big players who are implementing Big Data, and a closed regime of data openness (Person A and Person B).

The transition rate towards utilizing Big Data in this sector is considered to be slow. Manufacturing companies can be seen to have already been directing themselves towards Big Data as early as around 10 years ago, although only a few (Person B), however, the progress was slow. Data has been collected since then, but they did not do anything with it. Basically, companies are still figuring out the know-how of fitting Big Data into their business in order to maximize the value creation. This is related to one of the big challenges of Big Data in manufacturing companies, which will be discussed in the coming section. Other than the few companies who have started already, the rest are either starting to think about and to initiate projects, or are still waiting and trying to see and understand how it can fit their organization. In general, the implementation is still at a very early stage, and is expected to make rapid progress within the next three years, as claimed by Person A.

The implementation of Big Data is dominated by big players as the front-runners. It is still related to the progress of implementation across the sector, as discussed previously. A few big players are ahead with interconnecting the machines, although they are still in the midst of figuring out how to create value (Person B). The rest of the players belong to the two other categories, where they are initiating their move, or waiting to see the progress.

The regime of data openness is nowhere near an open regime. The data involved is private company data, or data from their network, customers, and service organization. It is not shared outside their network, as it can be a strategic threat towards themselves (Person A). Even more, Person B stated that companies *"… are extremely paranoid about the data […] it is very valuable thing even if they don't do anything with it*" (Person B).

Table 6 Comparison of characteristics in manufacturing sector with previous study.

Sector Characteristics	Expectation from previous study (Papachristos et al., 2016)	Findings from this study
Transition	Fast	Slow
Hegemony	Fragmented	Big players
Regime	Closed	Closed

Looking at the manufacturing sector, the previous study suggested that it is a sector with a quick transition, fragmented hegemony, and closed regime (see Section 2.3). However, the results do not agree with the previous findings, with the exception of the regime showing an agreement where data will not be openly shared. Regarding both the transition and the hegemony, the result shows that the transition towards Big Data is slow. This contrasts with the previous study that suggested the transition to be fast, and the hegemony to be fragmented. A possible explanation of the mismatch in transition could be that there is a huge challenge in reality that makes this a contrast. From the results, it is found that the know-how of implementing Big Data into the existing IT system is still limited and poses huge risks. The dependency on an IT management system, such as Enterprise Resource Planning (ERP) and Product Lifecycle Management (PLM), and the production quality requirement are two crucial aspects in the case of manufacturing. In addition, it is found that manufacturing companies consider the talent issue to be a huge challenge (Vermeire et al., 2017). Being able to have people that have the capabilities of dealing with Big Data is what companies need at the moment. For the mismatch in hegemony, it seems that the difficulty of implementing it poses a huge risk that small players cannot bear. Taking that huge risk would put them in a very unfavorable position in case there is a disruption.

4.2.2. Big Data Implementation

Application

Manufacturing companies can make use of Big Data in a number of applications. First, they can capture information from their machines and use it to create business value (Person C). They can also interconnect their machines in order to get a comprehensive view and understanding of what is going on in their process. Consequently, their overall performance is optimized and they can deliver a better product to their customers. Performance can be defined in several terms, for example uptime, energy consumption, or output quality.

Despite the possibilities, it appears that Big Data is not being implemented yet, or is at least still in a very early stage (Person D). The progress is uneven across companies, which Person D divided into three types. The first one is companies who are at the forefront, where they have already started interconnecting their machines back to 10 years ago. They want to extend this interconnection, and they are doing a lot of research on this to make the implementation happen. However, up until now, they have not done much with the data that

they already have with those interconnections between machines. The second category is companies that are starting to think of how to interconnect their machines, and they are focusing on IT projects to solve this. They are also starting to build their infrastructure to support it. The third category is the companies who are waiting to see what is happening with the Big Data landscape in the sector and trying to understand it. The implementation for them is still an expectation.

Benefit

In general, Big Data allows an increase in the efficiency of the process and better performance (Person C). However, there are a number of categories that can be distinguished between manufacturing companies, which are users of machines who make products, producers of machines, and component manufacturers (Person D). These three types of companies have different benefits if they implement Big Data. For the first category, the machine users aim for the optimization of their machines. This optimization can include uptime, energy consumption, output quality, or other parameters. For the second category, they build machines and sell them to clients. Their interest is to gain more understanding of the machines so that they have control over them, are able to interconnect them, receive feedback from clients, and therefore can improve their machines. By utilizing Big Data, they are able to realize this. The last category is the component manufacturer. This category is slightly different, because they only produce machine parts. Therefore, they only have control over small parts of much bigger machines. Interconnecting parts and components is not considered as feasible economically, so the advantage for them in utilizing Big Data is still vague. There might be an indirect effect, but it is still unclear.

Challenge

It is found that there is a huge challenge in the implementation of Big Data. Manufacturing companies depend hugely on their IT systems for their information handling in order to run their organizations, and their plants (Person C). This includes the Enterprise Resource Planning (ERP) system, and Product Lifecycle Management (PLM) system, and is typically used for transactions and financial activities. Because of this huge dependence, it is essential that the implementation of Big Data does not interrupt how the company operates using these IT systems. If it is not treated carefully, things can go badly wrong, for example the company is unable to produce, sell, and send invoices, and ultimately faces bankruptcy. The accompanying problem to this is that the know-how of utilizing Big Data, the most efficient way to implement it, and the best practices for this, are still in question (Person D). In addition, the complexity of the process itself is a challenge. The manufacturing involves tens of thousands of drawings, and hundreds of thousands of built materials, and they have to establish which parts fit into which products (Person D). At the same time, the quality control is very strict, where the success rate has to be at least 99.995%. This small room for error means that a slight problem in the implementation would cost a lot for the company.

4.2.3. Severity of Impact

Looking at the impacts that Big Data gives towards business, some observations can be devised. Similar to the oil & gas sector, in the manufacturing sector, companies are affected in almost all aspects of their business model. The results obtained from Person C and Person D show that all aspects, except the customer segments, are affected by the utilization of Big Data. The relationship with the customers, however, is positively affected by the utilization. All kinds of improvements that Big Data can give towards the company, such as the process improvements, and thus product improvements, can satisfy the customers' needs and requirements. This is applicable to machine manufacturers and product manufacturers, while for component manufacturers, the effect of Big Data remains to be seen. Meanwhile, partnerships is a grey area. Companies consider them to be important in building capabilities, and they are certainly looking into new partners to provide a solution for implementation. The extent of the impact, however, is not known, and the solution itself is not readily available in the market.

Major impacts can be seen in the activities and the value propositions. As the core of the business model, value propositions are hugely affected by the improvements from utilizing Big Data. A better process and better product are certainly at the heart of the value proposition, which is made possible thanks to a greater understanding of machines and the process, and also the ability to carry out predictive and corrective actions. Service is also a new value-offering that companies are looking into. These impacts in activities and value propositions lead to improvements, especially in the customer relationship. It is also expected that the growth of revenue and cost reduction will take place.

4.2.4. Impacts on Business Model of Manufacturing Companies

Activities

A number of impacts can be observed on the activities of manufacturing companies. First, in marketing, utilizing Big Data opens up new possibilities for new revenue models, which puts service at the core of the offering (Person C and Person D). Second, in product development, it enables manufacturing companies to define their machines' specifications and capabilities differently (Person C), because of the increased understanding of the machines and process. It allows them to define in such a way that they can have higher efficiency, better translation of customer needs, and thus more desirable output for the client. Also related to the understanding of machines and process, corrective and predictive actions can be taken by companies (person C), which lower the possible margin of error in the process, which is very low to begin with.

Resources

The main resource of a manufacturing company is the capital assets, including the properties and the machines (Person C). Consequently, the changes that can be observed in the resources entail the changes that can be observed on the machines being used. They include the information about the machines, the design specifications, the sensing systems, data capturing and cloud-based system, engineering resources, and analytics algorithms. Another change, beside the capital assets that can be observed, is the raw materials. Person D stated that: "The entire aim of production is to use as little resources [raw materials] as possible to make something". Due to Big Data utilization, fewer raw materials will be used for the production.

Value Proposition

As the core of the business model, value proposition is seen as an important aspect. It is found that the value proposition of manufacturing companies is affected by the implementation of Big Data. Firstly, companies can have quicker and more efficient production, and also have more control over machines. This results in a better quality that they can deliver towards the customer. In a wider view, this gives a boost towards the competitive advantage of a manufacturing company (Person D). Besides improving the existing process, there is also a possibility to move to a different business model that focuses on service (Person D), as briefly touched upon in the *Activities* section. In the new business model, they are planning to sell the right to use, and the clients will get the product. They are basically trying to couple the product and aftersales service, and sell it in one package. This kind of service is advantageous for both the manufacturer and the client. For the manufacturer, they find this kind of concept better because they would have a more constant flow of income due to the attractiveness. For the client, they find it better, especially when they have to buy a large number of products, because it is very costly and a very big investment when they have to buy the product. With this kind of concept, they are less reluctant to invest and buy the service. Upon employing this new business model, other aspects need to be adapted accordingly.

Partnership

At the moment, the partnership will be affected so far as to find a solution towards the implementation of Big Data in manufacturing companies. Due to the aforementioned challenge, which is seen as fundamental and risky, companies are looking for partners to be able to provide them with solutions for implementation. Up until now, there has not been any solution in the market for such a process that involves complex data (Person D). The available solutions are only suitable for other sectors with simpler processes. The impact of implementing Big Data on partnership remains to be seen in the future.

Customers' Relationships, Segments, & Channels

The customer relationship is affected positively by the utilization of Big Data. The more efficient process and better process understanding of the manufacturers' results in the better delivery of product and the ability to translate customers' needs (Person C). In addition, the

ability of gathering feedback also paves the way to a relationship with the customers. Feedback gained from customers will be received faster, and subsequent responses towards improvements can be done quicker. As mentioned in the value proposition section, the new concept of offering service will improve the relationship, as clients will find that to be more attractive and they will have less of a burden when investing (Person D).

In terms of segments, there is no change observed to be caused by Big Data implementation. Channels are also not affected, because the number of customers is limited.

Revenue Stream & Cost Structure

The new concept of a service-centric business model can result in a new revenue stream for manufacturing companies. Compared to the traditional business model of manufacturing companies, the new concept will probably result in higher revenue, due to the attractiveness and benefits for both producers and customers. Having said that, it has not yet been implemented and effects will only take place in the future. Companies that employ the traditional business model, and opt to improve it, will also see a growth in their revenue, due to the efficiency of their process and the increase in their value-offering for customers.

Regarding costs, Person C mentioned that there are two types of changes that can be observed. One is the direct effect, which mostly concerns the efficiency gains contributed from energy and raw material consumption. The other is the indirect effect, which mostly concerns maintenance and finding the root causes of operational inefficiencies. There will probably be a cost regarding organizational changes as well, however, it remains unclear at the moment.

Competition

It is found that currently the competitor will not be changed. When looking internally, applying Big Data can certainly give competitive advantage for the company. It is, however, also down to how other companies will progress. The future is still too opaque to actually tell how significant it will be (Person C). Some fixed variables are also playing an important role in what it will bring to the companies, such as warranty, technological risk, contractual, and product liability.

4.3. Health Sector

This sector is represented by Company D, a research organization that focuses on research around the health sector. In particular, it is an organization that focuses on medical research, human diseases, and children's healthcare. It is part of a university, and it works closely with a hospital. The organization is one of the front-runners in utilizing Big Data for DNA sequencing. The interviewees are researchers in the organization. Person E is involved in a team, which specializes in DNA sequencing, using the latest technology that is coupled with

Big Data analytics. Person F is involved in a research team focusing on cancer research, and works as a bioinformatician. It should be noted that the scope of the health sector being discussed is limited on the application on DNA sequencing. There might be other applications on a wider scale, such as those involving electronic health records and healthcare delivery, which are not considered in this discussion. Some information that was intended to be asked could not be obtained, either due to the interviewees' confidentiality concerns or due to the limited time that the interviewees had available.

Table 7 Findings in the health sector

Concepts	**Sub-topic**	**Company D**	
		Person E	**Person F**
Implementation	Application	DNA sequencing of exomes and genomes using Next-Generation sequencing	Sequencing of exomes and whole genome
	Benefits	• Able to look at whole genome, not only exomes • Smarter & quicker way to get end results	• More possibilities in terms of research, data science, technology, and science • Breakthrough findings on rare diseases
	Challenge	• Uneven access to high speed connection • Storage issue for data and RAM to work on • Condition of physical storage for servers • Standardization of findings & data due to compartmentalized group	• Longer time to have results, due to relying on another department for resources • Shared resource that limits for improvement on requirements • Different understanding across people
	Organizational Structure	Research groups comprise people from diverse background, dedicated bioinformatician for each research group	Different backgrounds of people in the group

	Progress	Currently 100% engaged	Being used but not to the optimum level
Sector Characteristics	Transition	Quick	Industry is ahead of academia, it is slower in academia
	Hegemony	Big Players and some small players	• In industry, both big and small • In academia, bigger institutions are more involved
	Data openness	Closed	Closed
Business Model	Activities	Able to use Next Generation sequencing with huge amount of data	More diverse activities and research focus
	Resources	• More funding is needed for high performance equipments • Balancing the allocation	Grant allocation for different options, the need to make decisions carefully
	Value Proposition	Smarter and quicker way to get findings	Better publications, sometimes no added value
	Partnership	• Much closer to computer science group • Establish relationship with commercial companies • Work closer with hospital partner	• Together with different universities with similar projects and focus • Service to commercial organization and university research group
	Customer Relationship	N/A	Improved, because the expected results are worth waiting
	Customer Segments	N/A	At this moment not, but there is a plan to expand
	Channels	N/A	Advertising the ability to work with Big Data within the university

	Revenue Stream	Attract more grants due to more publication produced	• Leads to more client • Soon providing service as well
	Cost Structure	• Huge investment in the technology • Hiring people who can handle Big Data as part of the research group	A plan for cost recovery model by providing service
	Competition	Other organization who also aim for the funding grant, especially those who also uses Big Data	N/A

4.3.1. Sector Characteristics

In the case of the health sector, the result shows that it is characterized by a quick transition towards Big Data, big players who are implementing Big Data, and a closed regime of data openness (Person E and Person F). Person F also added a distinction of progress between the industry and the academia, which will be discussed next.

