MASTER THESIS

How data-driven decision making can help managers and employees with creating business value

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Abstract
Nowadays, the way how organizations make decisions is fundamentally changing: where decisions used to be made on the 'intuition and gut instinct' of a manager, organizations now progressively make use of databased analytics to support decisions. This new way of decision making, with the help of vast amounts of data, can offer valuable insights and competitive advantage if it is supported by the right technological and organizational resources. Therefore, the Marketing Science Institute stated how the analysis and application of BD in various marketing strategies is as a top research priority for the fast developing digital world. However, researchers show how practitioners are currently in the dark when facing the implementation of data-driven decision making (DDD) in their firms, as well as researchers who are hindered in investigating the value of DDD.

For this reason, this study investigates how managers and employees can create business value from data-driven decision making (DDD). In order to answer the research question, we conducted semi-structured interviews with managers of Dutch companies that are actively working with the digitalization processes of their business. This study showed that there are large differences in the appliance of Big Data Analytics (BDA) on decision-making between organizations with various level of familiarity with BDA use. On one hand, organizations that already make great use of data for their decision-making, state that they are able to react way faster to unexpected changes on the market, next to obtaining valuable insights from the data. The managers and employees of these organizations underlined that there are some clear benefits of DDD, where it can lead to organizational benefits, improving decision making processes, enhance operational benefits, create transparency and strategic clarity, lead to potential new products or service innovation. In similar fashion, the organizations also addressed the potential benefits of DDD to obtain a better understanding regarding customers, that can be used to improve customer satisfaction and loyalty. On the other hand, companies that at more initial stages of BDA use were aware of the potential benefits that DDD can have for their organization and, ran multiple pilots to start experimenting with making more decisions based on data. The managers or employees showed overall satisfaction, with the first outcome of their initiatives, and this resulted in a situation where the management of the organizations only became more enthusiastic about DDD. Finally, there is also a third group of companies that do not yet adopt to consciously make more decisions based on data. These organizations still mainly make decisions based on intuition or expertise, because they generally believe that this is the right way to do so, or because they did not have the resources to invest in becoming more data-driven yet.

However, next to these benefits, the organizations in this study also acknowledge the challenges that come up during the process of becoming more data-driven. In line with the challenges described in the literature, we found that there are different categories of challenges: data challenges, process challenges, management challenges, and changing the organizational culture. Additionally, working towards becoming a data-driven organization, focused on supporting the digital transformation, requires an organizational cultural change that facilitates the use of big data. Hence, managers from organizations first need to come up with solutions to deal with these challenges, before the full potential of DDD can be realized. Therefore, this study clearly shows the potential business value that DDD can create for organizations, but it at the same time raises questions whether organizations already have the capability to deal with the challenges that come up during the process.

Finally, this study adds to the literature at the intersection of business value creation and DDD and helps scholars to get a better theoretical understanding of DDD and business value creation. Practical implications for companies, managers and employees are also discussed.

Keywords -- *Big data analytics (BDA), Data-driven decision making (DDD), Benefits and Challenges, Business value creation*

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1. Introduction

Nowadays, the way how organizations make decisions is fundamentally changing: if in the past decisions used to be made on the 'intuition and gut instinct' of a manager, organizations now progressively make use of databased analytics to support decisions (McAfee & Brynjolfsson, 2012). Advanced technologies such as expanded storage capabilities at relatively low costs enable companies to both produce and collect vast amounts of data. This new way of decision making, with the help of vast amounts of data, can offer valuable insights and competitive advantage if they are supported by the right technological and organizational resources (Morabito, 2015). Therefore, both academics and practitioners addressed the importance of understanding Big Data (BD) in business contexts and to investigate when Big Data Analytics (BDA) applications can be a valuable resource for companies to create business value or competitive advantage (Agarwal & Dhar, 2014; Abbassi, Sarker & Chiang, 2016). However, in spite of the excitement for BDA amongst academia and managers, exploiting BDA for enhanced organizational performance is still one of the major challenges for both academics and practitioners (George, Haas and Pentland, 2014; Kache and Seuring, 2017). Several firms sometimes experienced that more data is not necessarily the better, as BD pools make it difficult for companies to evaluate, analyze, and transform data into meaningful and valuable business information and action (Mikalef et al., 2017). For this reason, the ability of transforming BD pools, into relevant and meaningful data, and finally it into valuable knowledge and action has become a key competitive differentiator in today's market places (Bumblauskas et al., 2017). However, Gupta & George (2016); Pappas, Ilias O., et al. (2017) state how practitioners are currently in the dark when facing implementation of data-driven decision making (DDD) in their firms, as well as researchers who are hindered in investigating the value of DDD. For this reason, more and more digital marketing agencies and research departments within companies try to find new ways about how to make use of all this BD. Therefore, the Marketing Science Institute (2018) stated how the analysis and application of BD in various marketing strategies is as a top research priority for the fast developing digital world. Yet, McColl et al. (2019) and Popovič, Aleš, et al. (2018), argue how there is little empirically based knowledge by highlighting the real business value resulting from applying DDD in companies and thus encouraging beneficial societal changes. Therefore, scholars show that companies must develop the organizational capability to use BDA, including BDA infrastructure, management and personnel capabilities (Bumblauskas et al., 2017; Fosso Wamba et al., 2017).

At the same time, a wide study among 330 North American companies by McAfee & Brynjolfsson (2012) showed how the use of DDD was accompanied with more productivity and profitability than competitors. In their study, they discovered that among the companies surveyed, the ones that were primarily data driven benefited from 4% higher productivity as well as 6% higher profits. Additionally, Rodríguez-Mazahua, Lisbeth, et al. (2016) stated how DDD gives companies the opportunity to decide on the basis of evidence, rather than on intuition. This leads to better forecast of previously unpredictable outcomes, and improves process performance (Popovič, Aleš, et al. 2018). Therefore, Grover et al. (2018) discuss the potential business value that can be created through DDD, where it can for example lead to organizational benefits, by improving decision making processes in organizations, enhance operational benefits, create transparency and strategic clarity, lead to potential new products or service innovation, as well as customer benefits like: getting a better understanding of the needs of customers and create insights about customers and markets that can be used to improve customer satisfaction and loyalty. Hence, this study aims to address how with the help of DDD, this business value can be created. Hereby, the theoretical framework of this study will focus on clarifying the concept of BDA, and find out what is already known about the relation between DDD and business value creation according to the literature. Furthermore, the purpose of the research is to answer the following research question:

"How can data-driven decision making help managers and employees with creating business value?"

In order to be able to give a concise answer about this research question, we look at different challenges that managers and employees face while trying to implement a DDD culture for their companies. We use the conceptual classification model by Sivarajah et al. (2017) to identify three type of challenges that companies can face while implementing DDD, namely, process, technological, and managerial challenges. In addition, we use Shamim, Saqib et al. (2019)'s work to discuss the cultural challenges that organizations face when they develop a DDD culture, which were not included in the Sivarajah et al. (2017)'s model. The study 'creating business value from Big Data Analytics' by Grover et al. (2018) was used to identify how business value can be created through DDD.

Methodologically, we conducted semi-structured with managers of 11 Dutch companies that are actively working with the digitalization processes of their business. This helped us to broaden the current knowledge about business value creation and DDD and therefore provided new insights about the role of BD in decision making processes. This study offers contributions to both academic research and practice. This research is conducted and aims to contribute to the emerging research on digitalization and helps companies, managers and employees to obtain more knowledge about the relationship between DDD and business value creation. In terms of the theoretical contribution, this thesis will contribute to the emerging call for more research on the analysis and application of BD in various marketing strategies by the Marketing Science Institute (2018), who argue how there is a huge gap between the potential business value that BDA can have for organizations, and having the actual knowledge to make this happen. Additionally, we also proposed a novel theoretical framework that combines the work of Grover et al. (2018), Sivarajah et al. (2017), and Shamim, Saqib et al. (2019) that in the future can be used for research into different industries, contexts, cultures, or countries. In terms of practical contributions, this research provide managers of companies, employees, marketeers, insights about how to create business value by making use of DDD. Additionally, it highlights important managerial implications related to the impact of DDD on empowerment of employees, and how it can be integrated into organizations to augment rather than replace management capabilities (Popovič, Aleš, et al. 2018).

The rest of this thesis is structured as follows: chapter 2 introduces the key concepts and the theoretical framework used in the thesis. In chapter 3, the methodology of the research is presented, followed by the presentation of the results in chapter 4. Last, we conclude with a discussion of the results, contributions, limitations and suggestions for future research in chapter 5.

2. Theoretical framework

This chapter discusses the theoretical background of this research. Section 2.1 presents the key concepts of the thesis. Section 2.2 discusses the literature that describe how business value can be created from DDD. Finally, Section 2.3 provides a description of the different challenges that organizations face while trying to create the maximum value out of data analytics.

2.1 Key concepts

The key concepts of this thesis are: Big Data Analytics (BDA) and creating business value from data-driven decision making (DDD).

Big Data Analytics *(BDA)*

Big Data Analytics (BDA) is becoming an important topic of interest in multiple disciplines, such as management, marketing, as well as computer and information sciences. This resulted in a constellation of definitions that differ significantly (Constantiou, Kallinikos, 2015). For the purpose of this thesis, we focus on management and marketing literatures and review definitions of BD and BDA (Table 1). First, some scholars solely focus on the BD attribute of BDA and emphasize on its main characteristics. A commonly acknowledged aspect of BD is that it can be categorized as five 'Vs' in terms of volume (size of data), velocity (streaming data), veracity (messiness of the data), value (cost of data), and variety (unstructured data) (Davis, 2014; Akter *et al.,* 2016). The second perspective extends this view and includes technological procedures, tools and techniques that BDA employs. There is consensus that BDA allows to capture, manage, and process data beyond technological and rapidity capabilities of common software analytic tools (Bharadwaj *et al.,* 2013). Authors from the third perspective focus on the industrial and social impact that BDA entails, and define BDA as a wide range of new analytical technologies and business possibilities, particularly in terms of business value creation and competitive advantage (White, 2011; Schroeck *et al.,* 2012). Finally, Gantz & Reinsel (2012) provide a definition that unites all three perspectives. Accordingly, BDA is the sum of data, it applied analytics, and its presentation that result in business value creation. It includes not only the performance of analytics, but a wider spectrum of tools used to transform BD into actionable insight, as well as to develop competitive advantage from it. However, while the above-mentioned definitions encompass a wider spectrum of characteristics of BDA, they do not include elements critical to the success of BDA in terms of strategic value creation. In fact, to date, definitions that include concepts, procedures, and strategies how organizations can derive strategic business value from BDA and what resources they therefore need remain scarce (Grover *et al.,* 2018). This assumption is underlined by Mikalef, Pappas, Krostie and Giannakos (2017) who state *"*how previous research have shown the benefits of BD in different business contexts. However, theoretically driven research between the link of BD and gaining competitive advantage still remains scarce*".*

Author(s) and date	***Definition***
Davis (2014)	BD consists of expansive collections of data (large volumes) that are updated quickly and frequently (high velocity) and that exhibit a huge range of different formats and content (wide variety).
Akter *et al.* (2016)	BD is defined in terms of five 'Vs:' volume, velocity, variety, veracity, and value. 'Volume' refers to the quantities of BD, which are increasing exponentially. 'Velocity' is the speed of data collection, processing and analyzing in the real time. 'Variety' refers to the different types of data collected in BD environments. 'Veracity' represents the reliability of data sources. Finally, 'value' represents the transactional, strategic, and informational benefits of BD.

Bharadwaj *et al.* (2013)	BD refers to datasets with sizes beyond the ability of common software tools to capture, curate, manage, and process the data within a specified elapsed time
Schroeck *et al*. (2012)	BD is a combination of volume, variety, velocity and veracity that creates an opportunity for organizations to gain competitive advantage in today's digitized marketplace
Gantz & Reinsel (2012)	BD focuses on three main characteristics: the data itself, the analytics of the data, and presentation of the results of the analytics that allow the creation of business value in terms of new products or services

Table 1: Sample definitions of BD & Analytics

Creating business value from data-driven decision making (DDD)

With the advent of DDD, research on the role of DDD in the creation of business value has increased over the past years. McAfee & Brynjolfsson (2012), show the use of DDD is accompanied with more productivity and profitability than competitors. In their study, they discover that among the companies surveyed, the ones that were primarily data driven benefited from 4% higher productivity as well as 6% higher profits. Wamba et al., (2015) state how *"*value refers to the worth of hidden insights inside BD. Value represents the transactional, strategic, and informational benefits of BD Moreover, it represents the extent to which BD generates economically worthy insights and benefits through extraction and transformation*"*. Next, making decisions on the basis of data is not a new idea; Davenport & Dyché (2013) stated how it is as old as decision making itself. In addition, Rodríguez-Mazahua, Lisbeth, et al. (2016) addressed how the use of DDD can help managers to decide on the basis of evidence rather than on intuition. Therefore, with the growing amounts of data now available, companies in almost every industry are focused on exploiting data to gain a competitive advantage (Provost and Fawcett, 2013). However, Gandomi & Haider (2015) address how BDA have value when organizations use it for their decision making processes. However, in order to be able to make decisions based on evidence, it Is from importance that organizations develop efficient processes that can deal with the speed and diversity of the data, and turn it into meaningful insights. Past research has demonstrated the positive impact of BDA on decision making processes (Brynjolfsson et al., 2016). Hereby, data-driven organizations, BD and digital technologies have produced a new way of working, interacting, and communicating (Loebbecke and Picot, 2015) while also changing management practices at the same time. In addition, Carrilo (2019) stated how managers are becoming manager-scientists whose skillsets lays at the cross-roads of conventional business and management knowledge, data management, and analytical and modeling techniques. Additionally, the increased numbers of sources of data that have become available to marketers for their decision making have led to a situation in which potentially better market insight can be derived about the relationships between relevant marketing variables (Bruggen, van et al. 2001). 'Enabled by the increased capacity of information technology, companies have set up (often huge) databases with records of individual customers' (Wierenga, 2008). McAfee and Brynjolfsson (2012) state how all this data, brings the possibility to measure and therefore manage more precisely than ever before. However, Rodríguez-Mazahua, Lisbeth, et al. (2016) state how becoming a data-driven company is more than using analytical techniques and tools. In order to be able to create this business value, it is important that companies bring in employees that have the capability to work data-driven. This is because Rodríguez-Mazahua, Lisbeth, et al. (2016) state how: *"*Success in the data-oriented business environment today includes being able to think data-analytically. Since the amount of data is continuously growing, domain knowledge and analysis can't be considered as separate areas. Both academic and applied professionals of the companies are expected to have the analytical skills and to understand business processes*"*. In today's competitive, knowledge-based economy, organizations require the assistance of business insights tools to collect, analyze, and disseminate information so

that knowledge workers are able to make informed decisions (Hedgebeth, 2007). Furthermore, the study 'creating business value from Big Data Analytics' by Grover et al. (2018) focused on determining different ways how strategic business value can be created through DDD. This study showed some clear benefits of DDD, where it can for example lead to organizational benefits, namely: improving decision making processes in organizations, enhance operational benefits, create transparency and strategic clarity, lead to potential new products or service innovation, as well as customer benefits like: getting a better understanding of the needs of customers and create insights about customers and markets that can be used to improve customer satisfaction and loyalty. Additionally, this study underlined how the ultimate success of any BDA project lies in realizing strategic business value, which gives firms a competitive advantage. Therefore, this study 'creating business value from Big Data Analytics' by Grover et al. (2018) helped us to identify how business value can be created through DDD.

