

Influence of big data and analytics on management control

Why changes in management control by means of
big data and analytics are not achieved yet

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Abstract

This study investigates the influence of big data and analytics on management control, and the benefits and challenges that organizations experience by making use of (big) data. Existing literature on big data is primarily focused on theorization and formulation of expectations and often focuses only on the positive aspects of big data. Furthermore, within current literature the influence of big data on management control has received only minor attention. In order to expand upon existing knowledge, multiple interviews are held with five employees from five different organizations, who are members of the management team or closely involved with data and the developments of data in their organization.

The results of this study show that the expected impact of big data on management control is not attained in the different organizations yet. All five organizations have realized that they have to go along with the developments in the area of data because it is a progressive development in the market, and not going along with these developments could lead to adverse effects for the organization. For that reason, the interviewed organizations are engaged in various data projects in order to support the potential of data better, with the result that data gets a more prominent role in the organizations.

However, due to several technological and managerial challenges it turns out to be difficult to take advantage of big data benefits. This study shows results which are partially in line with the expectations present in existing literature, while existing literature pays only limited attention to the technological and managerial challenges that may arise in the process towards the use of more data. The results suggest that big data does not have a significant effect on management control, but despite the fact that big data currently has no direct influence on management control, an indirect effect on management control is suggested to exist. This indirect effect suggests that during the data projects organizations may shift from the use of a coercive form of control to a more enabling form of control.

The results of this study should be regarded with some limitations. At first, because this study has a qualitative focus, results are not generalizable. Secondly, this study only focused on five organizations and no distinction has been made between different industries.

Keywords: Benefits and Challenges; Big data; ERP; Management control

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1. Introduction

During the last decades, due to information technologies (IT) the use and the potential of IT applications has increased dramatically (Chen, Chiang, & Storey, 2012). This development provides organizations more possibilities to develop in the area of information technologies. According to Shaikh & Karjaluo (2015), organizations have seen these possibilities and have invested in different forms of information technologies and information systems, which may all lead to other benefits. However, besides the benefits, the rise of these information technologies also leads to challenges that organizations have to deal with.

One of the new technologies in IT is big data and analytics (McAfee & Brynjolfsson, 2012; Shao & Lin, 2016). Due to the rapid development of several information technologies, large amounts of information and data can be collected. This leads to higher volumes, variety, velocity and veracity of information (Assunção, Calheiros, Bianchi, Netto, & Buyya, 2015; McAfee & Brynjolfsson, 2012; Zhou, Fu, & Yang, 2016). Big data is according to several of these authors expected to lead to a shift in many aspects for a company. For example, a shift is expected to be made in thinking, this could be about infrastructure of data but also about business intelligence and analytics, and the information strategy (Frizzo-Barker, Chow-White, Mozafari, & Ha, 2016).

In recent literature, many advantages of big data are explained. For example, McAfee and Brynjolfsson (2012) suggest that big data provides companies greater opportunities for competitive advantages. By using big data it is possible to manage on a more precise level than before, because big data creates a greater availability, visibility and transparency of information. This provides techniques for organizations to find new patterns and connections in data on a level that was not achievable without the use of big data (Frizzo-Barker et al., 2016).

Moreover, besides these general benefits, existing literature also explains several expected advantages of big data related to the field of accounting and control. It is expected that big data and analytics lead to more advantages for effective and efficient decision support and decision making, which may lead to better firm performance (Chang, Kauffman, & Kwon, 2014; Frizzo-Barker et al., 2016; Zhou et al., 2016). Furthermore, according to Frizzo-Barker et al. (2016), by using big data and analytics it is possible to obtain more in-depth insights into processes of the organization which enables organizations to optimize the processes of the organization. For example, these benefits can be achieved by creating more possibilities for analyzing data by means of more advanced systems in the organization (Brynjolfsson, Hitt, & Kim, 2011; McAfee, 2002). Because these benefits are related to accounting and control, it is likely that this also influences management control.

In existing accounting literature, several definitions exist of the concepts of management control and

management control systems. Malmi and Brown (2008) define management control as all possibilities that managers have to ensure that the behavior of employees and the decisions they make, match with the objectives and strategies of the organization. In the view of Alvesson and Kärreman (2004), management control is the specifying, monitoring and evaluating of individual and collective actions within the organization.