The transition in the sector towards Big Data is found to be quick. The start can be dated back to 2007, with the growing demand for a data center, and an analysis technique to facilitate sequencing of DNA (Person E). The sequencing technology has kept evolving since then, so the infrastructure supports a huge amount of data that the sequencing generates. In addition, most universities and research institutions are now already utilizing Big Data in their sequencing, at least in the top 30 universities. Company D is also currently engaged with Big Data and rely on it a lot for their research, especially that involving DNA sequencing (Person E). Person F also stated that there is a difference in the progress between the industry and the academia, where industry in general is more advanced than the academia (Person F). The reasons are that firstly the industry can access the resources they need, such as server, hardware, and software, much easier than the academia. Newer and more advanced technologies can be readily available for them. Secondly, the organizations in the industry are much more focused on specific aspects rather than the academia who pursue more focuses. For instance, Person F stated that there is an organization in the industry where 20 people from the same background are doing projects with a similar focus. Exchange of ideas can be more fluid in these cases, where it is less possible in the academia setting.

The implementation of Big Data in the health sector is dominated by the big players. As mentioned before, at least the top 30 universities that specialize in medical and health research are putting investment into Big Data, and are involving Big Data in their research (Person E). It has to be considered that there is certainly a different degree of investment

across these universities. Larger universities are putting more investment into Big Data, as they usually have more financial resources and capabilities for doing the research.

The regime of the data in the health sector is a closed regime. The data being used is patient data, therefore there are very strict data governance rules to ensure the security of the data (Person E). Utilizing technology, such as cloud computing, also compromises the security of the data, for instance, when compared to using in-house servers (Costa, 2012; Marchant et al., 2014). In addition, the data is stored without patient identifiers like names. In some cases, data can be used, for instance, to develop databases (Person F). Efforts are, however, being initiated to be able to exchange data anonymously to generate valuable findings without being hindered and restricted, only because of data governance matters, and at the same time not compromising data security. Person E regarded the closed regime of Big Data as a barrier towards the progress of implementation in the sector. The data governance is a major reason for the implementation progress not being maximized as one would expect.

Table 8 Comparison of characteristics in health sector with previous study.

Sector Characteristics	**Expectation from previous study (Papachristos et al., 2016)**	**Findings from this study**
Transition	Slow	Fast
Hegemony	Fragmented	Big
Regime	Open	Closed

The health sector can be characterized as a sector with slow transition, fragmented hegemony, and an open regime. The health sector was initially found to be an open sector with regards to data openness. It was found in previous studies that the actors in the sector are expecting to have a positive degree of openness on data. This, however, is not found in the results of the interview with people who are working in the health sector. Both of them stated that the data is very closed and privatized towards the organization, in this context the research institute. It is open partially within the network of the organization, although it remains anonymous. The reason for the difference might come down to how the issue of data governance and security is tackled. It is expected in the future that assuming other factors are constant and supportive, data are becoming openly shared – maybe to a certain extent. The current findings, however, show that the issue still persists. The best way for organizations to handle the data at the moment is to restrict data sharing, limit it to the network of the organization, and remain anonymous.

4.3.2. Big Data Implementation

Application

One of the applications of Big Data in the health sector is in DNA sequencing. Sequencing itself is the technique of determining how DNA is ordered according to its constituents of base pairs

(NHGRI, 2017). It is used to analyze the DNA molecules, not on a single basis, but on a huge amount, and is referred to as targeted sequencing (Person E). There are two types of targeted sequencing: specific gene and all genes. The first one is usually referred to as exome sequencing, whereas the latter is called genome sequencing. Recalling the base pairs as the constituents, there are typically 50 million base pairs in exome sequencing and 3.5 billion base pairs in genome sequencing (Person E). Those immense numbers of base pairs also mean that it generates a huge amount of data as well. Per sample, the exome and genome sequencing generate around 30GB and 100GB of raw data, respectively. These raw data are then processed further using software to be able to look into them and carry out computational interpretation using algorithms. From this process, the size of the data footprint will roughly be doubled from the raw data size. Once the outcome from this processing is generated, researchers can then start to look at the data and interpret them according to their research interests and focuses. Currently, Company D has around 50TB of space for data storage to accommodate thousands of samples from the exome and genome studies.

In the longer term, the analytics of Big Data on genomes aim to shift the mechanism of prescribing medicine. Using databases, diagnosis and prescription will be data-driven, and increase the accuracy of treatment, for instance, targeted treatment for specific diseases (Costa, 2012). Data is already available, but the current practices are still not benefiting from it, and using analytics would help towards data-driven medicine direction (Marchant et al., 2014).

Benefit

Due to utilizing Big Data, the organization is able to explore various aspects in their research. In combination with the advance sequencing technology called Next Generation Sequencing (NGS), such analyses of exomes and genomes of humans are made possible. Specifically, with the organization working with rare diseases, there is a limited number of reports and documentation on the diseases. Opening up more possibilities in the exploration of the diseases helps researchers understand them more, and define the direction of the following research (Person F). Furthermore, a notable benefit that Big Data can give is the speed of processing, as stated by Person E that they are "… able to process the data in a timely fashion […] effectively convert that into base pairs of DNA […] that we can actually look at and start doing research". Person E also further claimed that using Big Data allows them to look at their data in a smarter and quicker way (Person E).

Challenge

In implementing Big Data, there are some challenges that Company D is facing. Firstly, there is the technical problem of not having a high-speed internet connection evenly throughout the institution (Person E). Having the connection is crucial in order to have the same access to the data in an efficient manner. It is also crucial in supporting the work of the high-speed computer, otherwise the advantage that they experience from having a high-speed computer

and other Big Data-related resources cannot be maximized. For instance, uploading 200GB of data can take two days without a high-speed connection (Person E). Secondly, there is the resource challenge – resource here means the server, hardware, and software to support Big Data. The shared resources prove to be a problem for some research groups. The central servers from the computer science group are shared not only with Company D but also with other departments in the university. Therefore, the requirements that Company D want to have might not fit what the computer science group can provide, since the shared resources have to accommodate all the needs across different groups (Person F). In addition, Person F also claimed that obtaining results takes longer in the sense that it has to go through bureaucracy. This can in turn hamper the possibility of using Big Data to the optimum level, and cause the group to be unable to utilize the latest supporting technology. Some groups have decided to use a commercial solution instead, however, the costly option needs to be considered carefully (Person E). Thirdly, there is the problem of the system's robustness, including how the servers are stored in a conducive environment. There have been a few occasions where a pipe flooded out the room and there was an interrupted power supply (Person E), which can disrupt the research process, especially when researchers are in the middle of doing something crucial. More seriously, the data center is at risk, and this means the data as the core of the research itself is at risk. In addition, a challenge of standardization concerns Person E as a researcher, because a number of groups are doing similar studies in similar areas but are hesitant to share within the same database. This is not the most efficient way of making use of Big Data in the research setting (Person E).

Organizational Structure

Company D is composed of a number of research groups. Each of the groups is made up of people who have different backgrounds, for instance biology, information technology, and bioinformatics (Person E and Person F). Each person handles different responsibilities throughout the study. Through employing Big Data in the study, there is more emphasis towards recruiting people with computer science or bioinformatics backgrounds, who can work with Big Data, make databases, and handle bulk analysis. This diverse composition possesses the inherent problem of communication and understanding, and groups are building shared understanding in order to achieve the goal (Person F).

4.3.3. Severity of Impact

Looking at the impacts that Big Data gives towards business, some observations can be devised. Similar to the oil & gas sector, in the manufacturing sector, companies are affected in almost all aspects of their business model. The results obtained from Person E and Person F show that all aspects, except the customer segments, are affected by the utilization of Big Data. It is, however, based on the most up-to-date state. There is no change in the customer segments of Company D, but there is a plan devised to look into new segments. By offering a service of analysis, Company D can serve other groups in the university, and other hospitals.

The resources aspect seems to have the largest impact regarding Big Data utilization. Person E stated that resources play a vital role in doing research with Big Data. Without resources, any analysis involving Big Data cannot be performed. The software, hardware, and servers are crucial in data storage, and data processing. Having good resources also attracts people to invest in the projects or join in the research groups, which contributes positively towards sustaining projects. In agreement with Person E, Person F also says that the budget to afford the infrastructure is very important in order to be able to perform analysis at the optimum level. Next to resources, partnership is also vital in realizing projects. The computer science group is important in order to manage the infrastructure of the data. A commercial company as a partner is also a viable option, with guaranteed output, and time efficient analysis despite the cost.

4.3.4. Impacts on Business Model

Activities

It is found that the activities of the organization are greatly changed. This follows on from the fact that utilizing Big Data opens them up to the possibilities towards their research direction (Person E and Person F). It gives the research organization the ability to break boundaries and study genomes as a whole, rather than only being limited to certain parts. Being able to work with and handle a huge amount of data helps them to understand more about the human genome and what is going on inside it. Utilizing Big Data means that the research can proceed by being coupled with the NGS technology. Having such advanced equipment will allow researchers to scrutinize DNA sequencing and consequently generate a huge amount of data. This is where the role of Big Data comes in, where it supports the NGS technology to handle that much data and be used further for the study.

Resources

The resources are affected in terms of the financial resources and technological resources. Financial resources mainly concern the funding of the research. For every project that the group is doing, they get a funding grant from the government, which is typically spent on paying salaries, hiring people, affording collaborative projects, buying extra space from the computer science group, and affording other options such as commercial solutions (Person E and Person F). What the group is experiencing is that the utilization of Big Data requires them to afford the supporting technology, such as high-performance computers, software, and servers to provide more storage. Sometimes it is difficult to afford those that fulfill the requirements or those that are the most advanced and beneficial for the research (Person E). Choices often have to be made, for example, whether the organization allocates the budget for a commercial solution, which gives them quicker analysis but is more expensive, or using the open software, which is slower but cheaper. Sometimes it is very contextual, depending on the limitation of the project in terms of time. For instance, there are projects that handle cases of children in the intensive care unit, in which a quick and reliable result is a given prerequisite (Person E).

Emphasis needs to be placed on technological resources. Although afforded by financial resources, technological resources have to be supported by financial resources. Examples of technological resources include hardware (e.g. high-performance computers), software, and servers. Without these resources, it is impossible for research groups to work with the amount of data generated and there will not be any new insights generated through the research. In addition, the amount and the complexity of the data generated will increase over time, faster than the ability of data storage, especially by working with whole genome sequencing (Costa, 2012; Marchant et al., 2014). Therefore, there is a real need for the infrastructure to cope with the increasing amounts.

Value Proposition

The value proposition of Company D is also affected due to the utilization of Big Data. Thanks to Big Data, they can do a more comprehensive research, involving the whole genome sequencing. This makes their results reliable, and "customers" such as clinicians are satisfied with these reliable results. It also allows them to assess and evaluate the direction of their research, as Person F stated, *"… broader perspective to what we do, what we can do, what we want to do, and to which extent we do*". In addition, since their end point is to submit publications of results from medical research, utilizing Big Data allows them to look at their data in a smarter and quicker way in order to obtain novel findings regarding rare diseases (Person E and Person F). These changes in value proposition will bring about other impacts, such as increased attractiveness to funding grants, which in other words affect the financial aspects of the organization's business model.

Partnership

Partnerships can basically be divided into two kinds: internally within the university and externally. For the internal partnership, they partner with the computer sciences group, where the group provided the infrastructure for the institute, such as the servers, and storage, excluding the commercial solution. By employing Big Data, the organization has built up a stronger relationship with the computer sciences group. The organization can benefit the stronger relationship, which they can ask for the computer sciences group to tailor to their needs. The external partnership is greatly affected by having Big Data, in that they would not be in contact with commercial companies if they did not use Big Data for analysis. The commercial companies provide them with the commercial solution, which gives the research institute a great advantage in terms of analysis time. The commercial solution includes the hardware as well as software to allow the computational and physical work. There are also other companies, which support the interpretation of the data, in order to build a database and allow the research group to look at the data easily. For instance, a person can have 3.5 million variants of DNA changes, and if they have a couple of unrelated individuals, it can go up to over 10 million. By employing the database, it allows the filtering of data so that the research group can look only at the interesting genetic changes. Another external partnership

is with the Children Hospital. People from the research institute work closely with those from the hospital, and perform similar analysis, only on a different scale. People from the hospital analyze the data for diagnostic purposes, such as blood tests or disease diagnostics, while people in the research institute analyze data to find novel and interesting findings. The scale of analysis in the hospital is smaller than that in the institute, however, when needed, the hospital can ask the institute for analysis in certain cases.

Customer Relationship, Segments, & Channels

Traditionally, a research organization as part of academia does not have customers; their end point is to publish their findings in publications. However, Company D is not a purely research-based organization, because they depend on others to get the data and projects. In a way, their customers are the clinicians (Person F). Utilizing Big Data helps Company D to improve their work, and in turn it satisfies the clinicians, as the clinicians get the result that they want (Person F). They can publish their breakthrough findings and fulfill the demand from clinicians at the same time.