Author(s) and Date	***Business value from DDD***
Wamba et al. (2015)	Value refers to the worth of hidden insights inside BD. Value represents the transactional, strategic, and informational benefits of BD. Moreover, it represents the extent to which BD generates economically worthy insights and benefits through extraction and transformation
McAfee & Brynjolfsson (2012)	A wide study among 330 North American companies showed how the use of DDD was accompanied with more productivity and profitability than competitors.
Frederiksen, 2009; Jin et al., 2015; Zhong et al., 2016; Gunasekaran et al ., 2016; Addo-Tenkorang and Helo, 2016; Munshi and Mohamed, 2017; Manco et al., 2017, Davenport & Harris 2007)	Extant studies have demonstrated that substantial value and significance in finding methods to promote emerging inter-disciplinary research, to better perceive the present, to better predict the future and to lower management risks and improve operation efficiency, can be attained by organizations through taking effective decisions based on BDA.
Skourletopolous, Mastorakis, and Mavroumoustakis (2018)	BDA is a resource for strategic decisions leading to significant improvements in operations performance, new revenue streams and competitiveness against rivals. In addition, enterprises that learn to capitalize BD utilizing real-time information coming from various sources like sensors, connected devices etc. can understand in more detail their environment and define new trends, create new and innovative products/services, respond quickly in changes and optimize their marketing actions
Brynjolfsson et al., 2016; Loebbecke and Picot, 2015	Past research has also demonstrated the positive impact of BDA on decision making processes. Hereby, data-driven organizations, BD and digital technologies have produced a new way of working, interacting, and communicating
Bruggen, van et al. 2001).	The increased numbers of sources of data that have become available to marketers for their decision making have led to a situation in which potentially better market insight can be derived about the relationships between relevant marketing variables
Grover et al. (2018)	DDD can lead to organizational benefits, namely: improving decision making processes in organizations, enhance operational benefits, create transparency and strategic clarity, lead to potential new products or service innovation, as well as customer benefits like: getting a better understanding of the needs of customers and create insights about customers and markets that can be used to improve customer satisfaction and loyalty.

Table 2: Summary of findings of research on DDD and business value creation

2.2 Challenges of DDD

Although the benefits and value of using BD to drive decisions is made clear by previous research, there are also important challenges that that organizations face while trying to create the maximum value out of data analytics. Sivarajah et al. (2017) argue that managers from organizations first need to come up with solutions to deal with these challenges, before the full the potential of DDD can be realized. This refers to how organizations need efficient methods to process large volumes of assorted data into meaningful comprehensions, in order to be able to facilitate evidence-based decision making. Sivarajah et al. (2017) address how the potential of using BD are endless but at the same time limited by the extent to which technologies, skills, and tools are available for BDA. Therefore, the potential value of BD is solved simply when leveraged to drive decision-making process. Generally, the literature showed how researchers agreed that the challenges are mostly data, management, and process related. These three different groups of challenges are described in detail by Sivarajah et al. (2017). The article consists of a comprehensive state-of-the-art review on BD Challenges and BDA methods theorized throughout a systematic literature review methodology. Furthermore, this makes the model suitable for this thesis, when looking at the general challenges that occur while implementing a data-driven culture in an organization.

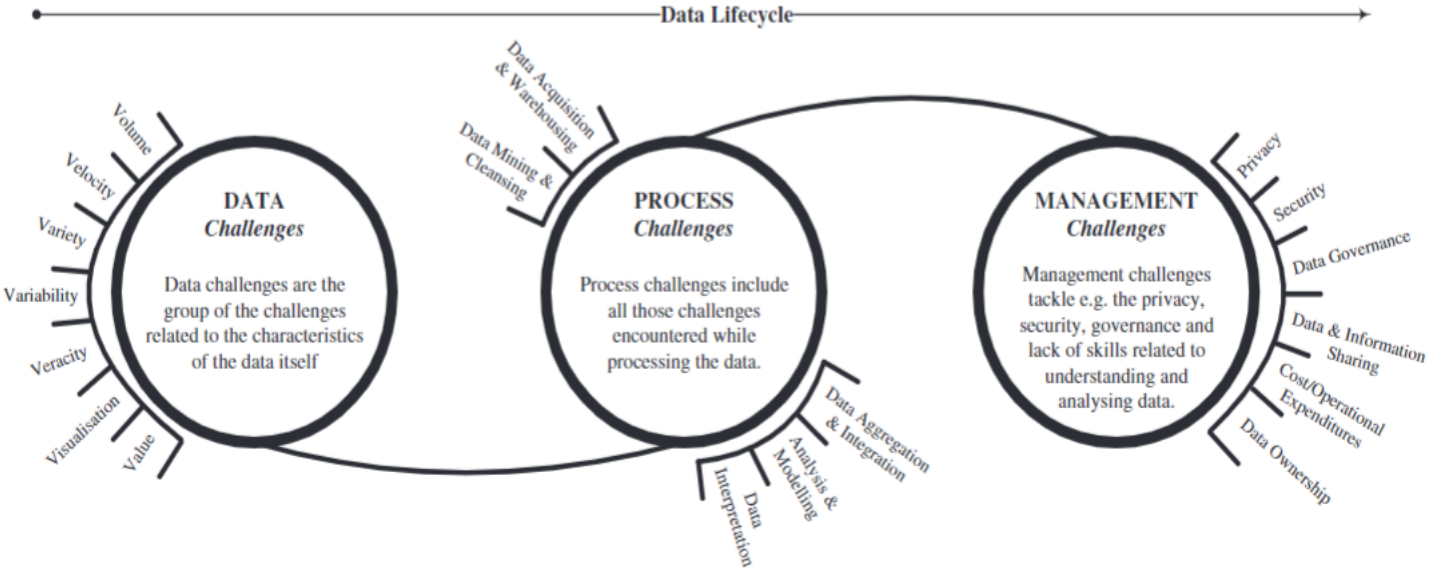

Figure 2: Conceptual classification of BD challenges (Sivarajah et al., 2017

Data challenges

In terms of data challenges, Sivarajah et al. (2017) state how these mostly relate to the features of the data, the 5 V's (e.g. data volume, variety, veracity, velocity, variability). Firstly, the volume of data, especially the data that is generated by machines, is growing substantially. This create the challenge of appropriately dealing with this huge amount of data. The second challenge that is related to the data, is about the variety. This refers to how a huge percentage of the data is unstructured and therefore hard to manage effectively. Thus, it raises the challenge where organizations often want to combine all this data and analyze it together in new ways. Thirdly, comes the challenge of the Veracity of the data. This comes down to how the data structures become increasingly more complex. Additionally, this challenge is not only focused on the quality of the data, but more about getting an understanding of the data, since there are essential differences in almost all the data collected. Fourthly, comes the challenge of the Velocity of the data. This refers to the situation where businesses start to get more value out of data analytics, which creates a success problem in which they want real-time analytics and evidence-based planning. Fifthly, comes the challenge of the variability of the Data.

This refers to the situation where the meaning of the data is continuously changing. Finally, comes the challenge of creating value from the data. BD researchers consider value as a crucial feature, because somewhere within the (unstructured) dataset, there is relevant information. Therefore, extracting this relevant information from the enormous dataset can be seen as a huge challenge for organizations (Sivarajah et al. 2017).

Process challenges

Sivarajah et al. (2017) state how process challenges are the group of challenges encountered while processing and analyzing the data that is from capturing the data to interpreting and presenting the end results. Therefore, process challenges are often related to series of how techniques: so, how to capture data, how to integrate data, how to select the right model for analysis and how to provide the results. Furthermore, Sivarajah et al. (2017) in their article discuss five steps that organizations need to overcome that are related to these process challenges. Hereby, the first step is Data Acquisition and Warehousing. This challenge is about how the data needs to be acquired from different sources and thereafter be stored for value generation purposes. The second step is Data Mining and Cleansing, in which the challenge relates to extracting and cleaning the data from an enormous pool of unstructured data. The third step is Data Aggregation and Integration. During this step, the process challenge is to aggregate and integrate clean data mined from large unstructured dataset. Fourthly, comes the process challenge of Data Analysis and Modelling. This challenge refers to the process after the data has been captured, stored, mined, cleaned and integrated. As a consequence, organizations need to develop new methods to manage BD and therefore be able to maximize the impact and business value. This change requires that organizations have a proactive mindset, since they not only have to follow the current trends, but also need to look for new ways for the future about how the quality of data analysis and modelling can be continuously improved (Chen et al., 2013). The fifth and final step is the Data interpretation. The main purpose of this step is to visualize the data and make the data understandable for the users that have to work with. This also means that the data analysis and modelling results have to be presented to the decision-makers in the organizations who are thereafter able to interpret the findings and extract sense and knowledge from it (Simonet, Freda, & Ripeanu, 2015). During this process, organizations also often do not have enough people with analytical skills, who are able to understand the data (Phillips-Wren & Hoskisson, 2015).

Management challenges

The introduction of DDD in organizations also means that the competences and the role of the management changes, which consequently also leads to some challenges that come up during the process. McAfee & Brynjolfsson (2012) state how organizations cannot take full advantage of the benefits of BD, when they do not effectively manage these challenges. Generally, management challenges are related to BD, for example while accessing, managing and governing the data (Sivarajah et al., 2017). The first challenge related to management concerns the privacy of the data, and how to preserve this privacy during the current digital age. Secondly, comes the management challenge of properly handling the Security of BD (Lu et al., 2014). Furthermore, when these security challenges are not dealt with in a nicely manner, people will remain skeptical and be very defensive about the information that they are willing to share. Next to the concerns of the privacy of citizens, comes the vulnerability of the BD for attacks. The third challenge related to the management, is about the Governance of the Data. Because of the fact that request for BD keeps increasing, organizations now become more aware of the importance of governing the data the right way (Sivarajah et al. 2017). The fourth challenge related to the management is about the way how organization handle their Data and Information Sharing. This challenge is particularly hard to deal with since every organizations or department normally own a diverse warehouse (specifically designed based on different technological platforms and vendors), which contains sensitive information and several departments are often reluctant to share their patented data governed by privacy condition (Al Nuaimi et al., 2015). However, when this is arranged in the right way, organizations will establish a close connection and harmonization with their business partners, in which trust among both parties is created (Irani, Sharif,

Kamal & Love, 2014). The fifth challenge related to the management is to find the best balance between the Cost and Operational Expenditures. This managerial challenge of data processing and other operational expenditures of the data center remains a difficult topic that at the same time also affects the way in how organizations adopt and implement technological solutions. (Al Nuaimi et al., 2015). The final management challenge by Sivarajah et al. (2017) concerns the Ownership of the Data, which is mostly a social issue. This challenge concerns the difficulties in determining who is entitled to claim ownership in data. Hereby, different stakeholders often claim that they have the ownership of specific data, because they for instance, created or generated the data, or because they use, compile, select, structure, re-format, enrich, analyze, or add value to the data. Therefore, different stakeholders will have different powers depending on their specific role. Hence, no single stakeholder will have exclusive rights (Sivarajah et al., 2017).

Management challenges – Organizational culture

In similar fashion, Shamim, Saqib, et al. (2019) report some important managerial challenges that organizations have to overcome before they can achieve the main desired outcome of the process, to improve the decision-making quality. In contrast to the article of Sivarajah et al. (2017), Shamim, Saqib, et al. (2019) mostly focus on the cultural challenges that organizations face while trying to implement DDD in their organization. For example, attracting the right people with the right skills, as well as overcoming challenges like leadership, talent management, availability of technology, and company culture are all very important issues that organizations need to address before they are able to realize the benefits linked to use of BD in decision making. Firstly, scholars have reported that the managerial challenges that organizations need to address usually start with the right leadership. This is because, in the BD era, success of firms is not solely contributed to having access to more and better data, but mainly contributed to having leadership teams who have a clear vision and set clear goals for the organization (Shamim, Saqib, et al., 2019). The second managerial challenge that organizations face according to Shamim, Saqib, et al (2019) is about talent management. Furthermore, when BD becomes more affordable and important for organizations, the complements of data analysis by data scientists also becomes more valuable. This makes it very important for organization to retain the BD experts in their organizations, or to acquire potential new talent who are able to speak the language of the business and thus facilitate leaders in formulating ways to tackle BD (McAfee et al., 2012). Thirdly, comes the managerial challenge of having the right technology to make use of the BD. Lawson, Raef, et al. (2013) state how the technological competency is essential in being able to use the BD for proper analysis. Over the years, many improvements have been made in tools, including open source software, that are able to handle the velocity, volume and variety of BD. This has changed the ways in which organizations handle data; where larger storage and higher speeds are required to gather, store and access data. Therefore, can be stated that the availability of suitable technologies for BD management can enhance the related decision-making capabilities of a firm. Finally, comes the managerial challenge of developing the right organizational culture for an organization. Hereby, organizational culture refers to: *"*the set of norms, values, attitudes, and pattern of behaviours that define the core organizational identity, influences leadership, working climates, strategy formulations, management processes, and organizational*"* (Laforet and Sylvie, 2017). Therefore, it is from importance that organizations who aim to become data-driven, develop a culture in which 'what we know' takes the place of 'what we think'. At the same time, McAfee et al. (2012) reported how the creation of the right organizational culture is one of the main challenges for BD management and state how most of the failures of BD initiatives in organizations are related to organizational culture rather than data features and technological factors. A well designed organizational culture enables a firm's to release the full potential of BD. Hereby, a proper culture is necessary to motivate decision makers to become actively involved in BD activities. Finally, it is important that organizations develop a culture of collaboration, where knowledge exchange is possible and where data science can stimulate the related executive interest and, thus, enhance BD decision-making capabilities (Shamim, Saqib, et al., 2019). Finally, the conceptual classification model by Sivarajah et al. (2017) and the study of Shamim, Saqib et al. (2019) are used as theoretical framework to answer the main research question.

3. Methodology

In this chapter, the research method of this study is discussed. In the first place, section 3.1 discusses the research design of this study. The main goal of this chapter is to give an explanation about how we aim to answer the developed research question. Furthermore, section 3.2 provides information about the different organizations that participated in this study and why they were asked to participate in this research project. Section 3.3 gives an description of how the data was collected, and explains why the chosen research method of semi-structured interviews is particularly interesting for this research project. Section 3.4 gives an explanation about how the data analysis of the semi-structured interviews is done. Finally, Section 3.5 discusses the reliability and validity of this research study.