In addition to the various definitions of management control, various forms of management control are discerned in literature. One of the forms to describe management control is based on the distinction between a coercive and an enabling form of control (Adler & Borys, 1996; Ahrens & Chapman, 2004). Coercive control has a top-down control approach with the emphasis on centralization and pre-planning. Enabling control in contrast, gives more power to employees to directly deal with the circumstances and events in their work. By means of four design principles of control it is possible to distinguish the differences between enabling and coercive control. These four design principles are repair, internal transparency, global transparency and flexibility.

However, despite these expected effects of big data, McAfee and Brynjolfsson (2012) note that there are several challenges for organizations to become a big data enabled organization. The implementation of big data in organizations may lead to challenges on a technological as well as on a managerial level. For example, technological challenges might arise because of limitations of the IT infrastructure, and also privacy and security issues that occur. Furthermore, there are also challenges with the collection, integration, processing and analysis of data (Goes, 2014; Quattrone & Hopper, 2005). Additionally, McAfee and Brynjolfsson (2012) mention some future challenges. According to them, good professionals and organizational culture is still a challenge for companies to attain the advantages of big data and analytics.

As a result of these challenges, the possibility for all companies to implement new information technologies such as big data is questionable. For example, many large and mid-sized organizations still have some struggles in integrating big data into the organizational cultures of their company (Frizzo-Barker et al., 2016). One of these struggles is the IT infrastructure (Sharma, 2016; Zhou et al., 2016). As mentioned in many studies (e.g. Quattrone & Hopper, 2005; Teittinen, Pellinen, & Järvenpää, 2013) the expected effects of IT-implementations on management control systems is not always feasible because of limitations in the system and limitations at the moment of implementation. For that reason, it is possible that systems of companies cannot fully provide the advantages of big data.

Furthermore, because big data is a relatively new concept, research of big data is in the early-stage domain (Frizzo-Barker et al., 2016). Additionally, the role of big data related to management control systems has only received minor attention. Therefore, this study aims to further examine the expectations present in the existing literature about big data and the influence of big data on management control. The question is how companies which will/have implement big data and

analytics deal with the challenges of it. To what extent can they succeed in implementing big data and what is the impact of big data and analytics on management control systems? This research aims to answer these questions.

1.1 Research question

This research investigates the role of big data on management control. The previously formulated questions lead to the following research question in this thesis:

“What is the influence of big data and analytics on management control systems?”

1.2 Goal of the thesis

The goal of this thesis is to obtain more insights into the influence of big data and analytics on management control. In order to achieve this, a literature study is conducted to examine the existing literature and the results of existing studies. To examine the expectations formulated in existing literature and research, multiple interviews are held within different organizations. This leads to new insights into the research area of big data, information technology and management control. It also adds new insights into the relation between big data and management control.

1.3 Scientific relevance

The scientific relevance of this research is twofold. At first, as Frizzo-Barker et al. (2016) note, because big data is a relatively new, emerging concept, research of big data is in the early-stage domain. This results in the fact that at this moment, there has not much research been done in this area. For that reason this thesis can add insights into this relatively limited studied research direction.

Secondly, many papers about big data are based on the benefits of big data or are very technical studies based on theorization and formulation of expectations, with limited emphasis on the challenges (Frizzo-Barker et al., 2016). Additionally, in the papers that are discussing the challenges of big data, practical evidence about these challenges by means of qualitative studies is missing. Furthermore, only few influences of big data are investigated. For example, not much research has been done that investigated the influence big data has on the principles of management control. For that reason, the focus in this thesis is on the challenges of big data and the link between big data and analytics and management control. In this way this thesis contributes to scientific research on the areas of management control and influences of big data. It provides scientists new insights into how companies deal with the benefits and challenges of big data and what impact this has on management control.

1.4 Practical relevance

The practical relevance of this thesis is especially for managers of organizations who either have started implementing big data or (want to) orientate with regard to the possibilities of big data applications in their organization. For these both groups of managers this thesis can provide new insights into the possibilities and expectations of big data for their organization. Additionally, because this study focuses on the challenges of big data, managers gain more insights into the issues that may occur during implementing big data in their organization.