Regarding segments, there is no impact experienced at the moment, however, there is a plan for Company D to focus more on providing services to university groups and other hospitals (Person F), which is to be expected within the next five years.

The way for the organization to reach the customers is not exactly affected by Big Data. It is, however, affected in the substance of what they are conveying in reaching their customers. They are advertising their ability to work with Big Data to fellow university groups (Person F) which is seen as a way of directing themselves more towards providing the service of working with Big Data, as previously discussed. They make use of advertising to convey their ability, and the value that they can offer towards potential customers.

Revenue & Cost

As mentioned previously, an improvement in the value proposition leads to an impact towards the revenue. In the case of Company D, the better value-offering results in increased attractiveness towards the funding grant (Person E), as the organization has proven that they are capable of delivering high-quality results and in turn can indicate that the grant can be turned into useful insights from the research. In addition, as also previously mentioned, the new plan to have more focus on providing services is currently underway, and in the future might provide a new revenue stream for the organization.

The cost is an aspect that is certainly affected by Big Data. The bigger investment is certainly inclined towards supporting Big Data, as it is seen essential for the research. These investments entail the servers, high performance computers, and software, including the commercial solution that might be opted for depending on the circumstances (Person E and Person F). The organization also incurs costs regarding the group composition, in which they

hire people from different backgrounds, especially those that are able to handle Big Data, like bioinformaticians and computer scientists. However, organizations can also make use of government support to lower costs in infrastructure. For instance, a data center built by the government in the region where Company D is located that can be shared among research organizations (Person E).

Competition

Competitors naturally appear as Big Data is being utilized more within the sector. Those that utilize Big Data will be strengthened and be direct competitors for Company D, especially in getting research funding (Person E). Mostly, they are part of the top universities who are also specializing in medicine and health. The role of Big Data is certainly affecting how the organization can compete with fellow funding-seekers, as it enables them to produce better publications through a more time-saving and more efficient analysis.

4.4. Summary of The Findings

Throughout this chapter, the empirical results have been presented for various sectors. The Big Data implementation can be seen within each sector, along with the impact that Big Data has towards the organizations in the respective sectors. From the results, the characteristics of each sector can also be observed. These aspects are summarized in Table 9.

Table 9 Summary of the findings in each sector

Sectors	**Characteristics**	**Affected Business Model components**	**Severity / significance**
Oil & gas	• Slow transition • Fragmented players • Closed data	• Activities • Resources • Value Proposition • Partnership • Customer Relationship • Channels • Cost structure • Revenue stream • Competition	• In general hugely impacted • No impact in customer segments • Main aspects are activities & partnership
Manufacturing	• Slow transition • Fragmented players • Closed data	• Activities • Resources • Value proposition	• In general impacts in almost every aspect

		• Partnership* • Customer Relationship • *Channels* • Revenue Stream • Cost structure	• No impact in customer segments • Main aspects are activities, resources, & value proposition
Health	• Relatively fast transition • Big players • Closed regime	• Activities • Resources • Value proposition • Partnership • Revenue stream • Cost structure • Competition	• In general impacts in almost every aspect • No impact in customer segments • Main aspects are activities, resources, & partnership

**Currently no impact, but still in search of suitable partners*

Following the presentation of the results, the next chapter will attempt to analyze the results in more depth, using the concepts discussed in chapter 2. The discussion on the analysis will also be presented in the next chapter.

5. Analysis & Implications for Organizations

Following the empirical part of the chapter, it is valuable to proceed with analyzing the empirical evidence that has been obtained through the interviews. The data will be made sense of using the established framework in the previous chapter (see Section 2). This section will contain the discussion on the utilization of Big Data, its impacts on business models, and implications for various stakeholders.

5.1. The Utilization of Big Data in Sectors

As mentioned previously in this study, the sectors can be different from one another regarding the utilization of Big Data. The differing characteristics reveal how fast a sector can take up usage of Big Data, who the players are that utilize Big Data, and how accessible the data is. This section tries to look deeper into these characteristics throughout different sectors, and how they differ from one another.

5.1.1. The Transition Towards Big Data

The *transition* of the sector towards Big Data is defined as the rate to which a sector implements Big Data. It can be attributed to a lot of aspects, such as the technical challenge and the complexity of process. The transition of the three sectors in the study is found to be different from each other. The findings will be compared to how the sectors were expected to be. As discussed before, the expectation was related to external events that are beyond the control of actors in the sector (Papachristos et al., 2016). Fast or accelerated transition can be contributed to by uncontrollable external events such as the policy on data security and the existing Big Data infrastructure, and slow or hampered transition can be contributed to by, for instance, climate change and natural disaster. The actors might find these external events as concerns that put them in a higher priority rather than focusing on implementing Big Data.

Oil & Gas

The oil & gas sector was expected to have a quick transition (Papachristos et al., 2016), however, the finding suggests that the sector is experiencing a slow transition. The oil & gas sector started in the 1970s with seismic data, and for years involved a huge amount of data, but most of the sector were unable to create value from the data. The sector is known to be a late adopter of Big Data (Vega-Gorgojo et al., 2016). Only in current years have companies realized the potential that Big Data can give to their businesses. The current progress looks more promising as most of the companies have started to reconfigure their businesses and equip themselves with the necessary infrastructures, and capabilities. At the least, companies are trying to make a plan towards utilization. The difference between the expectation and the finding can be contributed to by various reasons.

A possible explanation of the difference is the technical challenge that companies are facing. In the oil & gas sector, the involved process is considered to be complex, which involves a lot

of activities. To give an illustration, there are four major activities in E&P, which are exploration and scouting, production, drilling wells, and operations (Vega-Gorgojo et al., 2016). These activities can be broken down into a lot more detailed activities. The involved data for seismic activity alone can reach up to 6PB processed and raw data, as opposed, for instance, to the health sector, which has a total of 150TB for data. Tags for instruments are also adding complexity, with typically 80–100K per oil field that needs to be identified and it used to be done manually. These issues are what make the sector challenging technically, making the transition slower.

The oil & gas industry, as the energy regime, is also facing a threat from the emerging renewable energy technologies. The world energy mix will be shifted to not only be concentrated on the fossil fuel, but also other sources such as wind, geothermal, and biomass. The upstream part of the oil & gas industry will certainly be affected by the introduction of renewable energy sources. Some players might have a long-term vision that the fossil-based energy will not be favorable to invest in anymore. It can potentially be a threat for Big Data to be implemented into the existing production system. This cause of forestalled transition is actually supported by the related external events of climate change, which were found in the previous study, to contribute to a slow transition (Papachristos et al., 2016). Some oil companies, however, are starting to have a foothold on the renewable energy, including Company A. The implementation of Big Data might not be strictly for the process and technologies related to oil & gas, but more to those related to renewable energy.

The decline of oil prices, followed by the stagnancy of it, might also contribute to the slow pace of implementation. A huge decrease in oil prices has been a threat in the trading of oil. As found in this study, trading of oil is one of the major activities of Company A and a source of revenue. The utilization of Big Data can be an advantage to optimize price through real-time updates and transparency of prices, however, some players might have experienced a major loss to the extent that they could not invest in Big Data. They might have put more focus on how to regain their business' financial health instead of even considering innovation of their process and technologies further. Therefore, the transition of the oil & gas sector towards Big Data implementation is seen to be slow. They see and realize the potential of Big Data for their business, yet recovering from the oil price hit was a bigger issue for them to solve immediately.

Manufacturing

The manufacturing sector was expected to have a quick transition (Papachristos et al., 2016). The finding, however, shows the opposite. The manufacturing sector is relatively newer to Big Data when compared to the oil & gas sector. The implementation started around 10 years ago with a few companies starting to interconnect their machines. They have only been able to generate and store data, without doing much further with the data that they have. What makes the manufacturing sector considered slow is that the current progress shows relatively

no change compared to a few years back. They have quite a big concern in figuring out how to implement Big Data into their existing system and process.

The manufacturing sector faces a different challenge than the other sectors, and it concerns the implementation into the existing IT management system. It has been known for a long time that manufacturing companies operations greatly depend on information management systems like Enterprise Resources Planning (ERP), and Product Lifecycle Management (PLM), in order to assign tasks, schedule, and carry out transactional activities. Companies are still missing the know-how of implementing Big Data without disrupting the existing system at all. A disruption can greatly compromise even the existence of a manufacturing company. The standard of manufacturing is also very high, with a success rate requirement of 99.995%. This makes companies think twice before implementing Big Data, although they are aware that the potential values are very beneficial for the operations.

Regarding the solution that organizations need to implement Big Data, no such solution has been offered yet in the market (Person D). He explained that solution providers offer solutions that are more suitable in industries that have more linear processes, such as the advertising and travel industry. Data is much more complex in manufacturing processes, and the output quality level has to be extremely high (Person C). The complexity and high-standard manufacturing process contribute to the unavailability of commercial solutions for manufacturing companies to use.

In addition, the variance in the level of implementation throughout the sector can potentially cause solution providers to be more reluctant to work on such high-level solutions for manufacturing companies. As mentioned by the interviewees, there are three categories of implementation with different levels of implementation. Only the most advanced companies who already interconnect their machines seem to be potentials as the provider's customers. These advanced manufacturing companies only number a few. Other companies, who have started to define projects toward Big Data, might also be potentials, but certainly the companies that still "wait and see" the progress will not be employing any commercial solutions. Although the exact number is unknown, Person D gave a rough picture from the number of clients he knew who are asking for help from Company C. Out of 100 companies who are partnering with Company C, only about four are pursuing the direction of Big Data; it will most likely be less in the sector. The lack of potential customers for solution providers might contribute to the unavailability of such a fitting solution for manufacturing companies in the market.

The issue of solution availability can potentially be worse for the growth of Big Data implementation in the sector. From the point of view of the market of Big Data solutions, there seems to be an endless cycle between manufacturing companies on the demand side and the solution provider from the supply side. Since manufacturing companies are looking

for a suitable solution for the implementation, they try to find one in the market. However, there has not been such a solution for a very complex process such as manufacturing processes. In addition, the lack of R&D and uneven progress that pursue Big Data implementation can potentially make solution providers reluctant to develop one. It can be unattractive and unprofitable for them with such an uncertain industry and a huge effort is needed for development. This unavailability of the solution can in turn give a bigger gap for manufacturing companies to progress further with the implementation. They know that there is not a suitable solution for them to use, and they might find it pointless to develop further, since in the end, they will not be able to operate and execute processes that make use of Big Data. Developing the solutions by themselves is not an option for them, because they simply are not capable of doing so, and even though they might be able to do so, the cost of developing such a solution can potentially outweigh the benefit. In the end, manufacturing companies can be more reluctant to invest in Big Data. The cycle can go on and on, causing a downturn in the progress of Big Data implementation. This is certainly a kind of scenario that needs to be avoided, considering that Big Data is seen to give a huge benefit to manufacturing companies.

Health

In contrast with the other sectors, the transition of Big Data in the health sector is found to be fast, or to put it better, relatively faster than the other two sectors. Dating back to 2007, there was already an understanding that Big Data can provide a lot of benefits in the health sector. Since then, the implementation progressed further, and currently quite a number of organizations make use of Big Data in their research and activities. What makes the implementation in this sector fast is that although the starting point was similar to that of the manufacturing sector, the health sector has shown much more progress than the manufacturing sector. It is even found that Company D has engaged almost fully with Big Data. Interestingly, this finding of transition is also in contrast to what was expected (Papachristos et al., 2016). Potentially, the sector was expected to be slow due to the challenge of data privacy and security, which means that a lot of opportunities from Big Data cannot be realized. However, since the findings are based on a narrower scope of DNA sequencing, the privacy and security challenges do not significantly hamper it, thus it is an opposite and more positive finding.

The sector faces a number of challenges, and the biggest concern is regarding the privacy and data security. In particular, the data involved is patients' data. There is a good chance of patient identification being shared or exposed to the public if data security is not treated well. Although it is being anonymized, tracing can be made to come to a point where patient identification can be revealed. However, considering the starting point of the implementation, the evolution of the supporting technology (e.g. cloud servers, next-generation sequencing), and the current state of the progress and implementation, it can be inferred that the health sector has a relatively quick transition towards Big Data. It might

contribute to the extent that the challenge is affecting the implementation. The sequencing of whole genomes can still proceed using the next-generation sequencing, and the data can still be handled and processed by the Big Data infrastructure. The outcome can still provide a lot of insights into what is happening in the DNA sample, as experienced by Company D in their research activities. It can, nevertheless, be pushed further to a more optimum point when the data security issue can be overcome. Another challenge, which is resource accessibility, is also resulting in inefficiency related to cost and time. It does not, however, prevent organizations from conducting research by making use of Big Data. It is the way of doing the activities that can be improved and be more efficient. In addition, although the findings of this study are obtained from the perspective of academia, it would still not change the fact that the overall transition of the sector is rather fast. It is found that the industry side of the health sector has seen even faster progress than the academia side (Person F). Nevertheless, the main challenge of privacy and security remains a lot of work to be solved in the future to accommodate an even faster and further implementation.

5.1.2. The Hegemony of Big Data

The *hegemony* of the sector regarding Big Data implementation is also found to be different across the three sectors. While oil & gas has fragmented hegemony in the sectors, the health and manufacturing sector is found to be dominated by big players. Some findings differ from how the sectors were expected to be. The expectation was correlated with external events, such as the presence of big players, and environmental pollution (Papachristos et al., 2016). The presence of certain external events might contribute to a more supporting condition for big players, or vice versa.