3.1 Research Design

In order to answer the main research question *"How can data-driven decision making help managers and employees with creating business value?",* we conducted semi-structured interviews with managers of Dutch companies that are actively working with the digitalization processes of their business. We decided to choose semi-structured interviews as our research method because we in this study are particularly interested in the relationship between how the introduction of BDA changed the way of how strategic decisions are made in organizations, the benefits that organizations obtained from DDD, and the challenges that organizations face while trying to implement a DDD-culture. Hereby, qualitative research allowed us to obtain in-depth details about the concepts, as well as being open and flexible to potential findings. In addition, the interviewer had the option to come up with questions that arose during the interview, and participants had the opportunity to give new insights to the study (Galletta & Cross, 2013).

Furthermore, different research studies and models helped us to develop a semi-structured interview scheme for this thesis. The first one was the conceptual classification of BD challenges by Sivarajah et al. (2017). In addition, Shamim, Saqib, et al. (2019) discuss the cultural challenges that companies face when they develop a DDD organization. Since the conceptual classification of BD challenges by Sivarajah et al. (2017) is mostly technological orientated, it was valuable to use this study. Furthermore, the study 'creating business value from Big Data Analytics' by Grover et al. (2018) was used to determine different ways how Strategic business value can be created through DDD. This study underlined how the ultimate success of any BDA project lies in realizing strategic business value, which gives firms a competitive advantage (Grover et al. 2018). Therefore, using this theoretical framework is useful for this study, because the goals are in line with this research project, creating business value through DDD.

3.2 The organizations

In regards to finding the right organizations, the ACT (Achterhoeks center for technology) and SIKA network were used to find the most relevant companies out of the Eastern Netherlands. These network organizations are both established by and for entrepreneurs out of the Achterhoek (local area in Gelderland), who work in the manufacturing industry or ICT. Furthermore, the companies are all located in the Eastern Region of The Netherlands, and are mainly operating in the manufacturing industry. Furthermore, since we interviewed managers of different companies active in the same industry, we obtained multiple perspectives about how they see the role of BD on decision making processes for their organization. This at the same resulted in various insights, since there were differences in terms of the industry, size and the technological development for the organizations. To make this point more clear, the smallest organizations in this study had approximately 50 employees, whereas there were also organizations that had over 2500 employees. This also meant that the organizations were in different stages of DDD implementation, but also had different perspectives about the potential value that DDD can have for their organization. We tried to clarify these differences by making a distinction between the organizations that are relatively more experienced, average experienced, and less experienced in the process of DDD. Finally, Appendix I provides an overview of the organizations that participated in this research project.

3.3 Data collection

We conducted 11 semi-structured interviews with managers of 11 different organizations. The managers were also part of the management and therefore directly involved in the digitalization processes of their business. The interviews, which typically lasted 30 to 60 minutes, were audio-recorded and transcribed. The interview questions concerned different areas, for example about how strategic decisions are made in the organization, the role of BD in the process of making decisions, the benefits of making decisions using data, and the challenges that organizations face when trying to develop a data-driven organization. Thereafter, the outcomes of the interviews were coded into different groups. Additionally, we conducted all the interviews in a face-to-face setting with one interviewee and one interviewer. In order to minimize the chance that the interviewee gave socially desirable answers, we conducted all the interviews in person and at a location that was chosen by the interviewee. Additionally, all the interviews were recorded with a voice recorder to prevent misinterpretation. The interviewees were asked beforehand whether they agreed with recording the interviews by means of a phone recorder. Afterwards, the recorded interviews were each translated in verbatim transcripts. Moreover, for privacy reasons the identity of the interviewees and the name of the company were not included in this study. In addition, the respondents that were suitable for this research were contacted via e-mail. Furthermore, in order to be well prepared for the interviews, a desk-research was conducted where public documents and other related information regarding the organization or interviewee were analyzed beforehand. This helped us in obtaining a better understanding of the organizations. Finally, the fact that we compared multiple organizations in this study, enabled us to identify if there are similarities between the organizations, but is also showed substantial differences between various organizations. This provided new insights about the potential of the relation between DDD and business value creation.

3.4 Data analysis

After the interviews were conducted and transcribed, the data needed to be stored, categorized, named and connected. Hereby, coding techniques helped with organizing the data and to reduce it in relevant themes to represent the data (Creswell, 2017). While looking at the data analysis for the in depth interviews, several steps have to be followed. These steps are conducted in Dooley (2001) his book. The five steps are: transcribing, the first orientation on codes, open coding, axial coding and selective coding. Hereby, open coding refers to how the researchers stats with coding the data into major categories of information. Afterwards, axial coding must help the research with identifying one open coding category to focus on, this is called the ''core phenomenon''. The next step is to go back to the data and create categories around this core phenomenon. The final step is then selective coding, in which the researchers takes the model and develops propositions that interrelate the categories in the model (Creswell, 2017). ATLAS.ti was used to content-analyze the interview transcripts, and to code the information on the different topics that were interesting for this research study. These topic were divided into decision making and the role of data, the potential benefits of DDD, and the challenges of developing a data-driven decision culture for an organization. In the following, I rely on this information to interpret the findings and to enhance the understanding of the mechanisms that were described in the theoretical framework.

3.5 Reliability and Validity

Patton (2001) states how validity and reliability are two main factors which any qualitative researcher should be concerned about while designing a study, analyzing the results and judging the quality of the study. Therefore, some choices have been made in order to make the outcomes of this research reliable and valid. Firstly, every interview started with the same explanation about the main focus of this study, where a short description of the key concepts was given. Additionally, next to having the same introduction for every interviewee, the theoretical framework contributed to enhancing the internal validity of this research. In regards to increasing the external validity, only information was given about the goal of the interview and the method. This was done to avoid reactivity which could potentially affect the external validity (Dooley, 2001). The focus of this study will be on manufacturing

companies that are from the Eastern of the Netherlands, as the region is known for having a good concentration of manufacturing companies active in the industry. In terms of reliability, this more or less comes down to how consistency is key for qualitive research. Therefore, the main subjects within the interviews were kept the same during the interview process. Finally, like previously mentioned, the same information was given to any interviewee before the start of every interview.

4. Results

This chapter will present and discuss the main findings from the interviews with eleven managers of eleven different companies. Section 4.1 will discuss how strategic decisions are currently made in the organization, while also looking at the role data plays in making decisions. Section 4.2 focus on the benefits and advantages of making decisions on the basis of data, based on the study of Grover et al. (2018). This section will also look at the how business value can be created with the help of DDD. Section 4.3 discusses the different challenges that come up during the process of developing a DDD organization, using the conceptual classification of BD challenges by Sivarajah et al. (2017). Section 4.4 concludes with a presentation of results about how Shamim, Saqib, et al. (2019) address the need of changing the organizational culture in an organization, when they aim to become more data-driven.

4.1 Strategic decision making and the role of data

How organizations used to make strategic decisions

When looking at the way how strategic decisions used to be made in organizations, it often came down to how the management team still made the strategic decisions. These strategic decisions were often made for the long-term, and mainly based on the intuition of the management, and based on what their feeling about their expectations for the market. In these organizations, BDA was mainly used to describe things that had already happened in the past. This issue is addressed by the *CEO* of Company B, who at the same time currently works on changing this culture in the organization.

"So previously data was used when something had already happened, or when people already had a question. So we used data to solve a problem that was already on the table. This is very reactive, but you want to use the data to look at trends; so this is the data we see, what does this mean for the coming month? The coming quartile? The coming year? Do we see long-term trends or shifts coming, and then we can start thinking about how sustainable it is what we are still doing. In this way you want to approach customers. In order to be able to do this properly, also external data is needed." (CEO, Company B, Supplier of special mobile equipment).

A consequence of making strategic decisions in this relatively old-fashioned way, is the fact that you are not really flexible for unexpected changes. In addition, your intuition and feelings are generally not always right. This is nicely shown in an example of an old situation where Company C did not yet make strategic decisions based on data, and the decision was made on intuition:

"What I experienced myself at pricing in the past, before it became completely data-driven and when the process was still mostly based on intuition, was that a complaint about 2/3 products within a product group, which contains 1000 articles, led to a situation where adjustments were made for the entire product group. So we lowered the price, even though we should have never done that. Nowadays you are able to conclude, that based on the data we have, that these 2/3 products are critical and indeed need a change, but we can also look at items that are purchased so easily within that product group, that they can perhaps go up in price as a compensation. This way, at the bottom of the line, your margin stays the same or even increases." (Manager Digital Intelligence, Company C, Agriculture Wholesaler).

The given example by the Manager Digital Intelligence of Company C shows how the complaints about some products in a product group created a distorted picture in which all the other products were also negatively affected. Whereby, this whole situation could have been prevented if they at that time had access to the right data.

How organizations currently make strategic decisions

The introduction of data changed the way of how (strategic) decisions are made in organizations. While decisions used to be made, based on intuition or expertise, data now gives companies the opportunity to decide on the basis of evidence. This results in better forecast of previously unpredictable outcomes,

and also improves process performance (Popovič, Aleš, et al. 2018). The next step is to gain competitive advantage from this data. While it might look quite simple, there are however many challenges in different processes that organizations face, before they can actually derive value from their available data (Sivarajah et al., 2017). Because of these challenges, it is interesting to look at how organizations currently make strategic decisions, how they see the role of data in these decision-making processes, and how they see themselves as data-driven organizations or are willing (or not) to become one.

Firstly, became clear how the organizations that are further in the process of making data-driven decisions, generally have a more informal and decentralized organizational structure compared to the organizations that are relatively in the early stages of implementing a data-driven culture. An example of an organization that works informal and with a decentralized organizational structure is Company K, active in the Livestock Management.

"The Livestock Management department has its own market group within the company. This refers to how the different divisions within the company are subdivided into market groups. Every market group has all the disciplines in-house.. so there for example is Administration, Sales, Development (R&D), Customer support, Project agency, Hardware, Software, etc.. all those things are combined here, with the idea that we can keep the communication lines between employees open and short." (Strategic Business Developer, Company K, Livestock Management).

As the quote shows, Company K deliberately focused on designing their organizational structure in what they believe to be the most optimal way. This is accomplished, by keeping the communication lines as short as possible and generally having an informal and decentralized organizational structure across the organization. However, the organizations that are operating relatively more data-driven, (such as Company A and Company C) address how even though they have a decentralized and informal organizational structure, the board in the end often still makes the important decisions:

"We have a relatively flat organization, which is also very informal. But really the strategic decision making still lies with the board. Of course there is also a supervisory board that also gives direction. We are starting to make more data-driven decisions there. Sure it is not only on data, and we also use what we get back from the market, or from sales or suppliers, or trends .. but data is certainly an important pillar in our decision making." (Manager Digital Intelligence, Company C, Agriculture Wholesaler).

"I feel like that similarly to how other multinationals make strategic decisions, the senior management starts with preparing a proposal for a new project or a new idea. The next step is to unofficially present that plan to the board and managers, then that plan is submitted to the main directorate for approval. So there must be a valid business case, payback period, clearance about why we need to do it, and you must sufficiently motivate why it is necessary to make the investment. The management than decides if you get a go or no go. Often if you get a no go, you would have known this before. This is because the management is very approachable, where you in the early stages of a project are able to discuss your ideas." (Director Digital Innovation, Company A, Total Feed Company).

<u>*Role of data in these decision-making processes*</u>

The role that BDA plays in strategic decisions is different for each organization. However, Grover et al. (2018) state how organizations that make a greater use of data and analytics, enable managers and employees to make quicker, more flexible, and analytics-based decisions. This change was acknowledged by the *Strategic Business Developer* of Company K, who addressed that, when the data is available and accessible for the employees that are working closely to the project of which decisions have to be made, led to a situation where decision-making became more spread across the organization. This is a positive change, because the management of an particular organization cannot have knowledge in detail about everything that is going on in the different divisions. This will even

more be the case when an organization continues to grow in the future. Therefore, in this section we make a distinction in the companies that are relatively more experienced in the process of DDD (N=3), average experienced (N=4), and companies that are less experienced and only just started (N=4) investing in looking at the potential benefits that DDD can have for their organization. This distinction between the organization is mainly made in order to add clarity to the result section, and is based on an interpretation of the results of semi-structured interviews with the managers of that particular organization. This helped us to decide to which extent an organization currently has a DDD culture, or is planning to become more data-driven in the future. Furthermore, table 3 presents an overview of the drivers of how strategic decisions are currently being made in the different organizations in this study, and is based on a distinction between organizations that are relatively more experienced, average experienced, and less experienced with the concept of DDD.

Table 3 **Strategic decision making and the role of data**

Codes	Illustrative quotes
	Attitude towards DDD
*How strategic decisions are currently made in the **More experienced organizations** using DDD:* The main drivers towards becoming more data-driven for the organizations that are already relatively more experienced in working with data.	• "In general it is the case that the impact of decisions is increasing, where you in the current economy are no longer allowed to work through trial & error. The investments are too big for that. Additionally, the market no longer wants (conceptual) ideas, but they actually want predictable results in advance. In order to be able to provide these results, you need data." (Strategic Business developer, Company K). • "I feel like we have no other option other than investing in BD. We're in a low margin business. We make a lot of volume for feed, only we earn relatively little from it. So especially in these kind of business you start looking to optimal processes. Process optimization is also one-on-one connected to data. We are also in a sector in the Netherlands that is becoming smaller and smaller, there is a lot of competition, which means that you have to produce more and also more efficiently. Therefore, it is more and more important how efficient the process works." (Director Digital Innovation, Company A). • "In the future, we as a wholesaler expect that if you do not offer any further added value, the step from producer to end user will often be skipped. So you really need to create value, and we've been working on that for about 3/4 years now, and from a digital point of view. We are investing heavily in this area, and will continue to do this in the future." (Manager Digital Intelligence, Company C).
*How strategic decisions are currently made in **Average experienced organizations**:* and the more or less supportive role that data has in the decision making processes for the average experienced organizations.	• "Still too little on data, far too little on data. That's also one of the reasons why I'm here, and my approach is towards DDD. That is currently very limited. It is more situation driven. Anyway, we also do individual projects, of course, and customer projects that are already more data-driven. However, we do need to start making more decisions based on data, and I mean financial data in particular." (CEO, Company B). • "It certainly happens on experience. Personally, I do think that when you have data, you should use it as well. So if you can

base it on data, why not? To substantiate it. In general, your feeling puts you in the right direction, and then you can substantiate it with figures. So it has a more supportive role." (Manager Software, Company J).