1.5 Structure of the thesis

In order to get an answer to the research question of this thesis, various steps are taken. Firstly, chapter 2 contains a literature review, in which the current knowledge in the field of big data is described. This is focused on definitions of big data, benefits of big data, and challenges of big data. Based on the selected literature, this literature review illustrates gaps in the current knowledge about big data and the influence on management control. After this literature review, in chapter 3 the research methodology is included. In order to examine the expectations of the literature review, in chapter 4 multiple interviews are held within different organizations to answer the research question. Lastly, chapter 5 is devoted to the conclusion, discussion, limitations, and suggestions for future research.

2. Literature review

This part of the thesis aims to describe the existing literature in the area of management control and big data, in order to provide understanding and insights into relevant existing studies. This literature review forms the foundation of this study and involves the current state of knowledge that is present about management control and big data. In this, the literature review shows what research has already been done, what the results of these studies are, and whether these findings and expectations differ or match with each other (Saunders, Lewis, & Thornhill, 2009). In this manner it is possible to define gaps in existing literature which make it possible to reveal flaws in existing literature, in order to show in which areas existing studies can be extended. Ultimately, in this way also the added value of this study becomes clear.

2.1 Information Technology and Management control

2.1.1 Information Technology

During the last decades, the use and potential of IT applications has increased dramatically (Chen et al., 2012). This development provides organizations more possibilities to develop in the area of information technologies. This makes it possible for organizations to improve existing methods and systems, but also new technologies in information technology have arisen. These new technologies are based on systems, technologies, processes, business applications and software of organizations (Malaquias, Malaquias, & Hwang, 2016; Shaikh & Karjaluoto, 2015).

One of the reasons for the increase of the potential of IT applications is the development of the Internet (Demirkan & Delen, 2013). The emergence and rise of the Internet causes even larger amounts of data to occur in the world and this amount is still continuously increasing at incredible speed. This is emphasized in Moore's Law, that states that the amount of available data doubles every 18 months (Marsh, 2003). This creates new opportunities for organizations to deal with their available data, and they have seen these possibilities and have invested in different forms of information technologies. These technological developments may also have an effect on information systems, and for that reason organizations have also invested in these systems. Examples of these technological developments are ERP systems and information databases (Dull, Gelinias, & Wheeler, 2012; Shaikh & Karjaluoto, 2015).

Several benefits can be achieved by making use of information technologies. For example, information technologies can lead to an increasing speed and reliability of transactions and data. Moreover it can improve communication between and within organizations, but it can also improve internal processes (Malaquias et al., 2016; Shao & Lin, 2016). However, the rise of information technologies also creates challenges for organizations because they have to be able to deal with these large amounts of data. To accomplish this, for example more technological knowledge is necessary, which is not always easy to achieve (Chun, Kim, & Lee, 2015).

Examples of recent developments in information technologies are the rise of ERP systems and cloud computing (Granlund & Malmi, 2002), but also developments are visible concerning smartphones, tablets and other communication tools. Additionally, another development is the rise of big data (Shao & Lin, 2016). These new developments have changed the manner of collecting, storing and dissemination of data. Therefore, these developments may have a vital influence on management control and management control systems (Teittinen et al., 2013).

2.1.2 Management control

In the past, accounting was seen as a passive tool in helping decision making (Chenhall, 2003). However, this view has changed and nowadays many studies examined the active role that management control systems have (e.g. Ahrens & Chapman, 2004). Controls are necessary for two reasons. At first, because of personal limitations, employees do not always know exactly what the organization is expecting from them, nor how they can do their jobs as effectively and efficiently as possible. This may be caused by lack of skills, information or training, but also because of some personal biases. Some of these defects can be avoided, but some have to be resolved through controls (Merchant, 1982).

Secondly, it is possible that individual goals of employees do not match with the goals of the organization. In this situation there is a lack of goal congruence and in such situations it is necessary to have controls to ensure that employees do not act in their own interests (Merchant, 1982), which may occur due to two causes. At first it is possible that there is a lack of direction, and employees simply do not know what the organization desires from them. Secondly, also motivational problems are possible, this occurs when individual employees are self-interested and do not want to perform what the organization is expecting from them (Merchant & Van der Stede, 2012).