Oil & Gas

The oil & gas sector is found to be a fragmented sector, dominated by mixed big and small players who implement Big Data, and matches with the expectation (Papachristos et al., 2016). Different findings can be discovered from a different perspective. In the case of the E&P operator, this fragmentation is not uniform in the sense that not all of them are E&P operators. The operators are big players, and certainly have the leverage to move into Big Data utilization. The small players, however, act as vendors and specialized service providers. They connect with large operators and provide what the operator needs. Vendors, most of the time, sell instruments, drilling platforms, safety equipment, etc., and start-ups provide services in analytics, data visualization, algorithm development, etc. (Person A; Vega-Gorgojo et al., 2016). An interaction is found between big and small players, in which both of them can benefit from the interaction in the form of partnership. This can certainly lead to further progress of the implementation in the sector, as the involved parties can contribute to each other according to their capacity.

When looking strictly at the operators, the smaller operators are, however, not as far along as the big operators in the progress; it is the larger players who advance in the

implementation. Larger operators are relatively more prepared with their infrastructure and partner engagement, while some smaller operators are still behind with only planning and evaluating their business. The difference in implementation between larger and smaller operators can be caused by the financial capability that they have. Certainly, larger operators have more budget to invest in Big Data infrastructure than smaller operators. Therefore, smaller operators move later than the larger counterparts and they need to understand really well how Big Data can fit their business, so that they can allocate their budget as efficiently as possible.

For solution providers, they can be seen as part of the partners that E&P operators have. Although their focus is not only on the upstream part, they certainly engage in the upstream as one of their focuses. Among the providers only, an observation can be made. The fragmentation is more uniform, where both big and small players are providing solutions for customers in the energy, and oil & gas businesses. There is a difference in the width of the focus that these players have. Small players are strong in their respective areas of expertise and lead to diversification of technologies for supporting Big Data. Large players are more all-rounders as they have the capability and resources to do so. This shows that Big Data can give added value to both big and small solution providers. This can also have a positive effect on E&P operators as the clients of solution providers, where operators can also engage with Big Data further when they partner with a solution provider with various types of solutions provided for many parts of the operator's process.

The findings do match or do not match with the expectation, depending on how the sector is viewed. As discussed earlier, when speaking about operators only, the hegemony sector can be considered as dominated by the big players. When it includes the vendors, service providers, and solution providers as part of the partners and network, the hegemony of the sector can be viewed as fragmented. It might be best to go back to how the hegemony is defined. This study borrows the term from a previous study, where expectations were made for a number of sectors regarding Big Data implementation. It was suggested that the hegemony can imply whether Big Data can be diffused and can benefit large players only, or can include SMEs as well (Papachristos et al., 2016). No specific suggestion implied any details in the role difference. In the light of the suggested interpretation, the discussed difference whether to view operators in isolation or not is not problematic anymore. Including the network actors and partners would explain comprehensively how Big Data can give value to players in the sector. The finding in this study matches what was expected from the sector hegemony. Therefore, it is a good indication from the hegemony aspect that the oil & gas sector is going in a positive direction towards Big Data utilization.

Manufacturing & Health

The manufacturing and health sectors are found to be dominated by big players. In both sectors, the reason for having only big players to implement Big Data seems to be leaning towards the financial capability.

There is a mismatch between the expectation and what is found on the hegemony of the manufacturing sector. The expectation was that the implementation will be fragmented into big and small players (Papachristos et al., 2016), however, only big players are found to have made progress with the implementation. As mentioned previously, no solution is available in the market that can help manufacturers implement Big Data into their existing process and information system. In this sector, the challenge of implementing Big Data without disrupting the existing information management system implies that there is a huge risk of failing and thus disruption in all activities. Although the risk is very high, at least the big players have more financial leverage to bear the investment for infrastructure (i.e. interconnecting machines), conducting research, and engaging with partners that might help to solve the problem. The huge investment and huge risk of disrupting the existing system are large barriers for small players to make progress towards Big Data utilization. They are reluctant to bear such a huge risk, and therefore choose to either try to understand the added value they can have from Big Data, and evaluating the fit of their current business, or to wait and see what the progress in the sector will be, and how Big Data can be implemented.

The health sector was also expected to have fragmented players in the implementation (Papachristos et al., 2016). The finding suggests the opposite, with only big players that implement Big Data. To clarify, this is taken from the perspective of the academia side of the sector. In this sector, big research organizations are implementing Big Data in their research, and thus can advance their sequencing activities further. By big, this means the research organizations that are part of the top 20–30 universities in the country with the same research area. The investment for the physical resource seems to be too much for smaller players. Affording all sorts of infrastructure, starting from servers, high-performance computers, software, and the next-generation sequencing machine is a challenge for smaller players. Even among the big players, the extent of implementation differs between each other. The top big players are certainly ahead of the others, along with their capability of dealing with Big Data. It might be that the industry side of the sector has more fragmented players who implement Big Data, thus the expectation as such. It is unfortunately not possible to know from the gathered data.

5.1.3. The Regime of Big Data

The *regime* of the sectors regarding Big Data shows an agreement between the three sectors. As found in the results, all the sectors have no open regime. Data is not being openly shared throughout the sector. They are still very much concerned with data security and privacy.

The findings in the oil & gas, and manufacturing sectors are in agreement with what was expected (Papachristos et al., 2016). Sectors like oil & gas, and manufacturing consider their data to be very valuable and can create business value with the data. Sharing the data openly would be a threat for their competitiveness in the sector, as some data contains sensitive information about the company. Having a closed regime would actually promote innovation and the competitive advantage of companies. Data can be seen as very valuable, and companies can use it for innovation. Having privatized data can result in a competitive advantage of a company against other competitors. Therefore, companies in these two sectors pursue data security. In particular, Vega-Gorgojo et al. (2016) found that E&P operators might find some threats to their data. They view this as important, so that competitors will not be able to have valuable data that the company has. It might still be possible to share the data within networks, in order to create value from the activities done jointly. It is, however, important that the partners within the network also have sufficient measures on their data security. Otherwise, sharing data to these partners would also pose a threat to the operator's data, although the partnership can create benefits to the operator. Vega-Gorgojo et al. (2016) also found that partners of E&P operators can have issues in data security. Having a strong measure of data security can thus build trust between players in the network, and by achieving that, players can enjoy the benefit they intended to have from the partnership without compromising the security of the data. Having a good amount of trust can be beneficial for having innovation through Big Data, as suggested by Dwivedi et al. (2016). Sharing outside networks will least likely be the case currently and in the future. The privacy issue, which some other sectors like health are really concerned about, is not an issue in these two sectors, since data is not shared in the first place. No personal data is involved, thus the privacy issue is not a concern.

The health sector is found to not match what the sector was expected to be regarding the regime openness. The expectation of the sector was to have an open regime (Papachristos et al., 2016), while the finding suggests that the sector has a closed regime. The privacy and security reason are of importance in this sector. The data being involved are patient data, and are very easy to trace if they are openly shared. Therefore, it makes the data governance strict. There is, however, a view by one of the interviewees in this study that the current situation of the closed regime is actually not ideal, especially for innovation. There is an expectation for data to be more openly shared to a certain extent, without compromising the identity of the patients. The effort to make data more open in the health sector will be beneficial to advances in medical research, as sharing of data can generate insights from experts from different organizations. It can also promote innovation in the sector, since knowledge can be shared more freely and new insights can be retrieved from other actors. Currently some achievements have been done in the sector, for example to have clear regulation and directives regarding data privacy in the European Union and specific regulations for health-related data, such as the HIPAA in the US (Kupwade Patil & Seshadri, 2014). Efforts are also being made by commercial companies, such as Microsoft's

HealthVault, that allow the individual to control which data can be shared and which cannot (Westin, 2010, p. 178). However, the issue of data privacy and security still exists. In particular, it is reported in some resources that the use of cloud computing, as one of the supporting technologies of Big Data, poses a threat to data privacy and security (Costa, 2012; Marchant et al., 2014; Schatz, Langmead, & Salzberg, 2010). Sometimes local servers are a more favorable option, since some regulation has not supported cloud computing yet. However, the cloud solution is seen as more powerful and efficient, as stated by Person B in the findings. The key point here is to ensure a balance between the technological change and the ability of regulations to adapt with the change. All in all, the mismatch between the expectation and the reality shows that the issue of open data is still a major problem in the sector, and there needs to be more attention paid to the problem in order to realize a more open regime without compromising the security of patients' data and thus their privacy. When the issue can be tackled, it opens up more possibilities for Big Data to benefit the health sector, for example, data sharing to improve the healthcare experience, and genomic medicine to have a more accurate diagnosis and prescription for patients. These possibilities can potentially create new businesses that can support them, such as platforms, applications, and service itself. It will mutually benefit the sequencing side of the sector as well, and can result in further growth of the health sector.

5.2. Impacts on Business Models Across Sectors

This section will analyze the impacts on business models in more detail. Expectations of the impacts on business models from Section 2.4.5 will also be used for comparison with the findings to see how the impact takes place in reality and whether there are new unexpected impacts that take place.

5.2.1. Oil & Gas Sector

In the oil & gas sector, it is found that the activities and partnerships aspects experience a major impact. Of course, as the core of what the organization is doing, having a great impact on the activities seems to be a logical finding. A lot of the main activities are found to be affected, starting from exploration, drilling, maintenance, and sales. This, in turn, gives the ability to the company to better deliver the value that they offer for customers, for example, higher quality of product and optimized price of raw materials. Partnership is found to also have a great impact, since a lot of Big Data-related activities are done through the contribution of various partners such as vendors, and service providers. It helps the organization to build capabilities in utilizing Big Data to innovate further and also to reduce risk in investments.

These findings in fact agree with what was expected before, based on the literature. It was expected that the resources and partnerships aspects are going to be affected, due to the requirement for the talent to handle IT-related and Big Data-related activities (Bertocco & Padmanabhan, 2014). Although it is unclear from the interview whether talent is a major

issue, it can, in a way, be derived from the fact that there are a lot of new Big Data-related activities being done. Activities like condition-based maintenance and regulation of production imply that there is a need for people who can perform such tasks. It is also mentioned in the interview that organizations usually outsource activities related to Big Data. In a way, the need for human resources as a part of the resources aspect is covered by the emphasis in partnership, where operators can have people with the necessary capabilities in working with Big Data-related activities.

The occurrence of impact on partnerships correlates well with the fact that the sector is characterized as having a fragmented players hegemony. Having fragmented players in the sector enables both big and small players to be able to experience benefits from Big Data. Big players and small players have different roles in the sector, but they complement each other. As mentioned previously, big players need people who can handle Big Data-related tasks. On the other hand, small players offer services in Big Data-related areas that can be beneficial for big players. This complementarity is what makes the sector dominant not only for big players, but also small players. In various ways, different companies of different sizes can capture values that Big Data can offer.

5.2.2. Manufacturing Sector

Meanwhile, the manufacturing companies see their activities, resources, and value propositions as the aspects that are greatly affected by the utilization, mainly concerning higher efficiency, better performance, and better product delivery. Activities on the operational level are affected in various ways, for example, product development, and marketing. Resources are affected as machines are considered as assets. Interconnecting them and enabling them to support analytics will certainly change the resources.

When compared to what the expectation on this sector was (see Section 2.5.4), it appears that the finding on the impacts on business models is similar. The activities, resources, and value proposition are aspects that are impacted by the implementation of Big Data. The partnership aspects, however, are not affected as much as expected. It turns out that partnership is affected in that it has a collaboration on finding ways to implement Big Data completely into the manufacturing. It was expected that collaborations would include working together on developing and sharing knowledge on technologies like smart sensors, analytics, and automation. The collaboration serves as a way to fill the gap in the necessary know-how and skills, especially when these technologies evolve rapidly. However, in having partnerships, organizations are looking more for ways to implement Big Data in the first place. The challenge of implementing Big Data into the existing manufacturing process and information management systems makes the impact on partnership less significant than expected. As mentioned in Section 5.1.1, the unavailability of solutions that can help manufacturing companies to implement Big Data is seen as a big hurdle. Mostly, the partnerships try to fill this gap, and to discover how the implementation can be facilitated.

Until the issue of implementation is solved, the aim of partnership will remain the same. In the future, there will be more possibilities that partnerships can create, such as working together on supporting technologies like robotic and augmented reality, and supporting infrastructures like cloud computing. Therefore, the extent to which business models are affected depends on what the implementation of Big Data is in the sector. Organizations can adjust themselves depending on what the sector is, and they will try to adjust their business models to support the implementation into their organizations.

An interesting observation is the finding of a new type of business model in the sector. There is an emerging business model of machine manufacturers, which focuses more on service (Person D). Widely known as the subscription business model, this is a new way for manufacturers to have their revenue model. The affected business model aspects for this kind of business model might be different to the traditional business model in the sector. Basically, customers of the manufacturing companies are paying for the service, and together with it they get the product. This kind of business model allows the customer to be less reluctant to invest in machines, since financially it is less of a burden for them. In turn, more customers can be attracted by the manufacturing companies, and can potentially create a steadier revenue than the traditional business model of selling the product. They can also aim for SMEs, since they might financially be able to buy. Therefore, companies might expect to have an improvement in their revenue stream, as a result of their changed value proposition. Some aspects might not be affected by employing this kind of business model, such as activities and resources. This type of business model does not necessarily emerge from the implementation of Big Data, however, it can be coupled at the same time with the implementation. Big Data can contribute positively towards the process (i.e. on the activities and resources), and value in the product, and subscription can contribute to the value proposition of providing better quality product at a more reasonable price. The possibility of having both at the same time might have a positive effect on the business, and both can support the business to have a more sustained revenue.

5.2.3. Health Sector

The organizations in the health sector view their resource as having a great impact from implementing Big Data. Physical assets like servers, computers, and software are crucial in conducting the genomic research. They struggle to conduct research to an optimal level due to resource-related problems. Having good resources also attracts people to invest in the projects or join in the research group, which contributes positively towards sustaining projects.