- "Data obviously plays a role, look... all the data we have, that's what we're looking at. Data that we don't have, we can still say; that's what we're trying to get at. But that might take a year, so you can estimate the time before you can have certain data. And some data, you have to accept, we will never have it. But you can base very little, especially when it comes to strategic decisions for the future, on data from the past, because tomorrow the world will look very different again." (Managing Director, Company D).
- "Data therefore ensures that you can substantiate it with facts in addition to your emotional ratio. And if those two things match, then you quickly have support and you can also change things. So I certainly believe in the power of data. However, ultimately the entrepreneurial heart also plays an important role. Data cannot exist without people, and people cannot exist without data." (Managing Director, Company E).

*How strategic decisions are made in **Less experienced organizations:*** Factors why the organizations that are still relatively less data-driven still mainly make decisions on the basis of intuition or feeling

- "Data doesn't play a role in decision making at the moment, and it happens mainly on intuition/feeling, because we think this is the best way. However, I think there are indeed quite a few more possibilities, of which we don't know the existence at the moment. I think there are.. However, not a lot of research has yet been done into these possibilities within the company." (Managing Director, Company F).
- "If data is available, it plays an important role. However, this is not really the case at the moment, and this has a lot to do with the fact that we are a small team. So that there is simply no time and resources for it." (Customer Service, Company G)
- "We try to use some data, but in our case we often find that data from the past does not apply for cases in the future. So in the end, the biggest part of the decisions is still made based on gut feeling or intuition. This also means that the organization is too little aware of the possibilities that big data can offer for making decisions." (CEO, Company H).
- "Data plays a role, but we test it in the organization with the production manager, or with the help of the visions of employees. Because a very nice number can come out of it, we make profit/loss on a certain product group, that number can be red or green, but the truth can always be different, because we might have acquired this data the wrong way. Therefore, you should always check it." (Business Developer, Company I).

More experienced organizations

For Company C, an Agricultural Wholesaler, is the culture of the organization already very data-driven. Over the last years, they for example launched two projects, in which BDA plays a huge role. Firstly, they defined five key processes for their organization, and within these key processes they have all

kind of KPIs. An example of a key process is order to delivery, in which the time from when a customer ordered a product, until the moment it is delivered, is measured. Furthermore, when there is a deviation, or if things get worse, actions can be taken. Secondly, they have a project called: getting the basic rights, in which they focus on the customer experience. This refers to how they measure all the different variables that affect the customer experience. Similarly, when there is a deviation, or if they notice that things get worse, they are again able to take actions to make the processes more effective and efficient. By doing it this way, they aim to improve all different phases of the customer journey.

"Data is used for all phases in the customer journey. If you for example look at what we purchase as stock, then this is almost completely data-driven. We make use of parameters, so all sales data goes in it, also seasonal influences, we are now even working on putting weather influences in it. We do have software which enables us to do this. So if you put the right data in the software, you will receive a good purchasing advice. At the back we measure how good our stock values are, but also how good our turnover rates are from our stock. So then you validate whether you had the right stock, and if there was sufficient turnover." (Manager Digital Intelligence, Company C, Agriculture Wholesaler).

However, while data does play a big impact in the decision making processes of the organization, the *Director Digital Intelligence* of Company C addresses the importance of finding the right balance between making decisions based on data and the general intuition or 'gut feeling' of managers or employees.

"If we start looking at percentages, and if it is really about strategic decisions in the board, then I think that 60% to 70% should be based on data. I think that we are heading that way. There are of course always visionaries, who talk with all kind of consultants, have a clear vision. So it is a mix between the two.. and I think that's good too." (Manager Digital Intelligence, Company C, Agriculture Wholesaler).

In similar fashion, Company K currently develops a business strategy that is completely data-driven. Whereas they in the past, used to have their products on the market, based on a top-down functionality. So the customers used to decide which products they wanted to have, and then the company generally just delivered the product. However, this has changed to a situation where they now deliver their products as a service. Furthermore, service, with the help of data, is a continuous process, which completely changes the role of the organization.

"So the whole switch to a new role of our products, but also the role that we as an organization have to offer to our customers, is really new, and we are currently in a learning process, where have to learn how to offer our products as a service in the best way." (Strategic Business Developer, Company K, Livestock Management).

Consequently, it is a huge challenge for the organization, as well as for the customers and investors, to get used to the changes of this relationship. This is due the fact that the role of both parties in the process also changed drastically since Company K started delivering their products as a service. For example, investors were always used to bargain a lot with their customers, but you obviously do not want to do this with someone who you are providing service. This challenge is addressed by the *Strategic Business Developer* of the organization:

"So when we look at investors, they also have to get used to this new relationship with their suppliers. In the past, they were used to bargaining, and sometimes even squeeze suppliers out, but you really do not want to do this with someone who you are providing service. So you have to train both parties in that aspect, and just generally open the conversation. Therefore, I still often go to the senior management of our larger customers, just to explain what we want to achieve with service,

but also to see how they respond to this change. Hereby, it is also important that you openly discuss which role both parties are going to take in the process." (Strategic Business Developer, Company K, Livestock Management).

An organization that is aware of the potential that data can have on decision making, is Company A, who produces total feed solutions. Therefore, they started developing multiple pilots in which they experimented with how BDA can play a role in optimizing the different phases and processes in the customer journey (e.g. pre-purchase, purchase, post-purchase) in the farming sector.

"Data can still have an even bigger role for our decision-making. Therefore, we are working on the process of becoming more data-driven. We are currently running all kind of pilots, and we already use BD solutions for some projects, but it is still in the relatively early stages. We are aware of the potential, developing it, and thereafter does it get a place in our operation processes." (Director Digital Innovation, Company A, Farming Sector).

As the quote shows, Company A is aware of the potential of BDA and is working on creating feedback loops, in which the output of the different systems is used as input for future operations. Therefore, the first step is to create the input. Secondly, this input needs to be captured and stored. Thirdly, the input will be analyzed and the insights will finally be used to make decisions in the fourth stage. According to the *Director Digital Innovation,* this will enable them to continuously improve their processes in the Farming Sector.

Average experienced organizations

Company E, an integral construction company, also started investing on the potential benefits that DDD can have for their organization. This is mainly because, maintenance is already part of their primary process.

"So, maintenance is part of our primary process. We design, and realize a building, and thereafter the relation between the construction company and the principal would normally stop. *However, we also have contracts where we are responsible for the maintenance and energy management for 10-25 years. So we have to make conscious, modern choices at the front, to not be bothered in a later stage. This requires a different mindset." (Managing Director, Company E, Integral Construction Company).*

Therefore, the *Managing Director* of Company E addressed the importance of making conscious, modern decisions at the front, to not be bothered in later stages of the process. So the knowledge and data that is obtained during the maintenance, and energy performance of buildings, is now also used for the design phase, which enables the organization to work more precise and better in the future.

The *CEO* of Company B, which produces Heavy Duty Smart Solutions is also aware of the need to invest in becoming more data-driven. Therefore, the management is actively trying to change the culture of the organization into this direction. This is a really challenging process.

"There is a lot of data available, because we have a well-functioning ERP system, but just having data generally has no value. So, If you do not edit the data, process it, make it presentable, standardized, and able to use for management. Additionally, you also have to make it readable and understandable for the management. So if I look at my first ten months in the organization, when I want to know something, then I first have to instruct people to delve into the data. These people then start collecting data specifically for the question I asked them. This is because the data is not standardized, so it is also always the question of where the data comes from, and what is the

relationship between the data from one system, with the data obtained from another system." (CEO, Company B, Supplier of special mobile equipment).

Obviously, this way of working is very time consuming and therefore not very efficient. The *CEO* of the organization at the same time addressed how this way of making on the basis of intuition still works on the short-term, because a lot of employees at the organization already work there for a long time, or come from backgrounds that are similar to the one of the organization. However, he also addressed how this way of working will no longer be sustainable on the long-term, and this means that the management team is currently working on learning the employees in the organization how to work with data. This must eventually lead to better understanding from the employees about the direction that the organization is going.

Less experienced organizations

Finally, there are some companies in this study that have only just started looking at the potential benefits that DDD can have for their organizations. An example of an organization that currently does not make use of data to drive decisions, is company H, a Supplier of Metalworking Machines. According to the *Managing Director* of the organization, this is mainly due to the fact that service is not a primary goal of the organization.

"Service is not a main goal of the organization, you have to provide your customers with it when they ask for it, but it does not have our main focus, and we also do not offer service to third parties". (Managing Director, Company H, Supplier of Metalworking Machines).

The quote above also shows how the strategy of an organization is very important while looking at the extent to which an organization is data-driven. Therefore, can be stated, that organizations who are relatively more data-driven, generally focus more on aspects like providing service, process optimization, and improving the customer experience. In similar fashion, does Company F, a manufacturing company in drying systems, also not make use of data yet.

"Data currently plays no role in making strategic decisions, and it is still mainly done on intuition/feeling, because we think this is the best way. Ultimately, we simply look at what the customer wants and what he/she asks for. However, we just started with extracting data from the machines, to provide customers with more information from his system. So to find out what happens in a machine, and also be able to determine whether maintenance is needed. This comes down to providing service to our customers." (Managing Director, Company F, Manufacturer of drying systems).

4.2 Benefits of DDD

Most of the organizations that participated in this study are aware of the potential value that DDD can create for the company, and for their customers. Therefore, we linked the benefits addressed in this study with the BDA value creation framework of Grover et al (2018). Additionally, the interviewees in this study made a clear distinction between benefits for the organization, and benefits regarding getting a better understanding of customer. Therefore, the benefits are divided in two main groups: benefits for the organization, and benefits for the customers (table 4).

Table 4 **Benefits of DDD (Grover et al. 2018)**

Codes	Illustrative quotes
	Potential business value that DDD can create
	Organizational benefits
Organizational benefits: how DDD can improve the decision making processes throughout the whole organization	• "Actually, the main benefits of data is that is generally based on facts. Your gut feeling is often more focused on an opinion. So, data is a fact, and often when you have access to all kinds of different data, you can also get a broader picture of what's really going on. This is the case for everyone in the organization, who are now independently able to make better decisions based on the presence of the right data." (Manager Digital Intelligence, Company C). • They become decisions, in which you have fewer uncertainties. You're also able, and I think that's typical; it's called big data, but you're able to take smaller steps. You can take smaller steps, and say: we try those first, we can add more things, but we don't do that yet.. we take a small piece and see if that adds benefits for our customers. Then we're going to expand it. So a big impact it does have on decision-making is that you make much decisions, all of which are much smaller. Where 5-10 years ago you all chose a certain direction, and also knew, if we go that way, we can't go left or right again.. it's too big for that. (Strategic Business Developer, Company K).
Organizational benefits: how DDD can enhance operational benefits	• "You'll have a piece of convenience. Operational processes will becomes easier, a bit more transparent and it becomes more unambiguous. The process will always become the same. It's not like that when a certain operator is standing on the factory, that the person is enabled to do things in a particular way, in order to be done faster with his work, which at the same time decreased the quality. You hope to remove those kind of things." (Director Digital Innovation, Company A). • "I think that by means of data, you can start analyzing, weighing up; suppose you have two of the same machines, so two apple machines, and one is running 90% and the other 50%, you can now analyze why your machinery is operating in a certain way. So to find out the reasons for these differences and therefore be able to improve the effectiveness and efficiency of processes and products." (Business Developer, Company I).
Organizational benefits: how DDD can help with creating transparency, and strategic	• "The advantage lies in the fact that when you choose the right data, and certainly for employees, also the right amount.. that they get a regular, better, unambiguous feeling about where the organization

clarity	is going. This also allows them to better understand the urgency of things. But they can also get confidence about things that are going well. So it works both ways, in making decisions, both at management level, middle management, or with the direct supervisor in the workplace, data helps to create a joint unity, and it is no longer more the case that everyone has their personal ideas, and that eventually the biggest shouter in the room wins.“ (CEO, Company B).
Organizational benefits: how DDD can lead to potential new products or service innovation. *	• *“*In addition, on the basis of data, which is already live, we can serve the customer much better with his search, for example. This is all based on data, so buying behavior/click behavior of history is all in it. At the same time, we can use this data also to look at potential new products or service innovations, by analyzing the customer behavior, for example in the form of product reviews and/or consumer discussion forums. This can lead to valuable insights.*“ (Manager Digital Intelligence, Company C).*
	Customer benefits
Customer benefits: firms can get a better understanding of the needs of their customers	• *“* I think that customers benefit from a predictable formulation, i.e. a predictable recipe of our food. When the predictability increases, all kinds of perspectives arise. We supply guaranteed yields of meat, milk, and things like that. If you go all the way to the chain perspective, for example, supermarkets can very easily determine what substances they want in feed. These kinds of requirements are then neatly and transparently followed by a tracking system, but you need data for this.*“ (Director Digital Innovation, Company A).* • It is no longer our main goal to sell a lot of vehicles, but it is our goal to improve or solve the customer's process. The machines are somewhat unique, but that does not mean that they are so unique that we are the only company in the world that are able to make them. Therefore, you’re not going to sustain if you keep competing purely on machines. You really have to look for added value for the customer. You really need data for that. (CEO, Company B).
Customer benefits: BDA also create insights about customers and markets that can be used to improve customer satisfaction and loyalty	• *“* So you help the client with all his processes. For example, we help them with their purchasing, but we also discover potential new markets, and then we work together with the dealer. This also allows him to grow, which is a nice development.*“* (Strategic Business Developer, Company K). • *“*What we really want for customers.. is that we now have a lot of dedicated stock for customers, so really their own models that don't go to other people. So we would like that to see that these people in the future are able to log on to the website, or in our ERP package, and see how much of this or that is still in stock at instead of calling or emailing; how much is left of a particular product.*“* (Customer Service, Company G).*

Organizational benefits

The first benefit that DDD can have for organizations, is to improve decision making processes for all different kind of managers and employees in the organization (Grover et al. 2018). With the presence of data to support decisions, it is no longer the case that only the relatively higher placed managers or employees in an organization are able to make decisions. Therefore, when an organization enables their employees to have continuous access to data that is relevant across the organization, complemented with human decision making or are built into business processes, employees throughout the whole organization will now be challenged to make individually good decisions. This change is acknowledged by the *Strategic Business Developer* of Company K:

"I think that we with the help of data, even get more tools for making the right decisions in the organization. So even relatively very low in the organization, that employees will now be able to independently make good decisions. This is now becoming more visible and tangible." (Strategic Business Developer, Company K, Livestock management).

Besides the improvement in decision-making, companies also acknowledge how BDA enhances operational benefits. This refers to how it for example enhances the effectiveness and efficiency of processes and products. So organizations make more use of data, they are able to better forecast previously unpredictable outcomes, and improve process performance. This will lead to operational process benefits in the form of cost reductions, better operations planning, lower inventory levels, better organization of the labour force and elimination of waste, while leveraging improvements in operations effectiveness and customer service (Popovič, Aleš, et al. 2018). This will at the same time change the role of employees, because they no longer have to invest most of their time on doing the relatively easier repetitive tasks, and will now be able to dig deeper in certain aspects of their job.