Definition

In existing accounting literature, several definitions have emerged from the concepts management control and management control systems. Merchant (1982) is referring to management control as a tool that can ensure that employees work according to the plans agreed. According to him, management control is a behavioral problem and management control exists to influence employees' behavior in the desired direction. He mentions several types of control and argues that not all types of control are applicable in any situation. Furthermore, he argues that it is not always preferable to have a tight form of control, because this can have some adverse effects such as destroying morale of employees or employees who are only focusing on the measurable result areas.

Management control includes all capabilities that managers have to ensure that employees' behavior and the decisions they make, match with the objectives and strategies of the organization (Malmi & Brown, 2008). In order to achieve this, management is concerned with the organization of resources and guiding of activities, with the aim of achieving the organizational goals. In this,

management control is related to processes of objective setting and strategy formulation, because management control is the end of this process. Anthony, (1965) adds to this that management control includes processes that make it possible for employees to obtain resources in order to achieve these goals. Besides this, management control ensures that these resources are used effectively and efficiently. According to Merchant & Van der Stede (2012), management control is about controlling the behavior of employees. This is in order to prevent that employees exhibit behavior, which is not in line with the goals of the organization, or in order to prevent employees from failing in their activities.

This thesis is referring to management control as the specifying, monitoring and evaluating of actions of individual employees and the collective organization. In this, the focus is on the behavior of employees, but also on the output they produce and the minds of the employees. This management control aimed at minds is achieved through norms, emotions, beliefs and values, and this is indirectly affecting the behavior of employees (Alvesson & Kärreman, 2004). This definition of management control has been chosen because expectations present in existing literature suggest that big data affects all the described aspects of actions, both the actions of individual employees and the collective organization.

However, in addition to this definition, also the difference between enabling and coercive control is taken into account in this thesis, which is described below. This distinction is taken into account because existing literature expects that in case of organizational changes, a more enabling form of control may contribute better to achieving the potential of these changes (Jorgensen & Messner, 2009). Therefore, it is expected that the form of control in organizations affects the potential of big data for organizations.

Forms of management control

In addition to the various definitions of management control, various forms of management control are discerned in literature. One of the forms to describe management control is based on the distinction between a coercive and an enabling form of control (Adler & Borys, 1996; Ahrens & Chapman, 2004). In this research this distinction is taken into account because it can demonstrate the type of formalization in organizations. This type of formalization in organizations possibly has an influence on the way and to which extent new technologies such as big data are able to develop in organizations. For that reason this possibly can show to what level organizations can succeed in implementing new technologies and to what extent organizations can meet the opportunities of big data.

Coercive control is based on a 'top-down' control approach. The goal of this more coercive form of formalization is aimed at compliance to avoid reluctant attitude (Jorgensen & Messner, 2009). Coercive control also emphasizes centralization and pre-planning and it provides employees only limited options for actions. It has been developed with organizational rules with the aim to produce a foolproof system based on deskilling (Adler & Borys, 1996; Ahrens & Chapman, 2004). On the other hand gives enabling control employees more power, hence employees are enabled to deal on more

effectively ways with the inevitable contingencies in their work and work processes (Jorgensen & Messner, 2009). This is made possible by organizational rules that take the intelligence of employees into account. In this way no formal procedures are required to make work processes foolproof, as is required for coercive control. The only formal rules that are used, are focusing on supporting employees in their work (Adler & Borys, 1996; Ahrens & Chapman, 2004).

By means of four design principles of the system, it is possible to discern the differences between coercive and enabling control. These four design principles are repair, internal transparency, global transparency and flexibility, and they cover both coercive and enabling control. This in contrast to much literature, which attributes these four principles only to enabling control (Adler & Borys, 1996).