Compared with the expectation on the impact in Section 5.2.1, the findings in this study show agreement. The expectation was that the activities and the resources aspects would be affected by the implementation. The activities of the organization are certainly affected by Big Data. The ability to work with Big Data and the availability of the supporting infrastructure

allow researchers to push their research further. Firstly, they can work with the latest technology on DNA sequencing, which is the NGS machine. Using the machine, they are able to sequence DNA more comprehensively, allowing them to do whole genome sequencing instead of just targeted / partial sequencing. More insights and directions of research can be created through the advanced sequencing.

Importantly, the resources aspect is viewed as essential by people working in the field. Having to share resources can be disadvantageous for organizations. They cannot be fine-tuned to what is actually needed, since they have to be shared with other organizations, even outside the sector as experienced by Company D. Therefore, organizations cannot have the latest and best setting / combination of technologies to maximize their research. Having good resources (i.e. technical infrastructure) is important to promote innovation, since they can lead to good quality of data and can pose less risk from the point of view of data security (Dwivedi et al., 2016). Having in-house resources can overcome the problem, but it comes with a cost of investment, operation, and maintenance. Having an exclusive partner to provide resources might also be a solution, where organizations from the health sector can have optimum resources and there are experts who take care of the resources. It is provided by a commercial partner, however the costs are high. Since the dispute is on how to find the balance between having the best resources and best arrangement of technologies, versus having to save on budget, it then comes down to the available budget and the strategic planning of the organization. If they opt for the latter, then there are some intermediate options, like a joint development program, collaboration with other universities, and sharing resources with other organizations. This problem is more apparent in a research organization setting, since their budget is usually limited. From the industry side, it seems to be less of a problem since their funding is usually more sustained.

Partnership is an aspect that appears to be important through looking at the finding. It was not expected that this aspect would be impacted by the implementation. Organizations, especially those that lack the capability and funding to build and manage their own Big Data infrastructure, rely on their partners in doing so. This is strongly supported by the findings in the health sector. Company D is an organization that has a tighter budget and does not have sufficient infrastructure by themselves. Therefore, they rely heavily on the computer science group as their partner.

A new type of business model might be employed by research organizations, as stated by Person F. The difficulty in sustaining financial resources, and relying solely on research funds, triggers the idea of focusing on giving services in sequencing, in addition to the research activities that the organization always does. They can serve more customers from different organizations and hospitals. This kind of service can serve as the cost recovery model of the organizations. To recover costs used for research, resources, and experts, this service can be

used. It is expected that there will be an improvement in the revenue stream, which thus can be used for budget allocation.

There is also an opportunity for a new business model in providing security solutions for data security. Since data security is one of the prominent challenges in the sector, there might be more companies who offer to provide security solutions for the data that an organization has. The emergence of such business can firstly address the security issue, and secondly can complete the ecosystem in the sector. Data owners and data generators can benefit greatly from the provision of such a solution, and the network can benefit as a whole from having a higher quality of data being shared to create value. Bigger solution providers will obviously be active, but there might be smaller providers who will emerge. Looking back to the oil & gas sector, there are large providers as well as small providers who are present. Smaller providers can be strong in their respective areas, and can provide a diversification of technologies in their solution. This might also be the case with the security solution provider in the health sector. Smaller providers can also survive and be competitive in their business. SMEs can have a good chance to capture this opportunity.

5.2.4. Commonality and Differences Between Sectors

Comparing these three sectors, some similarities can be found. In all of the business models, value proposition, activities, and resources are at the core of Big Data utilization. Although the impacts on business models are found to be slightly different across organizations in different sectors, they culminate into those three main aspects. Value proposition and activities are closely related to each other. The value that the organization wants to offer to the customer is embodied in the activities of the organization. Through implementing Big Data, improvements are made on the activities, which can result in either enhancement of the value offering or the occurrence of a new offering. For instance, in the health sector, having the ability to sequence whole genomes instead of only exomes can result in the enhancement of novelty of insight, a value that the organization is offering. Constant improvements in the process of sequencing and analyzing data leads to higher efficiency and a smarter way of looking into data. This in turn leads to reliability of the insights generated. Resources are also crucial in the business model, as they act as support in making the implementation realized. By having good access to required resources, implementation can be done through the activities.

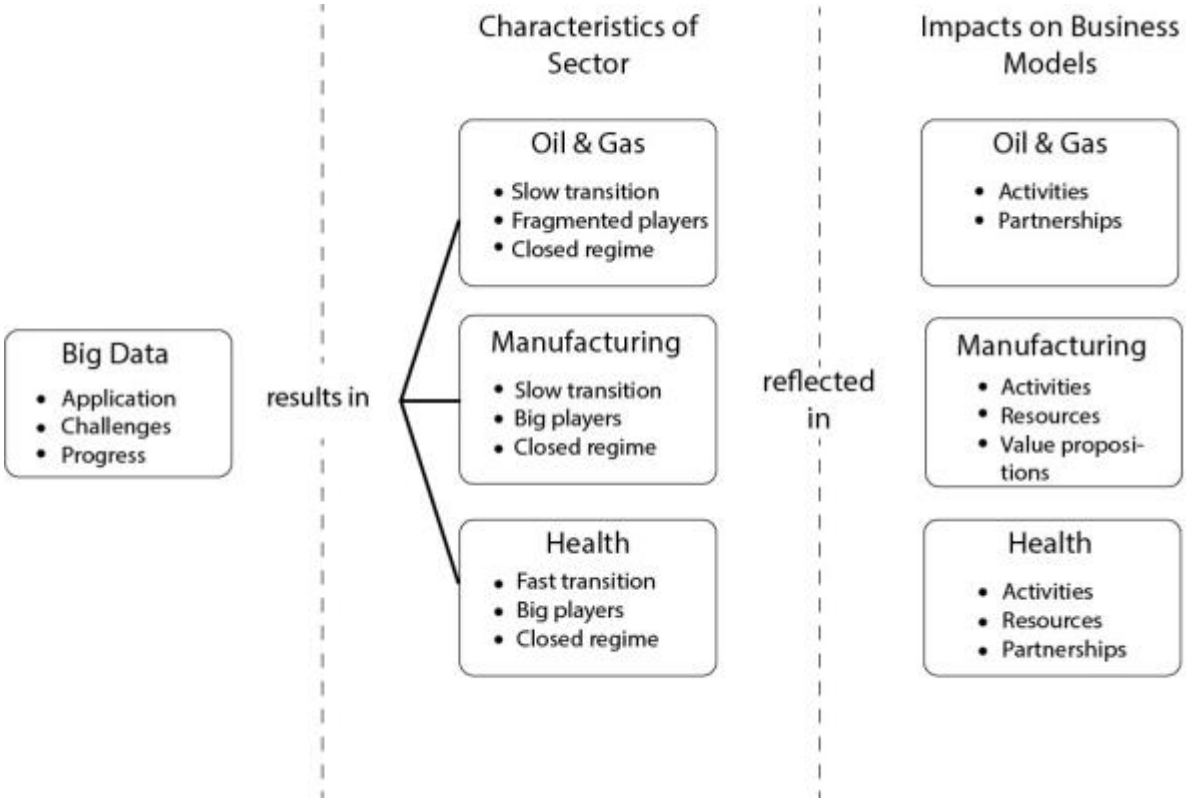

Figure 5 A depiction of the main findings and their relations

These three aspects of value, activities, and resources allow changes in other aspects. The availability of resources, and the capability of doing activities, are often supported externally by partners. Being able to better deliver the value proposition, customer relationship can be improved as the value perceived by customers is improved. Organizations can fulfill the customers' expectations better, and this is found to be valuable for improving customer relationship. The cost structure also addresses the effect by implementing Big Data into the activities. Channels can also be improved due to the need to deliver the value offered. It is, however, not always affected, as observed in the manufacturing sector, and E&P operator; it depends on what the customer base is. These mentioned aspects lead to the growth of revenue stream, or potentially emerging new revenue stream, and cost reduction. This commonality means that in implementing Big Data, those three aspects are at the heart of the change within business models, at least in all circumstances of the sectors in this study. Through improvements in the activities, organizations and companies can deliver improved or even new value propositions, and the improvements are made possible by the provision of the necessary resources.

Comparing the cases, one observation that can be made is that the customer segment appears to be unaffected. This is based on the organizations' current situation. This can be contributed by the specificity of the business of organizations and the experienced incremental improvements that can be directly beneficial to existing segments. Firstly, improved efficiency and optimized process do not directly lead to the expansion towards a

new customer segment. Instead, it remains as a possibility in the future to grow the business further once organizations are able to fully understand and exploit the potential of Big Data. The findings also show that Big Data has not led organizations to produce a new technologies or product that can be offered to new customers. What organizations can take advantage from Big Data is the improvement on their current process & products. Therefore, organizations choose to strengthen their position in the current customer segmentation by adding more value in their products. Secondly, it might be contributed by the specificity of their business. The value of the products that organizations offer to the customers in one segment might be different in other segments, as suggested by Mohr, Sengupta, & Slater (2010, p. 251) in the discussion of vertical segmentation (i.e. industry-specific segment). For example, the oil that is extracted by operators is only giving added value to companies that refine crude oil, and is not interesting for companies who do not refine crude oil. It is then sensible for organizations to focus on their current segments and strengthen their relationship with the customers rather than moving to new segments. Some interviewees foresee the change in customer segments in the future, for example those in the manufacturing and health sectors. Therefore, when taking into account only the current state, organizations do not see any impact in customer segments. The newly implemented Big Data is starting to take effect in their business, and organizations are starting to think about and evaluate which direction can they take the business further, and new segments are open as an option.

From a wider viewpoint, the findings suggest that the application, progress, and challenges of implementing Big Data affect how sectors are characterized, and business model is affected by the characterization, as shown in Figure 5. However, the polarized nature of the characteristics cannot completely show how business models are affected. The initial intention of the characteristics was to describe expectations on how various sectors will take shape in the future regarding Big Data implementation, as done in the study by Papachristos et al. (2016). There are some influential factors that affect the characteristics of the sector which can explain the impact on business models better. The challenges faced, and the progress of implementation that were addressed in Section 5.1, can explain how sectors are characterized. Given the characteristics, there are a number of impacts on business models that take place. Therefore, the challenges faced are precursors for both the way a sector is characterized and the way organizations adjust their business models accordingly. For example, in the oil & gas sector, there is a challenge with having talent that can handle Big Data-related activities. Operators are fulfilling the talent gap by engaging with external partners. This is reflected in the hegemony of the sectors that consists of fragmented players, where smaller players are part of the engaged partners. In the firm level, the business model experiences an impact in partnership, where due to Big Data implementation, organizations have to engage with partners that can help them to implement Big Data into their business. Basically, firms in their respective sectors are adjusting their business model in alignment with the environment in the sector they are situated in. A challenge might be inherent in one sector

and not found in another. This is shown by the difference in the challenges in the manufacturing sector. They face a huge implementation problem, since there are no infrastructural solutions available in the market for such complex processes in manufacturing. This challenge is, however, absent in two other sectors. Therefore, adjustments made in the business model might be idiosyncratic in a particular sector.

A more direct relation might exist between the challenges and the adjustments rather than the sectoral characteristics, which might explain the adjustments better than the characteristics. The same characteristics in two sectors can be contributed to by different causes, and the way organizations are adjusting is also different, although the sectoral characteristic is the same. Consider the following example: oil & gas, and manufacturing both have slow transition towards Big Data utilization. In the oil & gas sector, one of the contributors is the need for talent to handle Big Data-related tasks. The organizations, as displayed by Company A, adjust themselves by changing their partnership aspect to engage with partners to fulfill various activities. In the manufacturing sector, one of the contributors is the unavailability of an implementation solution. The organizations adjust themselves by looking for partners that can help provide the solution to implement. Although the same aspects are affected, the focuses of the partnership are different from each other, in which it is contextual in each sector. Therefore, the causes that are attached to the characteristics of sector should be taken into account, since those causes might be different for different sectors.

When looking at the three sectors, a distinction can be made between the organizations in each sector based on their roles on Big Data, as suggested in the taxonomy by Schroeder (2016). There are Big Data users, Big Data facilitators, and Big Data suppliers. Most of the organizations in the cases are both Big Data users and Big Data suppliers. They generate their own data from their process and use it for their business. These organizations make use of the data to improve their product development and their decision-making. Some solutions providers in sectors like oil & gas, and health act as Big Data facilitators, where they provide infrastructure, consultancy, and analytics. The different roles might influence how business models are affected. Large companies are mostly incumbent players in the sector, such as Company A in the oil & gas sector. They are usually the ones who generate their own data and use it for their business. The impact on their business model is usually incremental upon the introduction of new technologies, as it aims to build upon their current business model by improving their existing process and product. Smaller companies like SMEs are usually found to offer solutions for large companies who generate and own data. They can be regarded as Big Data facilitators who usually emerge because of the emerging opportunities that, for instance, Big Data can offer. Therefore, the impact on their business model tends to be radical, since they need to have an entirely new business model to accommodate what they are offering. Data facilitators can vary from smaller companies to larger companies, as implied by Person B.

The different roles in Big Data imply that there is an interdependency between organizations in different roles. It is, unfortunately, not possible to show the difference between these two empirically, since there are no cases that focus on SMEs. Whether companies need to adjust business model incrementally or radically is another issue. Abraham (2013) suggested in his paper that often firms, especially the large ones, fail in doing business model innovation and not having what they expected, because of too much doing incremental adjustments in a certain area.