"The operational part will become easier. Because we are working on process automation, a consequence is that the operational part will also in some way fall away. This also changes the role of employees, making it different and more fun, whereby they will be challenged to go more into the depth. (Manager Digital Intelligence, Company C, Agriculture Wholesaler).

It is however important to address that the these improvements in operations differ for each company, because it is also dependent on the firm's BDA capabilities. Like previously mentioned, do factors like data sourcing, access, integration, delivery, people, analytical capabilities and organizational factors like a BDA strategy, support of the management, financial resources, and engaging people in the process, play a huge role in the extent to which organizations can benefit from using BDA in their operations (Popovič, Aleš, et al. 2018). We will dig deeper into these factors, later in the result section.

Next to these operational benefits, can data-driven decision-making help with creating transparency, and strategic clarity in an organization. This is due the fact that DDD leads to more uniformity in communication inside an organization, but also with customers. Using BDA will therefore enable organizations to have better communication. The *CEO* of Company B addressed how instead of communicating by using through texts, now data can be used to support assumptions. This will like previously mentioned reflect back throughout the whole organization, because it enables employees lower in the organization to come up with ideas, or make the right decisions for themselves.

Additionally, the organizations in this study addressed how still a lot of work in the factories is done manually, in which the quality of the work is dependent on the person who is working behind the production line at that specific moment. With the help of BDA, these people can be supported, which makes experience at any given moment less important. At the same time, the *CEO* of Company B also addressed how DDD enables employees across the whole organization to individually make good decisions.

"The advantage lies in the fact that when you choose the right data, and certainly for employees, also the right amount.. that they get a regular, better, unambiguous feeling about where the organization is going. This also allows them to better understand the urgency of things. But they also get confidence about things that are going well in the organization. So it works both ways, in making decisions, both at management level, middle management, or with the direct supervisor in the workplace, data helps to create a joint unity, and it is no longer more the case that everyone has their personal ideas, and that eventually the biggest shouter in the room wins." (CEO, Company B, Supplier of special mobile equipment).

Finally, in terms of the benefits from DDD for an organization, can it also lead to potential new products or service innovation. This is because, organizations get the opportunity to obtain user-generated content on platforms like social media where customers share their experiences and feelings towards a product or service, or state problems among customers. Therefore, by analyzing this user-generated content on the different platforms, organizations have the opportunity to identify the most reported flaws/issues or customer desired features of products or services, which provides insights for future product/service innovation (Grover et al. 2018).

Customer benefits

Using BDA to drive decisions can also create benefits for customers. Firstly, with the help of BDA, firms now have the opportunity to get more knowledge about their customers. This can be very broadly seen, and can for example go from being able to deliver better service and (predictive) maintenance of their machinery, to improving the performance and efficiency, or to generally create a stable and optimal production process. This comes down to how the optimal production process can be created for a customer through continuous simulations. Furthermore, by creating the optimal process, the predictability of the outcome will go up, which consequently offers all kind of new perspectives for both the internal employees but also for customers.

"It will generally create convenience. It all becomes easier, a bit more transparent and it becomes clearer. The process will always become the same. Nowadays, it can for example be the case that a certain operator at the factory, does everything in a certain way, to be done with his work sooner. In the future you hope to remove things like this, so that every process is simulated and developed into doing the things in the best way possible. This will force the operator to just follow this guideline towards creating the optimal process." (Director Digital Innovation, Company A, Farming Sector).

"We want to go that way so that the company can get the most out of its installations. So our business processes are already very focused on that, especially in the feed and manufacturing industry. If you for example are able to take 10 seconds off the mixing time, this will already have a lot of impact. Because 10 seconds X so many times a day X so many days a week, it adds up really fast. So if you can optimize things there, or at least justify investments by helping things like that, helping the customer with data, this will certainly help. Especially here in the Netherlands, and in Western Europe. The other countries and regions need some more time." (Manager Software, Company J, Process Improvers).

Next to these operational benefits for customers, does BDA create insights about customers and markets that can be used to improve customer satisfaction and loyalty, lock in customers and suppliers, and create a niche market (Grover et al. 2018)°. This will improve the customer experience. For instance, a well-designed CRM system makes it possible for an organization to gain insights about their strategic customers. This will also enable organizations to take actions, that are specifically beneficial for a particular customer by providing much more precisely tailored products or service. Consequently, customers will become more satisfied, but will also attach more value to a sustainable relationship with the organization. Finally, Grover et al. (2018) discuss how organizations that make use of data can generally anticipate better on customers, sales or purchasing behavior, and therefore match better with the needs of the market. Company C, an Agricultural Wholesaler, is already actively working

together with their customers to help them with obtaining more insights about their potential market, and the *Manager Digital Intelligence* also gave interesting insights.

"So, we supply dealers, agricultural mechanization companies all over the world. They are operating in a village and they often have a kind of region in which they sell their products. So all farmers in that region come to that dealer, sometimes there are several dealers, and what we are doing now, for example, is that we are mapping out things like; which kind of farmers are active in a specific area? We currently know this for all the countries in Europe. So, things like: How much land do they have? How many cows do they have? And we have put a potential calculation behind that. So we can now show the potential reach of a dealer, and afterwards we are able to help that dealer with; hey, there are X number of dairy farms active in that area, so you have a potential there for so many euros to sell for product X". (Manager Digital Intelligence, Company C, Agriculture Wholesaler).

As the quote above shows, Company C currently invests a lot of resources on creating the best possible partnerships with their dealers across Europe. Hereby, the goal for the organization is to take an dominating position on the European market. Therefore, the company is actively looking at possible takeover candidates that can enable the organization to grow in the countries where they are still relatively small. This led to two acquisitions in 2018, in Italy and Spain, two of the five most important agricultural countries in Europe. The reason that the organization is always actively looking for partnerships, is because they feel like working together with other parties leads to the best results in the long run.

4.3 Challenges of DDD

Although the benefits and value of using BD to drive decisions is made clear, there are also some challenges that need be addressed when organizations aim to create the maximum business value out of data analytics. Generally, these challenges can be divided in the following groups: data challenges, process challenges, and management challenges (Sivarajah et al. 2017; Shamim, Saqib, et al. 2019). Table 5 presents an overview of the different challenges that organizations face during the process of becoming more data-driven.

Table 5 Challenges of DDD (Sivarajah et al. 2017; Shamim Saqib, et al. 2019)

Codes	Illustrative quotes
	Challenges that come up during the process of becoming data-driven
	Data challenges
Data challenges: Related to the features of the data itself: e.g. Volume, Velocity, Variety, Veracity, Value (Sivarajah et al. 2017).	• "In order to deal with these data challenges, you need to have good internal knowledge, so people who have understanding of databases. We are lucky that we have been building databases for a long time. But indeed, it is growing exponentially, and then you also have to take steps internally as an organization. The most important thing is that we listen carefully to the people who have to set it up and have the knowledge of it." (Strategic Business Developer, Company K). • "What we noticed in our organization, and where we already have taken several steps, is that dashboards were often located in different places, and that people also had login functionalities for a specific customer in different systems, so this was all very fragmented. We now created a website, in which you have a list of all customers, and that you can just click and then automatically go to the dashboard of that customer. This also applies to the internal staff, so a login environment

where you can access all the information you need.“ (Managing Director, Company F).

- “In terms of control techniques for accuracy and reliability of the data, we still have steps to take. We want to have smart solutions for this, but we still have a lot to do on this topic.. and we are really only at the early stages in this process.“ (Strategic Business Developer, Company K)

Process challenges: related to the series of techniques of the data: e.g. how to capture data, how to integrate data, how to transform data, and how to select the right model for analysis to provide results (Sivarajah et al. 2017).

- “So the whole building of a data warehouse, is certainly a challenge, and we're in the middle of it with the BI team. We also have quite a fragmented application landscape. This is also due to the growth we have made as an organization.“ (Manager Digital Intelligence, Company C).
- “That is difficult, then you get that companies, just like us, that get data from different software packages, so you have to make sure that that data becomes available in such a way, that at the moment you can start using data and link data together, that it has the same data unit, has the same quantity, so that it makes sense to start comparing variables.“ (CEO, Company B).
- “Capacity is a bigger challenge, because there is still a lot of work to be done there. We have such a large demand from the business about providing them with our data-driven solutions, that we cannot keep up. This creates the internal discussion; how much are we willing to invest in this? So yes, this is still a challenge that we are currently facing. So knowledge is okay, capacity is still a challenge. However, this is more of a budget issue.“ (Manager Digital Intelligence, Company C).

Management challenges

Management challenges: related to the privacy, security of the data, governance, ethical aspects (Sivarajah et al. 2017).

- “We've appointed a separate Security Officer to deal with the privacy and security issues. So he has to make sure the GDPR is correct, that our systems are not hacked, that we do not use data that we are not authorized to use, etc.“ (Director Digital Innovation, Company A).
- “In regards to data governance, it is indeed again a continuous challenge; so, who is allowed to see which data? Why? The more data you have, the greater the risk is that you give someone access to see data, that they are not allowed to see. So, when you start bundling data from different software, it is therefore very important that the design of the data governance is properly arranged.“ (CEO, Company B).
- “We always divide it into three parts. In processes, people, and technology. Technically it's just hard work, and then you have to make some investments to set it all up. Processes and culture need more time, especially because we have also put a part of the analysis in the business. It took almost a year before they took steps in this area.“ (Manager Digital Intelligence, Company C).

Management challenges: related to the changing organizational culture when implementing a data-driven strategy, which results in challenges like management

- “I think management support is becoming more and more important. I can't say that everything is going to be data-driven, but I think that our management has the right attitude about it. They are also aware that things are moving into that direction, where BDA is only going to become more important. At the same time, the competition is also investing in it, so you have to be careful that you do not fall behind to these different parties.“ (Director Digital Innovation, Company A).

support, leadership, talent management, and the design of the right company culture (Shamim, Saqib, et al. 2019).	• "The design of our building is also a bit based on how within the company, entrepreneurship, and freedoms, to a very large extent is placed at the people, where the company actually says; it is our concern that you can work well, sit well, so to facilitate it. But then it's up to you to make something out of it. Hereby, we have noticed that employees really have to get used to this, so there are people who fit in this kind of organization, and also people who really have a hard time finding their place." (Strategic Business Developer, Company K). • "By having a vision, a point on the horizon where we as an organization want to go. We try to involve everyone, install SPRINT teams that will innovate and improve on a certain part. This also includes regular feedback to the organization, and on the basis of projects show that something else, or better, can be done. So as management, we believe in serving leadership, and in this way I also try to participate and give direction, but also to further shape the company together with colleagues." (Managing Director, Company E)

4.3.1 Data challenges

Data challenges relates to the features of the data itself. Firstly, since data is generated at a faster rate than ever before, in combination with the fast progress that technology and analysis processes are undergoing, organizations now have the opportunity to create value out of this data. However, there are several challenges that come up during the process of extracting value from this enormous data lake. In terms of the data, Sivarajah et al. (2017) distinct challenges based on the 5V's (Volume, Velocity, Variety, Veracity, Value). These challenges were acknowledged by the *Strategic Business Developer* of Company K, who addressed the importance of having good internal knowledge about everything that is related to databases, because especially the Volume of data is growing substantially.

"In order to deal with these data challenges, you need to have good internal knowledge, so people who have understanding of databases. We are lucky that we have been building databases for quite a long time. But indeed, it is growing exponentially, and then you also have to take steps internally as an organization. The most important thing is that we listen carefully to the people who have to set it up and have the knowledge of it." (Strategic Business Developer, Company K, Livestock management).

This relates to the second data challenge, building a well-designed infrastructure despite the variety of the various data sources, in order to be able to obtain value out of the available data. This comes down to how a huge percentage of the data is unstructured and therefore hard to manage effectively. Thus, organizations want to combine the data from different sources, and analyse it in new ways. During this process, organizations have to make several investments. Hereby, the first step is to develop a centralised location where the data can be stored, which is also capable of combining various data and continually able to handle large-volume of new entering data (Sivarajah et al. 2017). This is generally referred to as the *Data Warehouse.* Furthermore, the challenge of developing this well-designed data warehouse is underlined by the *Manager Digital Intelligence* of Company C, an Agricultural Wholesaler:

"Building a good infrastructure is certainly a challenge, and we as BI are in the middle of this process. So the entire building of a data warehouse is complicated, due to the fact that we have a kind

of fragmented application landscape. This is also due to the growth that we have made as an organization over the last years." (Manager Digital Intelligence, Company C, Agriculture Wholesaler).

Furthermore, the *CEO* of Company B addressed how the main challenge of building this well-designed data warehouses comes from the fact that organizations often deal with different systems, in which the data has to be unlocked from each system, therefore is not very structured, and still needs to be integrated into the main ERP-system of the organization. This refers to the challenge of having Variety in your data.

"It is difficult to properly arrange your data acquisition and warehousing systems, because customers often, just like us, obtain data from different software packages. So you have to make sure that the data becomes available in such a way that you can link the data to each other, that it has the same data unit, the same quantity, so that it makes sense to compare variables." (CEO, Company B, Supplier of special mobile equipment).

In addition, the relatively smaller organizations addressed some other challenges, while trying to set up a well-designed data warehouse. They for example questioned themselves whether they had enough competence within their organization to build this data warehouse, if they had the right software packages, but also if they had sufficient investment options to set up or buy these software packages.

"So the challenge, especially with the slightly smaller companies, is; do you have enough competence within your organization to make this change? Do you have the right software packages? Do you have sufficient investment options to set up these software packages properly?" (CEO, Company B, Supplier of special mobile equipment).

There are several ways to deal with this challenge. The *Manager Digital Intelligence* of Company C acknowledged this challenge, but at the same time tried to explain how they tackle this issue:

"So we have a data warehouse for that, where we have different layers. So we collect data, and then it goes into a data model in which the data is integrated and normalized. As a result, the data becomes visible, and can then be used from a data platform lab. So, employees can then request which data they want, so for example; I would like to obtain insights about the stocks for the whole company.. then all business rules are defined under water. But that is all very complex, and it is a huge amount of work to record all of that. This also makes it a huge challenge, and very technical." (Manager Digital Intelligence, Company C, Agriculture Wholesaler).

The quote above shows the huge challenge of dealing with the Veracity of data, where organizations want to make sure that the quality of the data is ensured. At the same time, they also have to make the data understandable for the users, which can be accomplished by providing the right tools and analytics to manage and mine the data. This challenge is underlined by the *Strategic Business Developer* of Company K, who addressed the importance of working together with different parties that have knowledge about how to deal with these projects.

"You should not ask too much from yourself, and focus on your core business. So we always try to find partners who have experience in this field, and therefore are able to help us with these kind of projects." (Strategic Business Developer, Company K, Livestock management).