Repair is based on the question if employees are allowed to ‘repair’ defects in the systems by themselves (Jorgensen & Messner, 2009). When using an enabling form of control, employees have the freedom to recover breakdowns. In these procedures, it is even possible to achieve improvements. In coercive control any kind of deviation from the standard is seen as suspicious. There is no possibility for ‘repair’ by employees, procedures exist to inform superiors and employees should be docile (Adler & Borys, 1996; Ahrens & Chapman, 2004).

Internal transparency focuses on the internal functioning of the organization. In this, the question is if employees understand the systems and equipment they are using (Ahrens & Chapman, 2004; Jorgensen & Messner, 2009). When using enabling control, procedures and processes are clear for both employees and managers. The underlying reasoning and the idea of the rules are also clear. On the other hand coercive control is focusing on procedures and processes aimed at the enforcement of obligations and duties. The purpose is not to help employees, because employees only have to implement the work instructions (Adler & Borys, 1996).

Global transparency asks the question if employees know in which way their work is related to the organization as a whole. For example, the question is if employees interact with the organization. Enabling control uses the ‘usability approach’, which states that employees are aware of the wider process in the organization and they know how their job fits in this wider process. In this way, employees are able to cooperate in optimizing the processes. Coercive control in contrast is asymmetric, which means that employees do not know the wider processes of the organization. They only have to fulfil their own task and should not interfere in other people’s tasks (Adler & Borys, 1996; Ahrens & Chapman, 2004).

Flexibility is related to the flexibility employees have in using the systems (Ahrens & Chapman, 2004). Enabling control states that deviations from procedures and processes not only causes risks, but this can also provide learning opportunities for the organization. These opportunities may even contribute to the improvement of procedures and processes. On the contrary in coercive control, deviating from procedures and processes is more difficult. Permission from the supervisor is required when making deviations and the procedures and processes are strictly described and

employees have to comply to this (Adler & Borys, 1996).

Despite the obvious differences between these two forms of control, this difference is no distinction of extremes. A company is neither totally coercive nor totally enabling, they are present side by side in a company. This is confirmed in case studies of both Ahrens & Chapman (2004) and Jorgenson & Messner (2009). They both state that enabling and coercive control can interact with each other. In this way it is possible to achieve and balance both objectives of efficiency and flexibility within organizations. For example, this is possible by means of formalizations with centralization and standardization up to a specified level in order to attain efficiency, and flexibility and fine-tuning in the operation of processes which depends on operational specific situations. This flexibility ensures that local knowledge and experience serve as support in achieving the goals of the organization. In this way it is possible to both achieve efficiency and flexibility by using management control systems in an enabling way (Ahrens & Chapman, 2004).

2.2 Big Data

2.2.1 Introduction

One of the new technologies in IT is big data and analytics (McAfee & Brynjolfsson, 2012; Shao & Lin, 2016). During the last years, big data has emerged as a new area of IT-enabled innovations and there is a remarkable increase in the use and potential of big data and analytics (Frizzo-Barker et al., 2016; Goes, 2014). One of the reasons big data has become so popular is the availability and accessibility of data which has improved. This creates enhanced opportunities to investigate areas that were previously hard to examine due to poor availability of data (Liu, Li, Li, & Wu, 2016).

Contemporary society experiences an enormous explosion of information and data. People are interacting more with information and more information is shared (Demirkan & Delen, 2013). As a consequence of rapid developments of several information technologies, large amounts of data can be collected (McAfee & Brynjolfsson, 2012; Zhou et al., 2016). Big data is expected to lead to a shift in many aspects for the company. For example, a “shift in thinking about data infrastructure, business intelligence and analytics and information strategy” (Frizzo-Barker et al., 2016, p.403) is expected. A difference between big data and other information technologies is that big data is not only about saving or accessing data, but it is also about analyzing this data (Bello-Organ, Jung, & Camacho, 2016).

By using big data, organizations are able to measure significant more about the business in their organization and it is possible to make translations of that knowledge, which can improve the decision making and therewith the performance of the organization (McAfee & Brynjolfsson, 2012). By means of big data it is possible to combine private information of for example consumer preferences and products with information from social media to understand and predict the needs of customers more precisely, which can improve decision making. Furthermore, by using big data

organizations are able to optimize processes (Assunção et al., 2015). This means that big data can have considerable influence within organizations, also related to accounting and control. It is therefore likely that big data also has an influence on management and control within organizations. The remainder of this thesis is focusing on the development of big data and the influence it has on management control. It investigates what big data is, but also what the advantages and challenges of big data are and how this is related to management control.