Adjusting Business Models in an Innovation System

Looking deeper into the findings, Big Data implementation can be categorized based on the way it has an impact on the existing innovation system in various sectors. A distinction can be made between autonomous innovation, where innovation only affects a part of the existing system and therefore does not need complete reconfiguration, and systemic innovation, where innovation affects other parts of the existing system and thus needs complete adjustment; the change includes technological change, institutional change, and organizational change (Teece, 1996; Werker, 2001). Reflecting from the distinction, the implementation of Big Data can be seen as systemic. Firstly, there is a great need for necessary resources and infrastructures in order for Big Data to be implemented. Servers, hardware, and software all have to be developed at the same time so that they can accommodate the huge amount of data that is involved. Supporting technologies like sensors and machines have to be adjusted so that they are able to generate a huge amount of data and thus give beneficial insights to be analyzed further. This is actually shown in the findings by the great need of resource accessibility in order for activities that use Big Data to be conducted (e.g. in health sector). Secondly, there is the institutional change that is required in order to implement Big Data. Regulations need to be able to cover the use of a number of supporting technologies like cloud computing, so that these technologies can be utilized as a complement to Big Data utilization. Importantly, regulations have to be able to cope with technological change so that innovation is not hampered because of institutional reasons. A major change that can be observed is the existing issue of data security and privacy, which exists in all of the cases in this study. In the health sector, for instance, the expectation of having an open regime of Big Data has not taken place currently due to the issue. Institutions can play an important role in covering the issue of data security and privacy, and therefore enabling the innovation to proceed.

Consequently, organizations have to be able to utilize the innovation of Big Data so that they can benefit from the added value. Organizations need a set of capabilities in order to deal with Big Data, and they have to evaluate whether they already have them or not. Most organizations, especially those in the findings, do not possess such capability. Firstly, there is the difference in their core capabilities with what is required. The complementary technologies of Big Data have a wide scope, ranging from cloud computing, analytical software, to high-accuracy sensors. Organizations find the wide scope to be overwhelming,

and thus are unable to have the capability to proceed with the innovation alone. This is where the organizational change comes in as part of Big Data as a systemic innovation. As demonstrated in the findings of this study, a number of organizations who do not possess such capabilities are looking for these capabilities externally. Other firms, who act as Big Data facilitators, provide services and solutions with regards to the necessary capabilities. The organizations engage with these service and solution providers through collaborative partnership and outsourcing. This shows the interdependency and interactions between actors in order to have this organizational requirement changes. This applies to organizations in the oil & gas, manufacturing, and health sectors.

5.3. Implications for Various Organizations

The findings and the subsequent analysis can lead to a number of issues for discussion, which is organized based on the context for various organizations affected by Big Data utilization.

5.3.1. Implication for Large Companies

Companies can realize that Big Data can help them to deliver better value and offer more value, for example, the direction towards a new business model in the manufacturing sector. The service-based offering that is being planned will be beneficial for actors, including producers and customers (Person D). Customers will not be concerned with the huge investment upfront and can still improve their processes and grow their business. Producers can also grow their revenue and deliver better value to the customer by providing more advanced machines at a more reasonable price. Another example is the utilization of a digital platform for sales and operations, as displayed by the solution provider Company B in the oil & gas sector. Using a digital platform can help improve their reach to customers, getting feedback quicker and making subsequent improvements and fulfilling inquiries.

Resources do not seem to be a big issue in large companies, as they usually have sufficient financial leverage for investments in assets. However, resources not only entail financial aspects for physical assets, but there is also human capital resource and organizational capital resource (Barney, 1991). A concern that large companies might have is the human capital resources. The need for talent and expertise is a challenge that large companies must tackle (Bertocco & Padmanabhan, 2014; Vermeire et al., 2017). A way to solve it is to partner with experts on a specific area. As an example, Company A engaged with various partners, including SMEs, that are excellent in analytics, developing algorithms, data visualization, and condition-based maintenance. They engage with them to acquire capability in the respective areas. Company A, as a larger company, is still missing that capability, and it is the role of the partners to fulfill the capability gap.

Considering the aspects of business model, large companies can anticipate a more radical change in their business models rather than incremental change. In this study, it is shown that in all cases, almost all aspects are experiencing changes, and the exception of the customer

segment is also expected by a number of interviewees to have changes in the future along with the progress of implementation (see Section 5.2.4). This is also addressed by Abraham (2013), who suggested that companies usually change small parts in their business model, and this results in a failed business model innovation. Large companies should not hesitate to adjust their business model extensively when it comes to implementing Big Data. By effectively adjusting it, they can fully benefit from the value that Big Data can give to their business. Subsequently, changes in business model have to be reflected further into their strategy. By adjusting their business model accordingly, organizations would be able to transform it into necessary strategy in order to be more competitive in the market, as Casadesus-Masanell and Ricart (2010) regard strategy as "[…] choosing the way of the firm to compete". Thus, alignment has to be made between the strategy of the firm and how they operationalize their strategy in various aspects, and by doing so, firms can expect to be better equipped in capturing value from implementing Big Data.

Considering that the findings of the sector characteristics mostly do not match the expectation (see Section 5.1), large companies should prepare themselves to adjust accordingly. For oil & gas operators, the transition of the sector towards Big Data is slower than expected. The discussed possible explanations of the mismatch might be a consideration for operators to evaluate themselves, to see whether firstly they have taken those into account when implementing Big Data, and secondly to formulate strategy and plan on how to tackle the challenges. Some strategies have been done by several big companies, for example by also moving into the renewable energy business. Reevaluation has been done by most companies to embrace Big Data, as explained by Person A. However, they should also be aware of aspects that might slow down their implementation, and thus prepare themselves accordingly by adjusting their business model and carefully formulating strategies. The reevaluation and subsequent adjustments should also be done by companies from different sectors, by referring to their own sector characteristics and challenges.

5.3.2. Implication for SMEs

SMEs play a considerable role across various industries. They contribute 99.8% of the total contribution in the non-financial sector (Muller, Devnani, Julius, Gagliardi, & Marzocchi, 2016). Some inherent features of SMEs, which might by a disadvantage, are their limited resources, infrastructures, and technology (Riege, 2005). In addition, the lack in absorptive capacity (i.e. the ability to identify, assimilate, and apply knowledge (Rosenbusch, Brinckmann, & Bausch, 2013)) makes it difficult for them to turn knowledge into value in their business. However, SMEs in general are internally conducive for facilitating innovation, mainly due to their size, single-site location, and social relationship (Riege, 2005). Their agility is also an advantage for them to benefit from innovation. It can be facilitated through learning during the innovation process, which in turn leads to greater absorptive capacity (Rosenbusch et al., 2013).

SMEs can benefit Big Data in various ways. First, their decision-making process can be improved, helping to position them better in the market through a richer and robust data-driven decision-making, and also faster and more efficient (Engels, 2017). Second, optimization can be facilitated, as has been demonstrated by the cases (see chapter 4). It can help them to gain a competitive advantage, even when facing threats of competition from big companies. The focus-oriented nature of SMEs is proven to be a challenging encounter for big companies, as displayed in what Company B experiences (see Section 4.1.2).

Honing in on the utilization of Big Data, there are some typical challenges that SMEs face. First, they are behind in terms of the understanding of Big Data and how they can benefit from it (Coleman et al., 2016; Engels, 2017). It is reported that most of them are reluctant to invest in Big Data, as it incurs a lot of associated cost for them (e.g. processing, transferring, storage) and they do not recognize the full potential and value of Big Data. It most probably accounts for their lack of financial leverage (thus willingness to take risk in investment) and lack of absorptive capacity to process and transform Big Data into valuable insights. Second, the labor specifically for Big Data positions is limited which leads to competition in recruiting talent for the position, and results in a competing salary offer. It goes to the point where it is not feasible for SMEs to make such high offers (Coleman et al., 2016).

Therefore, SMEs need to find a way to overcome the existing challenge. For them, building innovation capacity is important in order to have value from Big Data. It can be accelerated through engaging in collaborative partnerships and networks (Forsman, 2011). Especially in sectors where processes are complex and thus capability is really necessary to innovate, building partnerships is beneficial for SMEs. Partnerships might be beneficial to help support research and financial capability. For instance, in the health sector, as resource is seen as a crucial aspect in utilizing Big Data (see Section 4.3.4), the provision of resources might be facilitated by the partnership so investing in Big Data might be the right decision to focus on. Narrowing down the focus might be advantageous, as displayed in the health, and oil & gas sectors. A very focused small player can still create competitive advantage within the sector and can still be a threat even to larger companies. It is also the reason why industry can excel faster in Big Data utilization compared to academia in the case of the health sector.

SMEs can also have an entirely new business model. There are a number of newly emerging business models that use data as the key resources, such as data-as-a-service and analytics-as-a-service (Hartmann, Zaki, Feldmann, & Neely, 2016). Another possibility is providing security solutions for companies who generate and own their data (see Section 5.2.3). SMEs can capture this opportunity of the value that data can create by providing services according to their core capability. An example can be seen in Company D, who intends to provide an analysis service in the near future. It views this new model as more sustainable for the organization and its research activities, since there will be an additional revenue generated from the service. Another example is provided in the oil & gas sector, where solution

providers can also be smaller companies. They have proved to be as competitive as their larger counterparts, and they are strong in their respective expertise areas (Person B). This shows that SMEs who pursue the provision of solutions can have an opportunity to survive and be competitive, as long as they can capture that opportunity from Big Data and can create value to be offered.

As discussed previously in Section 5.2.3, the concept can be widely applied to other sectors as well, such as in the health sector. They can provide security solutions for data owners, and data generators in the sector. An added value for providers is that data security is seen as very important and even still problematic in the sector. In the oil & gas sector, there is certainly a need to have SMEs that are able to perform analytical tasks and other Big Data-related activities, as found in the oil & gas sector. Both operators and solution providers can benefit mutually from each other. Other opportunities might be present in other sectors. This can create a good ecosystem in the sector, and can lead to further growth by the introduction of Big Data.

5.3.3. Implication for Research Institutions

Research institutions depend on their funding from funding grants. While some can be obtained from inside the institution, some others depend on what the government can provide for funding grants, as in the case of Company D. The concerns for research organizations are on how they can sustain research activities and even grow further, while funding is limited. Relying on research grants alone might not give good growth in the direction of research, given the potential that Big Data can provide. New business models or value offerings can be employed to allow for new revenue streams. An example is to have a new offering, as Company D is currently planning. They want to expand to providing a service on sequencing to research groups in universities and also for hospitals. Offering services to more clients would be a good way to grow revenue, as they can act as a cost recovery. The additional revenue from providing a service can be used to cover costs for research, resources, and experts.

Regarding the business model, research organizations can expect to have more radical change. This is supported by the fact that various organizations, including research organizations in the health sector, experience impact in almost all of their business model components (see Section 5.2.4). Particular emphasis might be put on the resource aspect, as it proves to be a big concern for research organizations, demonstrated by the findings. Generally, research organizations get their financing from receiving research funds, and sometimes this is not sufficient, especially when utilizing Big Data where they have to afford servers, high-speed computers, software, etc. They can also prepare themselves to embrace new applications of Big Data that might come into realization, such as genomic medicine, prescriptive analytics, and sequencing as a standardized test by, for instance, adjusting their

segments to include general practitioners or equip themselves with necessary resources and capability of such analytics.

5.3.4. Implication for Government

Supporting the uptake of Big Data might contribute to the growth of a sector. For example, the initiative in the UK for an open shared data center specifically for health- and medical-related research institutions could help research organizations to overcome the barriers in resource-related problems that hamper their research. Although it is only for part of a project, the project itself is initiated by the government agency NHS (Genomics England, 2017). Providing more grants for research related to Big Data can also promote the utilization of Big Data, for example NIH in the US, with the grant for Big Data related to biomedical research (Computing Community Consortium, 2016). Through initiatives like this, it can firstly raise the awareness that Big Data can really deliver value towards the society. Secondly, it can be beneficial for organizations in their respective sector to understand that implementing Big Data can grow their current activities and business, or even expand towards a new one. This can help to promote utilization in a sector and can contribute to the growth of a sector.

Governments can also provide support in terms of regulation, where unnecessary costs like administrative costs that inhibit smaller companies to grow can be omitted (Morvan, 2016). Therefore, companies do not have to worry about spending their money on superficial matters, and instead can focus on spending on innovation, including those related to Big Data. In addition, more focus can be put on supporting data privacy and security, since it is an issue in most sectors, as also found in all the sectors in this study. It is necessary for regulations to keep up with the technological change, as sometimes some technologies have not been covered in the regulation and thus are unable to be used despite the benefit. Support in terms of infrastructure can also help to ensure exchange of data in sectors that benefit from doing so, and at the same time to make sure data security and privacy are emphasized.

6. Conclusion & Future Research

To conclude the research, this chapter aims to provide the conclusions of the study, by looking back at the research question and the sub-questions, and trying to answer them based on the attempted analysis and discussion. In addition, the limitation of this study will be addressed, and lastly, some remarks on the future research will be established.

6.1. Conclusion

Big Data, as an emerging and ongoing trend, is being widely considered, researched, and implemented throughout various sectors. Although the level of implementation varies between different sectors, it is important to understand what it takes for one to implement, adapt the use towards their business, and ultimately reap benefits from utilizing Big Data. While the research on the technical aspect, as well as social and economic aspects has started to be more frequent, the research on how to implement and adapt towards organizations' businesses and activities remain generally under-explored. This study adds to the existing research by contributing to how the implementation of Big Data will impact on an organization's business model. The framework used in this study is constituted of a number of previous studies on Big Data utilization, and equipped by a modified template of business model that has been widely used by organizations. Some conclusions can be derived from this study. The main research question and sub-questions addressed in the beginning of the research will be answered.

Main research question: How do different industrial characteristics influence the business model component change when implementing Big Data?