The quote above shows how it is very important that organizations that want to become more data-driven, work well together with specialists of engineering firms, or software companies, that have knowledge about how to deal with these processes. These organizations can help with solving the difficult questions, in which solving internally would otherwise also take way too much time. In

addition, since companies generally want to be able to operate globally, they are also dealing with the fact that the rules for accessing the data, and also for the storage and security of data, is different for different countries. This is especially the case for the relatively larger organizations, like Company K.

"You have to do that with local parties, but we try to do that with parties that are active worldwide. So for example, Microsoft is available in China with data storage. We have Azure, the Azure Cloud, which is why we use Microsoft because we know that they are also active in China, we know that they are good in North America. So these are factors that you take into consideration when you chose the right party. Internally, we have a team of 4 or 5 people who have been busy for over a year to find the right way to do so. So, questions like; who should we work with? how should we arrange it? which contracts do we have to close for this? This are big projects in the organization." (Strategic Business Developer, Company K, Livestock management).

Fourthly, comes the challenge of the Velocity of the data. This refers to the situation where businesses start to get more value out of data analytics, which creates a success problem in which they want real-time analytics and evidence-based planning (Sivarajah et al. 2017). The final challenge is about being able to deal with the Variability of the different data. So, next to the data warehousing capabilities of firms, they also need efficient analytical algorithms that are required to understand the provenance of data and process the vast streaming data and to reduce data before it is stored. These algorithms need to understand the various contexts and also need to be able to interpret the meaning of the data in different contexts, which leads to a situation where value can be created. However, extracting this high-valued data from the enormous dataset remains a huge challenge for the different organization. This is because, organizations often do not have the capability of doing this on their own, and often look for external parties during this process. Additionally, because these organization are often limited to resources it is from importance to collaborate with the right organization. The challenge of finding the right party, is especially a huge challenge for the relative smaller organizations, according to the *Head Customer Service*, of Company G.

"Our own level of knowledge about setting up a data warehouse is too low, so we really have to rely on what other people advise us. But if we talk to four parties, then they all advise something different about which way we should go, how we should set it up, how we should handle security, and what we need to do in order to obtain valuable business insights.. so I think that the biggest challenge, especially for smaller organizations, is to find the right party to help you with these processes. These parties ultimately have the goal to sell a product.. so finding someone who is independent, has knowledge about your organization, and the wishes you have, and finally also has knowledge of what is possible, is not easy." (Head Customer Service, Company G, manufacturer of PET bottles).

4.3.2 Process challenges

Process challenges are generally related to series of techniques, like for example how to capture data, how to integrate data, how to transform data, and how to select the right model for analysis to provide results (Sivarajah et al. 2017). Firstly, the acquisition and warehousing of data is an important challenge for the different organizations. Hereby, data acquisition refers to the process of extracting relevant business information from multiple operational source systems, and transforming the data into a homogenous format. At the same time, data warehousing refers to the technique for collecting and managing data from varied sources to provide meaningful business insights. This challenge was underlined by the *CEO* of Company B.

"I think that it is a challenge, for which you actually need a kind of platform, where you can first make all that data a kind of ''source-neutral''. So when you approach the data you know that it is unambiguous, so that you can build up your Business Intelligence (BI) from that data pond." (CEO, Company B, Supplier of special mobile equipment).

Furthermore, the quote above shows how it is important that organization use smart filters during the acquisition and warehousing phase, that are able to capture useful information and delete useless information. This also requires efficient analytical algorithms that are able to understand the provenance of data and process the vast streaming of data and reduce the data before it is stored (Sivarajah et al. 2017).

The second challenge, is about how the data needs to be extracted and cleaned from a huge pool of unstructured data. Sivarajah et al. (2017) state how "this step in the process is referred to as Data Mining and Data Cleansing. So in order to obtain value of the data in a meaningful way, there is a need to develop an extraction method that mines out the required information from unstructured BD and articulate it in a standard and structured format that is easy to understand*".* The *Manager Digital Intelligence* of Company C, shared some ideas about how this can be properly done.

"There is definitely enough knowledge in the organization about how this should be developed, so we have a data architect who has an idea, we have our team, and there is also a technical leader for BI. He has the technical skills to design it, and then we have BI developers who do the executive work. So they make the ETL scripts to be able to unlock all data in a good way." (Manager Digital Intelligence, Company C, Agriculture Wholesaler).

The quote above shows how the extraction and cleaning of the data remains a continuous challenge for any kind of organization, and also underlines the importance of good communication because different employees are working together on this challenge. Furthermore, the third process challenge is about the Data Aggregation and Integration, in which organizations aim to aggregate and integrate clean data mined from large unstructured datasets. However, since the availability of data in large volumes and diverse types of representation, only continues to grow, it is important that organizations develop smart integration systems that enable organizations to create new knowledge (Sivarajah et al. 2017). Additionally, since the demand from the business keeps growing, this leads to another challenge, the capacity. This challenge is underlined by the *Manager Digital Intelligence* of Company C.

"Capacity is a bigger challenge, because there is still a lot of work to be done there. We have such a large demand from the business about providing them with our data-driven solutions, that we cannot keep up. This creates the internal discussion; how much are we willing to invest in this? So yes, this is still a challenge that we are currently facing. So knowledge is okay, capacity is still a challenge. However, this is more of a budget issue." (Manager Digital Intelligence, Company C, Agriculture Wholesaler).

The fourth challenge accompanied with the process of becoming more data-driven, is Data Analysis and Data Modelling. Hereby, the role of the Data Analyst is to gain insights from the data that is acquired. This must eventually help the business with making better decisions, and can for example be accomplished by merging data from multiple data sources together, or by running queries on existing data sources to evaluate analytics and analyze trends. In comparison to the Data Analysis, is Data Modeling done by a set of tools and techniques that can be used to understand and analyze how an organization should collect, update, and store data. The main challenge during this process, according to the *Strategic Business Developer* of Company K, is to make sure that your employees have some primary knowledge about the sector that the business is operating in.

"What we have really noticed is that employees throughout your organization, need to have some primary knowledge of agriculture or of the specific sector that he/she and the organization is operating in, in order to be able to interpret the right things from the dataset. After all, I no longer know what is important for a dataset, it is becoming too technical, and I don't even want to learn that anymore. However, the person who starts working with the dataset must know that. So he must know

at the given moment that the climate zone in which a piggery stands, is important. In addition, the feed type, and all different kind of variables. He must know what is going on in the sector, because otherwise he will not know if a dataset is correct and comparable to another dataset." (Strategic Business Developer, Company K, Livestock Management).

Therefore, Company K is actively working on dealing with this challenge, where they want to make sure that the employees who are involved in the process, get the space and time to obtain the necessary knowledge that is required to develop these datasets. In order to do so, the organization currently consciously sets up pilots in which they encourage these employees to try things out, or offer them the opportunity to do investigations in a piggery, all over the world.

The fifth and final step for organizations is the Data Interpretation, in which the main purpose of this step is that the data is visualized and made understandable for the employees that have to work with it. This means that the data analysis and modelling results are presented to the people that have to make decisions in the organization, who thereafter can interpret the findings and extract sense and knowledge about it (Sivarajah et al. 2017). During this process, it is again important that the personnel of an organizations has some knowledge about the specific sector that the organization is operating, in order to be able to interpret and present the outcomes of the data analysis properly. This challenge was addressed by the *Director Digital Innovation* of Company A.

"What we have really seen is that throughout your organization, the primary knowledge of agriculture or of a specific sector must be present to be able to interpret things properly. This refers to having knowledge about all the different variables that have an influence on a process." (Director Digital Innovation, Company A, Farming Sector).

Therefore, the same can be stated for when someone presents the results internal to other employees of the organization. A nice quote about this, given by the *CEO of* Company B:

"So you also have that with data, and when you are going to present data. Making sure people understand what they read.. So do not assume that they know something, because you know it. I think that this is an important challenge. Next to making it presentable, also ensuring that what you present is understood by the employees." (CEO, Company B, Supplier of special mobile equipment).

The quote above shows how data interpretation is huge challenge for any organization. In the end, it underlines how the employees of an organization remain essential during the process of becoming more data-driven, because they are the ones who need to identify the data that needs to be captured, interpret the outcomes, and finally create value from it. This statement is underlined by the *Strategic Business Developer* of Company K.

"The basic lies in creating a good dataset. We came to the conclusion, that this is the most important factor for a successful data-driven culture. So it is not in the algorithms. During the creation of the right dataset is were domain knowledge and the data that is produced come together. In the end, this is fine, because it also means that in the future the human understanding and ability to interpret the outcomes of the data will remain very important in creating valuable insights." (Strategic Business Developer, Company K, Livestock management).

4.3.3 Managerial challenges

Besides the mentioned data and process challenges, there are some managerial challenges that occur during the process of developing a data-driven culture in the organization. Management challenges mostly refer to for example privacy, security of the data, governance and ethical aspects (Sivarajah et al. 2017).

The first two challenges concern the privacy and security of the data, which are issues who are only going to become more significant. Generally, organizations have to make big investments in order to preserve privacy in the digital age, and to streamline processes. This is because, customers are often concerned about the private consequences of BD. These concerns are mainly related to the re-usage of data, reputation losses due to the use of data, and the wrong interpretation of data and information. This raises the question whether privacy concerns of customers and organizations leads to less sharing of information. The *Manager Digital Intelligence* of Company C explained how they are dealing with these privacy and security issues, and also addressed the difference between B2B and B2C data.

"So we have all our data stored in databases within the building, and we are now looking at what we can do with Cloud. Of course, a bit of GDPR is added. However, we are in a B2B customer relationship, so it is less critical than a B2C relationship, because consumer data is way more sensitive. Also, we have data about employees and such, and what we do there is that we do not throw it away, but make an identifier unique, and we actually encode it. So you also have to deal with data within the building, then there are all kinds of firewalls, for which we also have a security officer who ensures that all data stays within the building, with all firewalls (the entire technical story), and he also does checks, so brutal forces to see if hackers potentially can have access to the data." (Manager Digital Intelligence, Company C, Agricultural Wholesaler).

Additionally, the amount of privacy and security concerns also varies for different countries and cultures, because governments across the globe all develop their own legislation. Therefore, firms have to develop specific privacy measures for the different countries that they are operating in.

"Something that is also continuously in development, is that currently every country has their own authorization register. Therefore, we now have to make specific solutions for each country. However, you would prefer to have some kind of central log-in system, where you as a farmer can see which checkmarks are applicable for you, which ones are on, and ready. I think that we, but also competitors struggle in finding the best way to arrange this for their organization. (Director Digital Innovation, Company A, Farming Sector).

Overall, privacy can be seen as an ethical issue that requires more attention of firms than only sticking to the law. This requires a more customer-centric approach, in which organizations have to take great care of their customers. The same can be stated for the privacy and confidentiality of data from employees in the internal organization. However, handling these issues the right way is very important for any organization, because people will remain skeptical about being willing to share information, when these security challenges are not dealt with in a nicely manner.

The third challenge that is related to the management, is about the Governance of the data. This challenge comes down to the situation where organizations nowadays become more aware of the importance of governing the data the right way, mainly due the fact that the demand for BD is also constantly growing. This issue is underlined by the CEO of Company B, a supplier of special mobile equipment

"In regards to Data Governance, it is indeed again a continuous challenge; so, who is allowed to see which data? Why? The more data you have, the greater the risk is that you give someone access to see data, that they are not allowed to see. So, when you start bundling data from different software, it is therefore very important that the design of the Data Governance is properly arranged." (CEO, Company B, Supplier of special mobile equipment).

Furthermore, The fourth management challenge is about the way how organizations handle their Data and Information Sharing, which is very complicated since every organization generally has their own procedures, but also diverse data warehouses. The *Manager Software* of Company J, a

firm that is active in helping companies improve their processes, addressed how there is some kind of dichotomy among customers about the willingness to share data.

"You see that there is a bit of a dichotomy among customers, one side wants to give you access to everything in his organization, so he wants to connect his office network, and everything else to the control network. You also have another side who say; I have to run production, nobody comes to my networks. Additionally, you also have to deal with cultural differences or lack of knowledge. Even within a country it can be very different. It is more whether the IT man is in charge or whether it is the production manager,. who generally wants to be safer than the IT man. The IT man prefers to tie everything together. "(Manager Software, Company J, Process Improvers).

As the quote above shows, the management challenge of Data and Information Sharing can generally be seen as very complicated, since organizations, or departments within organizations, are often reluctant to share their data, and govern it by the privacy condition. However, when this is arranged in the right way, with the help of good communication between both parties, organizations will establish a close connection and harmonization with their business partners, in which trust among both parties is created.

Finally, the fifth and final challenge for the management is about the Ownership of data, which is mostly seen as a social issue. This refers to how often different stakeholders claim to have ownership of the data, because they for instance created or generated the data, used the data, compiled, selected, structured, or generally felt like they added value to the dataset. This leads to a huge challenge where different organizations, together have to determine the right revenue models. According to the *Manager Software* of Company J, good communication within both parties is essential during this process.

*"*So you are dealing with the fact that different suppliers all have their own *revenue models. Additionally, at the same time, everyone unlocks their data differently, which results in a situation where everyone is currently looking at how they are going to offer their service on the market. So are you going to do it by subscription? Ask a one-off fee? I personally think that it is going to depend on the product and service that you are going to offer. So it is very complicated, but interesting at the same time, because you are dealing with the process of how to unlock the data to the Cloud, the Cloud services itself, and thereafter with the revenue model of yourself towards the customer". (Manager Software, Company J, Process Improvers).*

As the quote above shows, the fact that DDD is only going to become more important in the different industries in the future, will raise some interesting discussions in the industries, in which every organization for themselves has to find the most optimal ways to deal with issues like Data Ownership, but also determining the right, new revenue models.

Organizational culture

When looking at cultural changes for organizations, data-driven decision-making requires a fully different mindset for the employees that work at the companies, but the same can be stated for the customers of the different companies. Therefore, the first clear challenge for the management is to create support throughout the whole organization, because in the end, these are the people who are mainly responsible for changing the decision-making culture in the organization (Shamim, Saqib, et al, 2019). This claim is underlined by the *Strategic Business Developer* of Company K.

"I noticed how important it is that the senior management of an organization acknowledges the importance of data. Because the implementation of a DDD culture is such a big change for any organization, which means that the management has to state their opinion about; like, guys: starting this moment, you are all going to deal with this, or hear something about it. That's why we nowadays

schedule morning meetings with the whole department, to briefly consult about short-term decisions". (Strategic Business Developer, Company K, Livestock management).