2.2.2 Definition

In literature, due to the rise of big data many definitions of big data and/or analytics have arisen with a variety of meanings, causing that there is no standard definition of 'big data' in literature (Porche, Wilson, Johnson, Tierney, & Saltzman, 2014). For example, Chen et al. (2012) refer to big data as large and complex data sets and techniques which "require advanced and unique data storage, management, analysis, and visualization technologies" (p.1166). These datasets are impossible to analyze by hand and need new database management tools because current traditional tools are often insufficient (Frizzo-Barker et al., 2016; Rao, Saluia, Sharma, Mittal, & Sharma, 2012). The big datasets will outpace the capabilities of organizations (Ma et al., 2015), because it has datasets that have sizes that go beyond the abilities of traditional and common software tools in organizations to capture, store, manage, and process the data (Bharadwaj, El Sawy, Pavlou, & Venkatraman, 2013; Chang et al., 2014). In this way big data causes a new wave of innovation (Tambe, 2014), and for organizations that want to become a big data enabled organization this means there should be made investments. This should be done on two levels: investments to process the increased amounts of data and also investments in order to make the processes of the organization more suitable to achieve substantial business value from the data and information. However, Bharadwaj et al. (2013) argue that only a few organizations have made these both investments.

Among others, Chow-White & Green (2013) argue that big data does not only require a technical development. They argue that big data also requires a social and cultural shift in organizations, which is necessary to become an organization which enables data-driven decision making. To obtain a broader and clearer understanding, it is important to take existing organizational and institutional settings of the organization into account. Besides this, also the interaction with already existing embedded practices of knowledge building and decision making within the organization should be taken into account. By means of the development of the social and cultural environment in the organization, it becomes more possible to collect and analyze information in real time, leading to better advantages for the organization. However, Chow-White & Green mention that one must be careful with the overload of data which can occur on a daily basis.

Goes (2014) is referring to big data as the "creation of massive amounts of data through an extensive array of several new data generating sources" (p.3). This is based on both structured and unstructured data, which have specific characteristics: it is based on large-scale data, it has issues with

the capabilities of applications for running this large-scale datasets, and it leads to easier and better interpretable analytics of the data (Cuzzocrea, Saccà, & Ullman, 2013; Due, Kristiansen, Colomo-Palacios, & Hien, 2015).

However as existing literature notices, it is difficult to formulate one uniform definition of big data and therefore this study follows several authors and refers to big data by means of the 4V's. This approach has been chosen because it provides insights into all substantive aspects of big data, which are described in the next section.

2.2.3 Parameters of big data

The technological changes caused by big data have caused that the possibilities with the generated data have greatly increased. Literature distinguishes four aspects that have caused this change, referred to them by means of the 4V's: volume, velocity, variety and veracity (Frizzo-Barker et al., 2016; Goes, 2014; Porche et al., 2014; Salehan & Kim, 2016).

Firstly, volume is based on the amount of data. During the last years, the amount of available data has grown explosively (Sharma, 2016), and it is expected that this growth continues the upcoming years. An important aspect of big data therefore is the large volume of data which becomes available. This is for example possible because measuring data by using sensors has become more feasible as more and more devices are equipped with sensors, such as smartphones, machinery and vehicles. These sensors create the possibility to bring these data together. Besides this, also a second development is visible, which is the development and use of social media, such as Facebook, LinkedIn and Twitter (Assunção et al., 2015; McAfee & Brynjolfsson, 2012). This development has led to an exchange of public information on a more widely level than before, but has also led to a change in the way that data should be processed (Sharma, 2016).