The sectors are characterized using the previously mentioned characteristics of transition, hegemony, and regime. These three characteristics were actually developed in the previous study of Papachristos et al. (2016) as trends of Big Data in sectors. It depicts how the implementation of Big Data in various sectors is expected to be and how sectors are preparing themselves from the perspectives of actors and institutions. The characteristics are found to be related to how the implementation of Big Data is actually going on. Some factors that influence the characteristics include how Big Data can be applied in sectors, what challenges sectors face in the implementation, and how far the progress of implementation is. For instance, the huge implementation challenge that the manufacturing sector is facing makes the transition slow, as shown in Section 5.1.1.

Furthermore, this study shows that certain business model aspects change depending on how the sectors are characterized. For example, in the oil & gas sector, the issue of talent and capability forces companies to adjust the partnership aspect of their business model, since it can greatly help their activities related to Big Data (see Section 5.2.1). However, the polarized nature of the characteristics cannot be completely able to actually tell how business models are affected. Some contributors, such as challenges faced in implementation and progress in implementation, can explain some changes in business model better, as shown in the

partnership aspect in the oil & gas and manufacturing sectors (see Section 5.2.4). In addition to the difference, the implementation of Big Data in various sectors shares some similar impacts on business models. Activities, resources, and value proposition are three aspects of business models that are certainly affected, regardless of what the characteristics of the sector are.

Several sub-questions were derived to further enhance the understanding of the main research question and act as complementary to the main question. Sub-question 1 emphasizes the benefits of implementing Big Data for organizations in terms of the added value. With this fact, the second sub-question explores the possibility that the implementation takes place differently across sectors. It is then complemented by sub-question 3, which concerns the difference of the implementation between sectors on an organizational level in the form of business model impact.

Sub-question 1: What added value can Big Data give towards business?

Big Data can create a lot of potential value for businesses, and this is seen as a good incentive for organizations to implement Big Data and grow further themselves. Some significant added value from Big Data can be seen in the ability to have better forecasts, process improvement, and increased efficiency of operations (see Section 4). These lead to optimization of the overall process and reduction in cost. Considering that there are overlaps between the potential value that organizations can give and the actual value that organizations can create, organizations are currently able to turn their data into meaningful systems. Despite not being maximal, they succeed in creating added value out of data that they have. This can be observed from at least two out of the three sectors in this study, which are oil & gas, and health. Being able to have added value, it shows that the progress of implementation in both sectors is promising and going in a good direction. Challenges still remain, however, it does not significantly hamper the implementation to be going further. An exception can be found in the manufacturing sector, where they seem to be struggling with the implementation (see Section 5.1.1). They show an understanding of how Big Data can give them added value, but there is still a big gap in the execution part. No evidence can be found of the companies having obtained added value from Big Data. The problem lies in the missing solution of the implementation, which even commercial companies cannot provide. There is a potential that due to this challenge, the implementation will remain stagnant or even see a decline.

Sub-question 2: What trends are characterizing sectors in implementing Big Data? How do these differ across different contexts?

The ability of Big Data to create a variety of value can lead to Big Data implementation across sectors. Sectors, however, might react differently to the introduction of Big Data, as demonstrated in the expectation made in the previous study by Papachristos et al. (2016). It is reflected in three trends that can characterize a sector, which are based on the rate of transition, dominance of players, and data openness. These trends were originally derived

from a set of external events that are seen as influencing yet uncontrollable. The trends are used in this study as a tool to differentiate sectors, and at the same time to see whether the expectations take place in reality.

From the findings, there seems to be some mismatch with the expectation from the same previous study. The transition in the oil & gas sector is slow towards the uptake of Big Data, which is the opposite to what was expected. This deviation can be contributed to by a number of aspects, such as the technical complexity of the process, the emerging threat from the renewable energy regime, and the decline of oil prices in recent years. The transition in the manufacturing sector is also slow towards Big Data, opposite to what was expected. It is mostly due to the difficulty in implementing Big Data into the existing process and information system. There are no available solutions yet in the market, making the implementation risky. Solution providers mostly offer solutions for simpler processes, and manufacturers do not find them suitable for their complex process. In the health sector, the transition is also found to be the opposite of what was expected. The transition is relatively fast towards Big Data, where research can already benefit from the implementation. However, the challenge of data security and privacy is a huge barrier towards further implementation, and actors find this to be an obstacle in having the most efficient activities to innovate further. Resource accessibility is another barrier in creating more value out of the implementation, as actors find the resource to be a requirement to implement Big Data in their activities.

The hegemony of Big Data implementation is also found to be different than expected in some sectors. The manufacturing sector shows that big players are dominant in the implementation. Since the implementation is difficult for manufacturers, players have to bear a huge risk of activity disruptions when something goes wrong. With such huge dependence on their information management system, disruption can cost a lot, and smaller players certainly cannot deal with the risk, since it could mean survival or bankruptcy for them. The findings in the health sector also show a discrepancy with the expectation. The big players are found to be dominating the implementation, which mostly concerns their ability to afford resources, which for many smaller players are difficult to afford. The oil & gas industry has different hegemony than the two other sectors, in which smaller players are also enjoying benefits from Big Data. They are strong in their expertise area, and they are very specialized. They mostly give services to bigger operators who are willing to move into Big Data but do not have such capability to do so. In this way, bigger and smaller players are found to benefit each other.

The regime of Big Data implementation is found to be uniform across the three sectors. All sectors show a closed regime towards Big Data. In comparison with the expectation, the oil & gas, and manufacturing sectors show similarities. Data is seen as valuable and can create a competitive advantage for companies in both sectors. Sharing them within their network is acceptable, as this can create more value to their business. In doing this, data security is seen

as very important among the players in the network, as a weakness of security in one party can greatly affect other players in the network. Sharing them outside their network is, however, not acceptable as it can be capitalized on by their competitors and threaten their position in the market. In the health sector, the regime of openness does not match what was expected. Data privacy and security is an important reason. Although sharing data openly can promote innovation by sharing new insights and knowledge between actors, patients' identity can be greatly compromised. Sometimes the problem is that the regulation has not covered a certain Big Data-related technology. Overcoming this data privacy and security problem can open up more possibilities from Big Data in the future, such as improvements in healthcare experience and having genomic medicine to have a more accurate diagnosis and prescription.

Sub-question 3: How does the impact on business model differ across the cases observed empirically?

Across the three sectors, value proposition, activities, and resources are three aspects of business model that experience the most impact, as discussed in Section 5.2.4. Big Data implementation will directly affect these aspects, and impacts on other aspects will follow. Mostly, customer relationship will be improved, and this leads to improvements in the revenue stream. Customer segments can hardly experience any impact, as the implementation usually leads to improvements in the existing segments. Through improvements in the activities, organizations, and companies can deliver improved or even new value propositions, and the improvements are made possible by the provision of the necessary resources.

The impact of implementing Big Data on business models is found to be significant. From all the aspects of business model, only customer segments remain unaffected. This can be contributed to the specificity of the business of organizations and the experienced incremental improvements from utilizing Big Data. Improved efficiency and optimized process do not lead directly to the expansion towards a new customer segment, instead, it remains as a possibility in the future to grow the business further once organizations are able to fully understand and exploit the potential of Big Data.

In the oil & gas sector, both the activities and partnerships aspects have an impact through the implementation of Big Data. These findings match what was expected before. Activities throughout the process in the upstream business are affected in a number of ways, such as the introduction of condition-based maintenance, higher accuracy in exploration, and the possibility of introducing technologies like drones and augmented reality to support processes. Partnerships are mostly affected in the way that operators engage in partners that provide services and solutions for Big Data implementation. The partners also include SMEs, who are experts in certain areas. This partnership can overcome the lack of talent and capability that big players have, especially in Big Data-related areas that are fast evolving and wide in scope.

In the manufacturing sector, activities, resources, and value propositions are affected by the implementation. Some areas of affected activities include product development and marketing, where manufacturers are able to have higher efficiency, better overall process, and better product delivery. They regard their machines as their resources, therefore a big impact can be found in their resources in the form of improved machine capability of understanding the process. Partnership was an aspect that was expected to have great impact, as many collaborations in a number of technologies and process optimization can be done. However, currently partnership is used by manufacturers to find a solution for implementing Big Data into their existing process and information system, since there is still no available solution in the market. New business models can potentially emerge, which offer subscriptions for customers to pay for the right to use the produced machines. This can attract more customers, including the small manufacturers, as the offered pricing is lower and results in lower investment.

Business models in the health sector experience impact in their resources aspect. They find physical assets like servers, computers, and software to be important in conducting activities like DNA sequencing. The key for organizations is to consider between having the best resources and arrangement of supporting technologies and having to save on their budget. This is usually more apparent in research organizations, as they generally have a more limited budget compared to private companies. There is also an emerging business model focusing on providing a service in sequencing. In particular, a research organization can make use of this to recover their costs and have a more sustained revenue. Another business model that can be important is providing security solutions for data owners and data generators. As data privacy and security is very important, companies, especially SMEs, can capitalize on this opportunity by providing such a solution.

6.2. Research Contributions

This study can contribute both academically towards the knowledge, and practically towards the practice by organizations.

6.2.1. Academic Contribution

This research can contribute conceptually towards the knowledge in innovation system and business model. Technological change that takes place in an innovation system implies that organizations that adopt new technologies would experience changes in their business. Big Data can be seen as one of the technological changes. Representative of how the business operates, the business model would show a change when the business is affected, and this study has shown that business models experience changes under certain circumstances in the innovation system.

Furthermore, the knowledge in business model, especially in adjusting changes or sometimes known as business model innovation, can be added by this research, since this research shows certain aspects that are affected and need to be adjusted. These affected aspects are dependent on how the sectors act towards the introduction of certain technologies (i.e. Big Data and supporting technologies).

This study also contributes to fill the gap in the existing knowledge. In particular, to the author's knowledge, there were very few previous studies that have addressed business model change with regard to Big Data implementation (e.g. Muhtaroğlu et al., 2013 and Schroeder, 2016). In addition, the differentiation of sectors based on how a certain sector acts towards the introduction of Big Data is used in this study to differentiate impacts on business models, in which such a relation has never been explored before.

6.2.2. Practical Contribution

Practically, this research can contribute to organizations and companies who are planning to implement Big Data into their activities and process. First, this research emphasizes how Big Data can create value in a number of sectors. Organizations in the same or similar sectors can understand better that they can create a lot more value from their business by making use of the data that they already have, the data that they can generate in the future, or the data that other companies have. Opportunities can also be captured in a number of ways, for example, the emerging business models of subscription, service, and solution provider, that even smaller companies can stand a chance to capture successfully and have a high-level expertise in the respective areas. This can trigger companies that have moved into Big Data to improve their implementation further, and companies that have not moved into Big Data to invest in the implementation.

Second, this research can be useful for organizations that encounter problems in the implementation. They can re-evaluate their business and activities to see how they adjust themselves during the implementation. Organizations might not pay sufficient attention to certain aspects of their business, as they find their improvement not as expected before. After realizing that they can adjust better in certain aspects, they can make a better strategy in order to maximally capture benefits from implementing Big Data.

Third, organizations who are situated in potential sectors other than those discussed in this research can make an evaluation of how their sectors are embracing Big Data. They can find out whether a particular challenge encountered by many organizations in the sector contributes significantly to how fast Big Data is being utilized in the sector, or they can evaluate whether SMEs in the sector have a good chance of capitalizing on the opportunity that Big Data creates, in terms of financial resource and added value.

Fourth, regulators can re-evaluate their regulations, if they have sufficiently covered the theme of Big Data. Some supporting technologies might not have been covered by the existing regulations, and thus organizations and companies cannot exploit the potential value of utilizing such technologies. Coping with the technological change can result in better regulation, and furthermore can result in further growth of the sector.

6.3. Limitations of The Study

Due to some aspects, this study displays a number of limitations, which will be addressed as follows.

1. The number of sectors is limited to three. It does not pose any problem methodologically by having this number of sectors, as the sampling is done using theoretical sampling, however, the choice of sector can be improved using inherently opposite sectors in terms of the characteristics. By choosing extremely opposite cases, they have a high chance to be able to display the point of interest of the study clearer (Eisenhardt, 1989). The inability to choose as such also comes down to the practical limitation of data collection.

2. The variety of organizations is limited in this study. Ideally, there should be a representative of different roles within a sector, so that a comprehensive view on the impact on business model can be scrutinized. It opens up the chance to know more about the ecosystem within the sector and how it can contribute to further implementation of Big Data. A distinction can thus also be attempted on the impact of business model on different roles within a particular sector. It is, however, not feasible to have such composition due to the practical limitations of data collection.

3. The limitation of time inhibits the possibility to obtain more data through interview. In addition, a lot of contacted interviewee candidates either declined to be interviewed, or gave no response to the invitation. Waiting for responses also contributed to the inability to use time efficiently.

6.4. Future research

The mentioned limitations and also the findings of this study provide a way to add to and improve this study.

1. A possible future research could be to enrich the interviewee so that a comprehensive view of a sector can be obtained and thus give better insight into impacts on various business models. Exploring different interviewees with different roles and background can also be emphasized more, which can contribute to how Big Data and the implementation are viewed differently.

2. Extending the sectors can also be done to firstly enrich the insights from various sectors, and secondly, to have a clear difference on the impact, by selecting the extremely contrasting sectors based on the characteristics (e.g. fast transition, big players, and open regime, in comparison with slow transition, fragmented players, and closed regime).

3. Implications on various sectors and organizations within the sectors can be explored more, by establishing a roadmap for implementation, best practices of implementation for organization, and a balanced scorecard to evaluate and plan the implementation in organizations.