The quote above underlines the importance of having an clear data strategy if organizations want to be become more data-driven. Vidgen et al. (2017) state how "This requires the right people on the job, with the right skills to effect and data-driven cultural change, these people may be unique and potentially in short supply, so up-skilling may be required. For this reason do need data scientists with strong statistical and mathematical skills, but they also need IT skills, notably any ability to program (e.g., R) and an ability to manipulate data (e.g., SQL). However, rather than rely on one tool, whether it be an enterprise products such as SAS or an open source product as R, the data scientists also need to be able to use the most appropriate tools to hand, to combine different technologies, toolsets, and analytic techniques to fashion a local and relevant solution. This reinforces a key challenge for the different organization, in that 'building data skills in the organization' is fundamental for the success of the transformational journey" (Vidgen et al. 2017 These challenges are acknowledged by the *Manager Digital Intelligence* of Company C:

"Data is available, and we have an analytical tool to use this data: Tableau. But Tableau is mostly a tool where you are able to visualize data, which works great for creating dashboards.. But sometimes employees also want to do their own data preparations, and there is still a bit of a mismatch there. So data is available, but if you really want to make full use of it, you need to know a bit of SQL, or R, or Python to get started. Those skills do not yet really live within the business." (Manager Digital Intelligence, Company C, Agriculture Wholesaler).

At the same time, the organization is actively trying to tackle this issue:

"So in order to address this issue, we created an internal community. There are 20 people within our organization who want to learn more about data-analytics, and we are giving them all kinds of courses, lectures, in order to provide them with more knowledge about these topics. So we want to become more data-driven, data warehousing and dashboarding is one, but if you want to be able to do a bit of predictive or AI, then additional steps have to be taken. There are a number of smart minds within our organization that can already work in these areas, or have the potential to do so. So it's a kind of internal community, where we either have a speaker once a month, another time we schedule a course, Another time we have plenty of people who know SQL, so then we for example have an SQL training." (Manager Digital Intelligence, Company C, Agriculture Wholesaler).

However, it is not guaranteed that all organizations have enough employees who have the potential to work with data. Therefore, is the use of (more) data not supported by all the employees. This study also showed how often younger employees in organizations are more willing to invest in working with BD than older employees. The same can be stated for customers, where there is also a difference in BD adaptation.

"You have early adopters, late majority, and a group that will never use data. You also have that with our customers. So there are always groups that pick up a little earlier than others do. We also noticed how he younger generation is generally more open for these changes, than the older generation." (Director Digital Innovation, Company A, Farming Sector).

Additionally, there is also a difference between the different divisions in an organization. The *Director Digital Innovation* of Company A, addressed how they are currently running multiple pilots in certain divisions, in which the results already show so much potential of the use of data in decision-making, that this has an effect on the whole organization.

"So we are currently running some pilots at customers, and what we do see is that with the first pilots that are being run and the results that come out of it, the results are already so valuable that it only creates more enthusiasm across the organization. So the whole company is very enthusiastic and wants to see more, more and more details." (Director Digital Innovation, Company A, Farming Sector).

A consequence of a data-driven culture, is that it is no longer relevant for an organization to just sell as much products possible. This change can especially be hard to get used to for investors. Therefore, we pay greater attention to this managerial challenge, and also address the drivers that are important for the management, in order to make a DDD culture successful.

"We still have to get used to providing service. We, but also customers, aren't used to this. This also applies to investors who were used to doing a lot of negotiations in the past, but nowadays you don't want to do this with someone which you are providing service. Therefore, our senior management currently spends a lot of time on explaining the customers what we want to achieve with service, but also to look at how they respond to this change." (Strategic Business Developer, Company K, Livestock Management).

The quote above shows how there is a complete cultural transformation in the organization when it decides to shift to a different business model where they start selling their products as a service. Next to the cultural transformation of an organization that becomes increasingly data-driven, employees also need to learn how to work with data. This requires a pro-active mindset, which is a time-consuming process and a huge challenge for any organization since BDA is a strategy and operational activity. An organization needs to build a team of people with sufficient BDA skills and talent to capitalize on the promise of BD (Grover et al. 2018). The outcomes of the interview how a lack of BD expertise in organizations is one of the major issues.

"So we are also working on implementing a data-driven culture. In our organization, for example, there was not a single meeting where the beamer was used if I didn't ask for it, because everyone was still used to write on a piece of paper and talk based on what was on the table. However, the company has experienced enormous growth in the last 20 years, so it is not that you need data because otherwise things will go badly.. only at a certain moment you can get above a certain size, that you are no longer able to act on gut feeling anymore." (CEO, Company B, Supplier of special mobile equipment).

So, training employees, both to get feeling with the value of using BDA to make decisions, but also to make them able to extract value from the different data sources, is a continuous challenge. One way of overcoming this challenge is by having good communication between the management and the employees. This refers to a situation where the management plays a crucial role in presenting and developing this new direction for the organization, and therefore are willing to answer questions from the employees. This is particularly important, because the employees are the people who have to make the cultural transformation work, and therefore have to feel support from the management. The importance of good communication inside the organization is underlined by the *Strategic Business Developer* of Company K, in which the management invested resources in planning daily meetings in which the plans of the organization are discussed with their employees.

"So we have here what we call the discussion area, in which the management nowadays introduces the new ideas, to clearly indicate the plans for the future, to state what is important, and to inform the employees about the direction that the organization is going.. Doing it this way, the employees also immediately get the opportunity to ask questions, or are able to react to the plans. We feel like this is the right way to do it, since the employees in the end have to make things, and therefore also have to back the plans up." (Strategic Business Developer, Company K, Farming Sector).

This also relates to another important cultural driver, creating discipline and transparency in the organization. This is because, the *Manager Digital Intelligence of Company C* noticed how employees often fall back into old routines. So when an organization agreed on the fact that for example some employees at one point start working two days in the week on becoming more data-driven, it is important that they stick to this plan.

"So what we noticed, is that when you invest in making someone work on analyses, and make the data available in the analytical tool, that they in the beginning start working on it 2 days a week, but we also notice that this will slowly decrease, and that the people fall back into old routines. So they fall back into just doing the operation tasks." (Manager Digital Intelligence, Company C, Agriculture Wholesaler).

The same goes for creating transparency. This refers to the situation where employees have different dashboards, or style of doing things. This problem can be fixed by creating mutual templates, for all the different people involved in the process. Finally, comes the challenge of arranging access to the various data sources for the employees. This comes down to determining which person in the organization has access to which data source. In addition, a huge amount of data points are partly connected. This leads to the challenge of organizing where different employees in the firm can collect and analyze the right data in the best way.

Organizations mainly deal with this challenge by designing an authorization-matrix, in which Is determined which data source is accessible for the different employees. This must eventually lead to a situation where Value can be created: *"So, employees do not have access to all data, as we work with an authorization matrix, which I together with the business design. Hereby is the access of someone based on his or her role in the organization." (Manager Digital Intelligence, Company C, Agriculture Wholesaler).*

5. Discussion and conclusion

In this chapter we discuss the findings of the study and answer the central research question. We also illustrate the theoretical contributions and practical implications. Finally, we explain the limitations of our study and the directions for future research.

5.1 Discussion

This thesis focused on answering the follow research question: *"How DDD can help managers and employees with creating business value?"* This study showed that there are important differences in the appliance of BDA on decision-making in the organizations. Generally, organizations that already make great use of data for their decision-making, state how they are able to react way faster to unexpected changes on the market, and obtained valuable insights from working with the available data. Next, there were some organizations that were aware of the potential benefits that DDD can have, and in which currently multiple pilots run where they start experimenting with making decisions based on data. These companies stated that they are satisfied with the first outcomes of their initiatives, and that it resulted in a situation where the management of the organization became even more enthusiastic. The first results of these pilots also underline a strong indicator for the far reaching potential of the concept of DDD. Finally, there are some companies that still consciously make decisions based on intuition or expertise, because they generally believe that this is still the right way to do so, or because they did not have the resources to invest in becoming more data-driven yet. The *Managing Directors* of these companies also addressed how they felt like the organization is too little aware of the possibilities that BDA can offer for making decisions.

In addition, this study also showed that there are different factors that influence the extent to which an organization already developed a data-driven culture. Firstly, the organizations that were relatively experienced with data-driven decision making, addressed how an informal and decentralized organizational structure helped them to speed up the process of developing a data-driven culture. Next to the organizational structure, do the results of this study acknowledge the assumption by Grover et al. (2018) who addressed how factors like data sourcing, access, integration, delivery, people and analytical capabilities, as well as organizational factors like a clear BDA strategy, support of the management, financial resources, and engaging people in the process, play a huge role in the extent to which organizations currently benefit from applying BDA in their decision making processes. To make this point more clear, especially the less experienced organizations in this study acknowledged how they are struggling with finding the right people that are able to work with data, or to find the right external party that can help with developing this DDD culture without being too expensive. This often leads to a situation in the organization, where the management wants to become more data-driven, but do not have the resources to do so, or the employees do not have the skills or capabilities to adjust. The managers in this study also addressed how the adoption and implementation of DDD depends on the type of manufacturing company. For example, it is easier to become more data-driven when organizations have a homogenous production line, or for wholesalers, who can just optimize their processes due simulations. However, there are also manufacturing companies in this study that have a heterogeneous production process with different steps, different departments. This means that the process is constantly changing, which at the same time makes it more complex to create a stable optimal process that is driven by data.

Furthermore, this study showed some clear benefits of DDD, where it can for example lead to organizational benefits, namely: improving decision making processes in organizations, enhance operational benefits, create transparency and strategic clarity, lead to potential new products or service innovation, as well as getting a better understanding regarding customers, namely: getting a better understanding of the needs of customers and create insights about customers and markets that can be used to improve customer satisfaction and loyalty (Grover et al. 2018). However, next to these potential benefits, organizations at the same time acknowledge the challenges that come up during the process of becoming more data-driven. Research showed how these challenges can be divided into three main categories: data challenges, process challenges, and management challenges. The biggest challenges of data are related to the features of the data itself, the 5 V's (e.g. data volume, variety,

veracity, velocity, variability). Process challenges are generally related to series of techniques, like for example how to capture data, how to integrate data, how to transform data, and how to select the right model for analysis to provide results. Finally, management challenges mostly refer to for example privacy, security of the data, governance and ethical aspects (Sivarajah et al. 2017).

Additionally, working towards becoming a data-driven organization, focused on supporting the digital transformation, requires an organizational cultural change that facilitates the use of big data. In order to make this successful, it also requires a shift in the capabilities and mindset of the employees in these organizations towards incorporating data-driven initiatives. Therefore, organizations have to set clear data roles for their employees, define the expected levels of data literacy proficiency and need to have a clear cultural change plan, to be able to start speaking data as a native language and to make sure that real impact and business value can be obtained from this digital transformation. This means that the management of an organizations first has to focus on creating support about DDD implementation throughout the whole organization, because the employees are in the end mainly responsible for changing the decision-making culture in the organizations. This is also about defining the main business goals and objectives, so to make clear why becoming more data-driven is important for the organization. The next step is to create a clear data strategy, which involves providing the employees with quality data that is ready for analysis, as well as learning them the right skills, and tools to abstract value from the available data. Since the amount of people that already have these skills remain scarce, up-skilling may be required. Additionally, when a firm aims to strengthen their DDD capabilities, leaders of the organization must set clear vision and goals, and at the same time boost the employees to make more data-driven decisions. This is because, they are role models for the rest of the organization, which means that they have to show the value of data-driven decision making (Shamim, Saqiq, et al. 2019). Therefore, the leadership needs to communicate the BD initiatives top-down, act as pioneers, and generally create ownership about the decision to change the organizational culture. Furthermore, after they created recognition and understanding in the organization, the next step is to translate the objectives and goals into reality. At this point, it must also be clear which role each person in the organization has in the process of becoming more data-driven, as well as what is expected from them. These expectations of all the different persons in the organizations can than be monitored and evaluated, and thereafter continuously improved (Shamim, Saqiq, et al. 2019).

To conclude, managers from organizations first need to come up with solutions to deal with these data, process, management, and organizational culture challenges, before the full potential of DDD can be realized. Therefore, this study clearly shows the potential business value that DDD can create for all kind of organizations, but it at the same time raises questions whether organizations already have the capability to deal with the complex challenges that come up during the process.

Finally, this research showed how the more a company adopts a DDD culture, the more the organization shifts toward more centralization. This is due the fact that employees throughout the whole organizations are now able to independently make good decisions. However, the organizations in this study address how there always remain issues that cannot be automated or codified through DDD, and still rely on human involvement or judgment of the management. For this reason, it is from importance that organizations in the future find the right balance between making strategic decisions on the basis of data, and still relying on human involvement or judgment of the management. Finally, a summarization of the results of this study is given in table 6.

Table 6: Summary of the results in this study

<table>
<tr><th colspan="4">Benefits: based on Grover et al. (2018)</th></tr>
<tr><th colspan="2">Organizational</th><th>Customer</th><th>Recommendations</th></tr>
<tr><td colspan="2">Improving decision making processes.
Create transparency and Strategic clarity.
Lead to potential new products or service innovation.</td><td>Getting a better understanding of the needs of customers.
Create insights about customers and markets that can be used to improve customer satisfaction and loyalty.</td><td>In order to derive business value from the benefits of DDD, it is important that the management of an organization first decides the main business objectives and goals of becoming more DDD. This will also allow them to make clear which processes, with the help of data, need to be improved in terms of productivity and efficiency. Afterwards, collecting data and making data based decisions, should not be a goal itself. However, the organization need to focus on doing something meaningful and valuable with the data that becomes available.</td></tr>
<tr><th colspan="4">Challenges: based on Sivarajah et al. (2017)</th></tr>
<tr><th>Data</th><th>Process</th><th>Management</th><th>Recommendations</th></tr>
<tr><td>Related to the features of the data itself (e.g. Volume, Velocity, Variety, Veracity, Value).</td><td>Related to the series of techniques of the data (e.g. how to capture data, how to integrate data, how to transform data, and how to select the right model for analysis to provide results).</td><td>Management challenges mostly refer to for example privacy, security of the data, governance and ethical aspects.</td><td>Managers from organizations first need to come up with solutions to deal with these challenges, before the full potential of DDD can be realized. Therefore, this study clearly showed the potential business value that DDD can create for organizations, but it also addressed the importance of having the capability to deal with the different challenges that come up during the process.</td></tr>
<tr><th colspan="4">Challenges: based on Shamim, Saqiq, et al. (2019)</th></tr>
<tr><th colspan="3">Organizational culture</th><th>Recommendations</th></tr>
<tr><td colspan="3">The management has to create support throughout the whole organization, because in the end, these are the people who are mainly responsible for changing the decision-making culture in the organization.
Have an clear data strategy if organizations want to be become more data-driven, in which building data skills in the organization' is fundamental for the success of the transformational journey.
An organization needs to build a team of people with sufficient BDA skills and talent to capitalize on the promise of BD. This requires creating discipline and transparency in the organization.</td><td>In order to create the right DDD organizational culture, it is important that the management clearly explains the value of making DDD to the rest of the organization. This also includes providing the employees with quality data, as well as learning the right skills, and tools to start abstract value from the available data. This means that they need to define the data roles within an organization. They also need to show strong leadership during the development of a DDD-culture.</td></tr>
</table>

5.2 Theoretical contributions

This thesis contributes to the emerging research on digitalization and helps people to understand the relationship between DDD and business value creation. In terms of theoretical contribution, this thesis contributed to the emerging call for more research on the analysis and application of BD in various marketing strategies by the Marketing Science Institute (2018), that argues how there is a huge gap between the potential business value that BDA can have for organizations, and having the actual knowledge to make this happen. In fact, to date, definitions that include concepts, procedures, and strategies how organizations can derive strategic business value from BDA and what resources they therefore need remain scarce (Grover *et al.,* 2018). This assumption is underlined by Mikalef, Pappas, Krostie and Giannakos (2017) who state how *"*Even though earlier studies have shown the benefits of using BD in different contexts, there is a lack of theoretically driven research on how to utilize these solutions in order to gain a competitive advantage (p. 391)*".* Therefore, this research helped to get a better understanding between the relationship of DDD and business value creation. We identified this relationship by first addressing the different benefits that DDD can have for organizations and customers, as well as discussing the main challenges that organizations face while trying to implement a DDD culture. In doing so, we proposed a novel theoretical framework that combines the work of Grover et al. (2018), Sivarajah et al. (2017), and Shamim, Saqib et al. (2019). Firstly, the study 'creating business value from Big Data Analytics' by Grover et al. (2018) was used to identify how business value can be created through DDD. Secondly, the research the research studies by Sivarajah et al. (2017) and Shamim, Saqib, et al. (2019) helped us to identify the main challenges that organizations face during the implementation of a DDD culture. In the future, this novel theoretical framework can also be used for different industries, contexts, cultures, or countries.

5.3 Practical contributions

In terms of practical contributions, this research will be explanatory and aims to give managers of companies, employees, marketeers, or other researchers knowledge about how they can create business value by making use of DDD. The need of having this knowledge was addressed by Bumblauskas et al., (2017), who argued how the ability of transforming BD pools, into relevant and meaningful data, and finally into valuable knowledge and action has become a key competitive differentiation in today's market places. However, Gupta & George (2016); Mikalef et al., (2017) addressed how practitioners are currently in the dark when facing the implementation of data-driven decision making (DDD) in their firms. This assumption is underlined by McColl et al. (2019) and Popovič, ,Aleš, et al (2018), who argue how there is little empirically based knowledge by highlighting the real business value resulting from applying DDD in companies and thus encouraging beneficial economic societal changes. Therefore, based on the work of Grover et al. (2018), we showed how business value can be created through BDA. We also discussed how in order to derive business value from the benefits of DDD, it is important that the management of an organization first decides the main business objectives and goals of becoming more DDD. This will also allow them to make clear which processes, with the help of data, need to be improved in terms of productivity and efficiency. Afterwards, collecting data and making data based decisions, should not be a goal itself. However, the organization need to focus on doing something meaningful and valuable with the data that becomes available.

Therefore, this research study helps practitioners to get a better understanding of the relationship between DDD and business value creation, and will provide them with valuable insights about how business value for organizations can be created through DDD, and also comes up with potential solutions to the challenges that they will face during the process of becoming more data-driven (Gupta & George, 2016). In addition, this research showed how managers from organizations first need to come up with solutions to deal with these challenges, before the full potential of DDD can be realized. Therefore, we showed the potential business value that DDD can create for organizations, but also addressed the importance of having the capability to deal with the different challenges that come up during the process. Next to these challenges, we also discussed the drivers that make a DDD implementation for an organization successful. We highlighted how in order to create the right

organizational data-driven culture, it is important that the management clearly explains the value of making DDD to the rest of the organization. This research study highlights important managerial implications related to the impact of DDD on empowerment of employees, and how it can be integrated into organizations to augment rather than replace management capabilities (Popovič, Aleš, et al. 2018). This also includes providing the employees with quality data, as well as learning the right skills, and tools to start abstract value from the available data. This means that they need to define the data roles within an organization. They also need to show strong leadership during the development of a DDD-culture. Finally, this will enable practitioners to start making data-driven decisions based on future trends, risks and opportunities, and therefore makes them stay ahead of competitors and create business value.

5.4 Limitations and suggestions for future research

This thesis has three main limitations. Firstly, a total of 11 managers of 11 different companies participated in this study in which only perspective was obtained from each organization. Therefore, if we want to conclude that we can rely on the results of this study, we must expect that the interviewees gave reliable answers to all the different questions. Next to giving reliable answers, it might have been the case that the interviewee did not have enough knowledge about a particular subject, which therefore affected the reliability and validity of the outcomes. Therefore, future research could consider interviewing more than interviewee from the same organization, in order to get a better and wider grasp about the DDD processes of that organization. This will at the same time improve the reliability and validity of the outcomes. In similar fashion, we are also aware of the small sample size in this study, in which future studies can therefore expand to a larger sample size.

Secondly, although most of those companies operate in the manufacturing industry in the Eastern of the Netherlands, there are still huge differences between the organizations in terms of size, type, and the markets they are operating in. This resulted in a situation with huge differences in terms of the extent to which a organizations currently has a data-driven culture currently. We tried to clarify these differences by making a distinction between the organizations that are relatively more experienced, average experienced, and less experienced in the process of DDD. Therefore, future studies can take a sample of organizations that are relatively active in the same market, and have the same size, and type. Next to this, since this research was conducted in one particular region in the Netherlands, it might also be interesting to generalize our findings across other industries, contexts, countries, and different cultures. Additionally, it could also be interesting to take a sample of only SMEs, family-owned enterprises, business groups, state-owned enterprises or multinational enterprises. This might lead to interesting results and potential differences, and will at the same time ensure that the results of the study are more comparable.

Thirdly, this study represents an exploratory work on creating business value from data-driven decision making. As both previous studies and our results show, this topic is still in its infancy and needs more empirical evidence. Hence, future research can use our insights to test, via quantitative design, hypotheses and propositions on the relationship of DDD and business value creation. Research of this kind can lead to more concrete information and examples about how the potential business value out of DDD can be maximized in organizations, as well as information about how organizations can properly deal with the challenges that occur during the process. For example, future studies about the organizational culture changes, the benefits, and how the challenges are addressed in organizations that are already more experienced in terms of DDD, can be extremely beneficial for all kind of practitioners and organizations that are struggling with the digital transformation for their own company.

5.5 Conclusion

To conclude, this study investigated how managers and employees can create business value from data-driven decision making (DDD). In order to answer the research question, we conducted semi-structured interviews with managers of Dutch companies that are actively working with the digitalization processes of their business. The results showed that there are large differences in the appliance of Big Data Analytics (BDA) on decision-making between organizations with various level of familiarity with BDA use. In addition, this study also showed that there are different factors that influence the extent to which an organization already developed a data-driven culture. Furthermore, this study also acknowledged challenges that come up during the process of becoming more data-driven. In line with the challenges described in the literature, we found that there are different categories of challenges: data challenges, process challenges, management challenges, and changing the organizational culture. Additionally, working towards becoming a data-driven organization, focused on supporting the digital transformation, requires an organizational cultural change that facilitates the use of big data. Hence, managers from organizations first need to come up with solutions to deal with these challenges, before the full potential of DDD can be realized.

In addition, this research contributed to the emerging research on digitalization and helps companies, managers and employees to obtain more knowledge about the relationship between DDD and business value creation. In terms of the theoretical contribution, this thesis contributes to the emerging call for more research on the analysis and application of BD in various marketing strategies by the Marketing Science Institute (2018), who argue how there is a huge gap between the potential business value that BDA can have for organizations, and having the actual knowledge to make this happen. Additionally, we also proposed a novel theoretical framework that combines the work of Grover et al. (2018), Sivarajah et al. (2017), and Shamim, Saqib et al. (2019) that in the future can be used for research into different industries, contexts, cultures, or countries. In terms of practical contributions, this research provide managers of companies, employees, marketeers, insights about how to create business value by making use of DDD. Additionally, it highlights important managerial implications related to the impact of DDD on empowerment of employees, and how it can be integrated into organizations to augment rather than replace management capabilities.

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Appendix

Appendix I. Company overview

Company	**Company sector**	**Company size***	**Respondent's Function**
Company A	Feed Industry	± 2700	Director Digital Innovation
Company B	Heavy Smart Solutions	± 300	CEO
Company C	Agriculture Wholesaler	± 3500	Manager Digital Intelligence
Company D	Low Flow Fluidics Handling Solutions	± 500	Managing Director
Company E	Integral Construction Company	± 100	Managing Director
Company F	Manufacturer of drying systems	± 125	Managing Director
Company G	Manufacturer of PET bottles	± 50	Customer Service
Company H	Supplier of Metalworking Machines	± 50	CEO
Company I	Metalworking product solutions	± 125	Business Developer
Company J	Process improvers	± 50	Manager Software
Company K	Livestock Management	± 750	Strategic Business Developer

***At the location of the interview and worldwide**

Appendix II. Dimensions and indicators

Dimension	Indicator	Concretization	Question
General	Individual introduction	General information about the function of the interviewee	G I
	Company introduction	Shortly description of the company and their services	G II
Decision making	Strategic decision making	How strategic decisions are currently made in the organizations	DM I
		Current role of data in these decision making processes	DM II
		Relation decision making based on BDA vs. intuition/expertise	DM III
		Drivers for DDD vs. aware of potential DDD	DM IV
		Touchpoints in the customer journey vs. planning to become more DD	DM V
		Changes in the results of decision making vs. planning	DM VI
Benefits of DDD	Benefits from literature	Benefits for the organizations	BI
		Benefits for the customers	BII
		Thoughts on possible future benefits from DDD	BIII
Challenges of DDD	Data challenges	5 V's	CD I
		Sufficient infrastructure to make good use of BDA	CD II
		Control mechanisms for accuracy and reliability	CD III
		How access to data sources is granted	CD IV
		BD and the relation with ERP-system, and security	CD V
	Process challenges	Data Acquisition and Warehousing	CP I
		Capturing the data to interpreting and presenting the end results Data analysis, Data Modelling, Data Interpretation	CP II

			CP III
	Management challenges	How the privacy and confidentially of the data is controlled	CM I
		Data Governance: what data is warehoused, analyzed, and accessed	CM II
		To what extent BD is used across the whole organization	CM III
		Organizational culture: Cultural, structural and technological shift because of the presence of BD	CM IV
		Top management attitude/support towards DDD	CM V

Appendix III. Interview questions

Introduction to the research

I would like to start with thanking you for taking the time to do this interview. My name is Rick Arink and I am a master student at the University of Twente. For the finalization of my master Business Administration at the University of Twente, I am doing my thesis about how DDD can help managers and employees from organizations with creating business value. Furthermore, In this interview, I'd like to discuss your companies actions regarding the implementation of a DDD culture. The interview starts with some general questions about your company, and your function at the company. Afterwards, some questions will be asked about how decisions are currently made in the organization. Hereby will also be addressed whether the use of data plays a role during this decision-making process. The benefits of using BD to make decisions will also be discussed. The final questions will be about the main challenges that come up with the implementation of a DDD culture in the organization. The interview follows a semi-structured approach with open-ended questions. Please answer freely and add experiences and thoughts that come to mind during the interview. The analysis of the data will be done confidentially and anonymously and will only be published in an anonymous form. This means that names of persons or the name of the organization will be left out of the thesis or out of other publications. In order to study the interview results, the interview is recorded, transcribed and temporarily saved for scientific purposes. The recordings are just used for this purpose and the research results will be provided to you after finalizing them. With your participation you consent to these conditions.

General information about the company

1. Introduce yourself; What is your function at the company and for how long have u been working here?
2. Introduce the company; How would you shortly describe the company and their services?

Decision making

1. How do you currently make strategic decisions in the organization? (e.g. formal vs. informal or centralized organizational structure vs. decentralized organizational structure)
2. To what extent does BD currently play a role in making these decisions?

If BD plays a role in making decisions

3. How many decisions are nowadays generally based on BD in relation to intuition/expertise? And in which way does the organization use data to make decisions? (descriptive, diagnostic, predictive, prescriptive analysis)
4. What are the main reasons for the organization to make decisions based on BD?
5. For which touchpoints in the customer journey does the organization mainly use BD in order to make decisions? (e.g. prepurchase, purchase, post-purchase)
6. Have you experienced changes in the results of decision-making since you started working with BD?

If BD doesn't play a role in making decisions

3. Why do you generally still make decisions based on intuition/expertise in relation to BD?
4. To what extent do u feel like the organization is aware of the potential of using BD to make decisions?
5. To what extent is the organization working on becoming more data-driven? And what are the main challenges for the organization while trying to implement a DDD culture? (process, management, data)
6. How does the organization plan on fixing these challenges in order to be able to efficiently and effectively work on making more decisions based on BD? Future?

Benefits of making decisions using data (YES = questions are asked based on their actual experience; NO = discussion open for the future)

If BD plays a role in making decisions

1. How does BD help to improve efficiency and effectiveness of processes and/or products?
2. What are the main benefits of using DDD for the employees in operations and processes?
3. To what extent do u feel like using BD can allow the organization to create better opportunities and a better understanding towards customers? Also for the future?

If BD doesn't play a role in making decisions

1. Which potential future benefits can the use of DDD have for employees in operations and processes?
2. To what extent do u feel like using BD can allow the organization to create better opportunities and a better understanding towards customers? Also for the future?
3. What is your perspective about the company's use of BD in the future?

Challenges of data implementation (Questions can be asked for data/non-data organizations)

Data challenges

1. To what degree are the characteristics of the data itself a challenge for the organization? (the 5V's)
2. To what extent do you feel like there is an adequate infrastructure that enables the company to develop a data-driven organization?
3. Do you feel like the BD that is currently available in the organization can already be analysed and be used by users? If this is the case, does the organization already rely on this data while making decisions? (Control mechanisms for accuracy and reliability)
4. To what extent can all the employees in the organization access the different data? And how is the access to diverse data sources determined?
5. Is the BD integrated in the ERP system of the company? And what actions have been taken to secure the data of the organization?

Process challenges

1. Are there any challenges in relation to the acquisition and warehousing of the BD?
2. To what extent does the organization face challenges during capturing the BD to interpreting and presenting the results of the BD analysis? Also in cleaning and extracting value from the data?
3. To what extent do u feel like there is enough (skilled) personnel in the organization to deal with these new data processes? If not how are you trying to solve this issue? (new extracting or analysing tools)?

Management challenges

1. What actions does the management take to ensure that the privacy and confidentiality of the diverse data is protected?
2. To what extent is the data governance a challenge for the organization? (warehousing, analysing, and determining access)? Are there any other challenges?
3. Does the organization support the use of BD throughout every division and for every member of a team? When this is the case, in which way and to what degree?
4. Does the management notice any cultural, structural and technological transformation since the organization started to make more use of BD?
5. To what extent does the top management of the organization support the investments towards developing a DDD-culture? And how does the same management transfer this attitude towards the employees?

Closing te interview

Is there anything else that you would like to mention for this interview?

Thanks again for taking the time to help me with this research. I greatly appreciate your time and valuable input!