4. Ethics and responsible innovation regarding Big Data implementation might be a direction that can be pursued. The issue at stake is to find a balance between the benefits that organizations can have and the threat of privacy and security for many people, as can be seen in the health sector. Concerns about privacy and data security are growing, and based on the findings in this study, they are contributing to the hampering of Big Data implementation in sectors, and organizations are expressing this concern. Some of them believe that once this issue has been overcome, the implementation can be boosted even more.

5. Introducing some other aspects to see their influence on Big Data implementation might be a direction to pursue. The cultural effect of different countries can possibly be one contributor to how a sector is characterized regarding Big Data implementation. Some studies also suggest that culture has an implication towards innovation or innovation capability (Kaasa & Vadi, 2010; Lin, 2009; Vecchi & Brennan, 2009). This follows the line of the work from Hofstede, where a number of dimensions influence the cultural differences, such as power distance, uncertainty avoidance, individualism level, masculinity versus femininity, and the length of orientation – developing versus developed countries.

6.5. Reflections on The Research Process

The whole research process is new to me and the topic is also very new to me, since I was not familiar with Big Data and what it can give. I have only heard of the term without knowing more, since I am originally not very knowledgeable in areas relating to IT. On one hand, I had to work extra hard to try to understand Big Data before proceeding with making the proposals and doing the research. On the other hand, I now understand more about Big Data, especially how it is actually a buzzword for most companies and organizations, and how it can improve businesses. The way of doing research itself is also new to me. Firstly, my previous education was in engineering and technology, so carrying out such a piece of research in management is new to me, aside from the projects and assignments I have done for the last two years in my courses. Secondly, my previous education was in applied sciences where I was trained to

do more practical works, and my thesis was very much practical-oriented. Developing a research like this study was quite a challenge for me, since academic contribution is also important. This study is a good experience for me, since I got the chance to carry out such a study at this academic level. I also got the chance to apply some knowledge that I gained from MoT courses into this study. Moreover, I also have a wider perspective on how organizations work and how organizations can grow themselves (e.g. by implementing Big Data as this study has shown). This is a positive input towards my understanding of how they work and how technological change can contribute to organizations.

Time management is indeed a crucial issue when it comes to planning and executing a research. I realized that I underestimated the time needed to collect data. Since the methodology employed for this research relies on the interview results, conducting interviews is one of the priorities in order for the research to proceed. Contacting interviewee candidates, planning the interview schedule, and conducting the actual interview turned out to take a lot of time, in fact more than I expected. A lot of challenges were present, such as the difficulty in finding contacts, getting no response, finding a lot of mismatches in the available schedule with the candidates, and knowing at the very last minute that the mode of conducting the interview that I proposed could not actually be used to contact the interviewee. All in all, it amounted to an extension of five weeks for the data collection from what I proposed before the kickoff session. Due to the extension, I also missed a lot of time to start writing, since the analysis and comparison are done when data has been collected. As a result, I was under a lot of pressure at the end; more than I expected in order to finish writing the whole thesis. This made me realize that I need to carefully make plans and take into account unexpected circumstances.

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Appendix I Interview Questions

This section presents the interview questions that were asked to interviewee. The construction of the questions follows the concepts discussed in Section 2. The questions serve as a guide for the semi-structured interview. It provides direction, but is still open to other contextual questions that might pop up on the spot, depending on how the interviewees react to the questions.

The list entails 3 different topic areas. First is the general and Big Data implementation, which addresses the general information of the organizations, what they do on a regular basis, and their involvement in Big Data. This topic area can potentially reveal how Big Data is being applied in the sector as well as in the organization, the faced challenges, and general impact towards the organizations. The second topic area concerns the Big Data utilization in the sectoral level. This topic tries to reveal whether a particular sector reacts similarly or differently towards the Big Data implementation. It is meant to support sub-question 2 about differentiating between sectors related specifically to Big Data uptake. The third topic area deals with the impact of Big Data on business models. Using the Canvas business model template, the questions in this topic tries to reveal impacts on different aspects in the business, which can be reflected through changes in business model.

Topic area	**Example of questions**
General & Big Data implementation	1. Can you tell me a bit about your organization? What kind of services do your company organization? Main activities of your organization? Any clients or purely scientific research? 2. Can you tell me **your role** in the organization? 3. In what way are your organization involved with Big Data? How long have you and your organization **involve / research big** data? What about **other utilization of Big Data in the sector**? In which main **activity** does big data implemented/play a big role in health sector? 4. Can you tell me a bit about **who benefits your research** and how can they benefit? Does it give any **benefits**? What kind of **benefit do companies** experience from implementing big data? (decision making/predictive analytics/control & automation/value of information/efficiency/low cost/productivity) 5. Where do you get the data (i.e. data source)? Is it only from internal or also external? **What kind of data are you using**? (Any data supplier?) 6. Does your organization **develop the infrastructure** as well, or make use of other external parties? 7. How far is your organization with the implementation? Is your organization 100% fully engaged in utilizing big

	data? Is big data fully integrated in the activities? If not, are there something that needs to be done or should be done? 8. Does **your company also involve** in implementing to manufacturing companies / provide solution? Any teething problems when implementing? Currently any **challenge** that the company is still facing? (E.g. data management, processing, analysis, infrastructure, translation to strategies) 9. Do you think there are any impacts on **organizational structure**, for example new division or team that handles big data in particular? 10. Do you think there will be any **business performance improvements** after since big data is implemented? If yes, in what way? Any numbers / percentage that you can share with me? 11. Does implementing big data give an impact towards **competitor / competition** in the sector? Do you have competitor who does more or less the same? How is the competition affected in the sector? Do a lot of companies already implement it to your knowledge? Are companies in favor of doing so / heading to the direction? **Since when** big data is seen as important or valuable within the sector? 12. Are there any **learnings** regarding big data in the sector? Does it involve a lot of companies? Any **consortium or joint effort** for example, or only from research organization towards firms? **Seminars / workshops**?
Characteristics of industry/sector	1. Do you know whether other companies in the sector are implementing big data as well? (already addressed above) Are companies in favor of doing so / heading to the direction? Since when big data is seen as important or valuable within the health sector? 2. Can you tell me a bit about the **players** within the sector? Is the implementation dominated by **several big players**? Who are them? Are there a lot of **small players** also implementing and how influential are they in the sector in terms of power & controlling supply & demand? Is the implementation **consolidated** to big players or **fragmented** to many small players? 3. How is the access of data & **data openness** in the sector? Is it openly accessed or very **privatized** to the company? Is it an issue in the sector? Are there going to be any change in directions towards more open or closed?

Business model impact	1. Are there any impacts on **key activities**, for example problem solving, production, optimization, capabilities? What is usually the original activities (already addressed)? What aspect or kind of activities will be affected? 2. Are there any impacts on **key resources**? What were the typical resources for automotive manufacturing? Any additional resources? Where are the resources from, external or internal? Is data becoming a resource? 3. What are the **value offered**? Are there any impacts on value propositions? Is it better delivered or even new value propositions? 4. Who are the **main partners**? Are there any impacts on partnerships? Does the company engage in more partners or is there no change? 5. Are there any impacts on **customer relationship**? Any improvements or benefits? 6. Who are your customers? Are there any impacts on **customer segments**? Any additional? 7. Are there any impacts on **channels** / way of reaching customers? 8. Are there any impacts on **Revenue stream**? Additional? 9. Are there any impacts on **Cost structure**? Additional costs? 10. Which, from these 9 aspects of business model, has more **prominent** impact? 11. Any additional impacts that expected to take place, in case not 100% yet implemented?

Appendix 2 Building Blocks of Canvas

As the chosen basis for this study, one of the advantage of Canvas is a visual-friendly feature that can be easily adapted for a lot of businesses. It is placed based on its category: financial aspects, relational aspects, value architecture aspect, and core activities aspect.

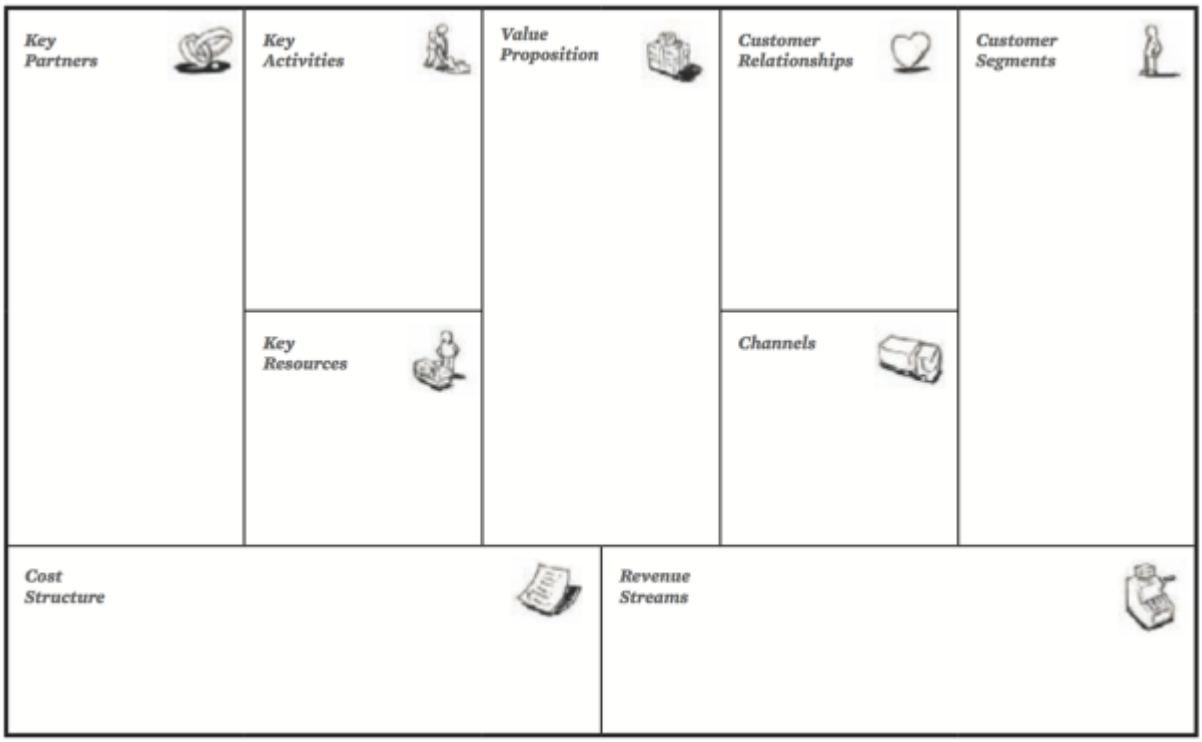

Figure 6 A visualization of Canvas business model, where value proposition is central in the framework (Osterwalder & Pigneur, 2010).

Key Activities

Key activities component is crucial in business model, since it comprises activities that could enable other components of business model, for example those that can deliver the proposed value, those that can create such revenue stream, or those that can reach such segments that the business intends to. According to Osterwalder & Pigneur (2010), key activities can be distinguished into 3 types: production, problem solving, and platform/network.

Key Resources

Key resources component describes the resources needed in order for the business to operate. Similar to key activities, key resources can enable the delivery of value proposition, or enable to reach certain intended customer segments. It describes the resources that it takes to fulfill other components of the business model. The resources are not limited to those that are tangible, such as financial, human, and physical, but also include intellectual.

Value Propositions

Value propositions describes the value that the focal company / organization wants to put forward and deliver through their products / services / activities. These values can be either quantitative or qualitative. Some examples of quantitative values are price and speed of service, and examples of qualitative values are customer experience and design. Value proposition aspect is central in a Canvas business model. This emphasize the aim of a business to create and deliver value, which is visualized by this framework.

Key Partnerships

Key partnerships component entails the network that the focal company / organization is situated in. It includes for example suppliers and strategic partners. This component aims to describe who the important partners are in their business and in what kinds of partnerships are they supporting the business.

Customer relationship

This component describes the relationship that the focal company / organization wants to have / build with its customers. Osterwalder & Pigneur (2010) categorize customer relationship into several types, which are personal assistance, dedicated personal assistance, self-service, and automated. The categorization ranges from personalized to automated, with the first one being on the personalized side and the last one being on the automated side. The choice depends on what the company wants their customer to experience, and the choice also involves a relationship with other business model components, such as cost structure and value proposition.

Customer segments

This component describes the focus of customers group that they want to reach. This component is important as the customers are the ultimate receivers of what the business is doing. They are the ones whom the company wants to deliver its value. Companies can have a single segment that they focus on reaching, such as mass market or niche market, or it is often the case that businesses have two or more customer segments. These segments can be related or unrelated.

Channels

This component entails the way the focal company / organization wants to reach their customers. There are a number of channels that companies can make use of, whether it is self-owned or having a partner to realize it, or whether it is a direct or indirect channel. Mainly, having a mix of different channels helps company to gain awareness from its customers, enable customers to purchase the product or service, and properly delivers the value they intend to deliver to customers (Muhtaroğlu et al., 2013; Osterwalder & Pigneur, 2010). This component is therefore closely related to value proposition component.

Cost structure

This component describes all the main costs that the organization has to bear when operating their business. It relates closely to all other components since it basically explains the cost that occur in order to fulfill the other components. At the extremes, there are cost structures that are cost-driven, where cost has to be minimized, and value-driven, where value has to be put forward no matter the cost incurred. Mostly, organizations' cost structures lie in between these 2 extremes.

Revenue streams

This component describes the generated cash from the customers that the focal organization has. The revenue streams can come in 2 types: a one-time and a continuous revenue streams. The latter can come from continuously deliver the value proposition or providing support for customers. It comes side by side with how much the focal organization is going to nominally value their product or service, and how much the customers are willing to pay for the offered product or service. There are also other streams such as licensing and advertising that an organization can consider.