Secondly, variety is based on the diversity of formats, sources, and types of data, in structured and unstructured forms (Frizzo-Barker et al., 2016; Porche et al., 2014). With the introduction of big data also the variety of data has increased considerably (Sharma, 2016). An example of this is the introduction of social media, in which big data has the form of different notifications, messages, and status up-dates, but also images which are posted on the various media. This variation is also caused by the different kinds of sensors that exist nowadays, by means of historical weather information and forecasts, GPS signals coming from cell phones and tablets, and so on. This results in a stream of data that has emerged in many different ways and therefore is available in many different forms. This variety can cause difficulties at the time of bringing the data in connection with each other (Assunção et al., 2015; Frizzo-Barker et al., 2016; McAfee & Brynjolfsson, 2012).

Thirdly, velocity is the speed at which analyzing of data becomes possible (Frizzo-Barker et al., 2016). This is also related to the speed in which searches in the data can be made and the speed of data retrieval (Porche et al., 2014). Big data has caused the rise of speed of these features due to a higher calculation speed of the system and this leads to more current information, the so-called real-

time information (Goes, 2014). In many situations, this speed of data creation is more important than the volume it creates because this speed can provide competitive advantages (Davenport & Harris, 2007; McAfee & Brynjolfsson, 2012). However, other authors mention that most of the time this competitive advantage is of short duration because the data-driven insights are easily to replicate by other companies (e.g. Ross, Beath, & Quaadgras, 2013). The development in velocity of data is also in connection with the developments of computers, which enables the processing of this real-time information to be done on a better and faster way.

Fourthly, veracity is related to the reliability and quality of data (Assunção et al., 2015). This veracity of data is important when using data for example for strategic decisions. Besides the importance of veracity of data, also veracity of analysis is becoming more important. This because when using big data, coupling different kinds of data is possible in order to obtain a variety of analyzes. To ensure that this analysis is useful and that rational decision making is possible, reliable and up-to-date data is necessary, but also the method of analyzing needs to be correct and management need specific skills to be able to draw conclusions. Not using reliable and/or data with high quality would lead to data with limited value, or it can even have negative influences on business performance (Jamil, Ishak, Sidi, Affendey, & Mamat, 2015; Park, Huh, Oh, & Han, 2012).

Besides these 4V's, some literature also distinguish a fifth aspect, value. This fifth aspect is in addition to the 4 other V's, it measures if the data has usefulness and is value relevant for its intended purpose and is also related to the quality of data. This is necessary because this can support decision making on an effective and efficient way, and data only matters when it is useful (Frizzo-Barker et al., 2016; Zhou et al., 2016).

2.2.4 Characteristics of big data

Big data has several characteristics. At first several formats of data are possible because big data consists of structured, unstructured and semi-structured data. Furthermore, big data consists of several sources of data, for example the Internet, social media and sensors. Lastly, there are also differences in the processing of data.

Basically, big data consists of three different formats. Firstly, structured data is the most straightforward form of data. Structured data has specific, fixed formats, making management of data relatively easy (Chen et al., 2012). Secondly, as opposite of structured data also unstructured data exists. In this unstructured data specific patterns are missing. This is an important feature of big data, because of this characteristic of unstructured data it goes further than many traditional data or analysis. Data is collected in various formats, not only in figures, but also by means of texts, photos, video's, and even geographic locations and time by means of GPS signals. Because the increasing possibilities for such measures of unstructured data enormous challenges for organizations emerge (Chang et al., 2014; Chow-White & Green, 2013; Sharma, 2016). Lastly, semi-structured data is a combination of

both structured and unstructured data. Semi-structured data is not always manageable by means of standard techniques but despite this, analyzing these formats of data is still possible by using ad hoc or one-time execution (Chen et al., 2012).

Furthermore, big data appears in many different forms. At first, one of the most well-known sources of data is the Internet. Nowadays the Internet is a great source of data, because about anyone is in any way connected to the Internet through mobile phones, tablets, laptops or even television (Demirkan & Delen, 2013). By the use of these devices, people's behavior can be viewed and the use of these devices creates vast amounts of data and information, which are largely unstructured and this amount is still growing because of the many possible applications (Rao et al., 2012).

Secondly, also social media is an emerging source of big data. During the last few years, social media and its use, such as Facebook, Twitter, LinkedIn and blogs, increased considerably (Assunção et al., 2015; Demirkan & Delen, 2013). On one hand, organizations make use of these social media-tools for promoting their products and services and to keep in touch with their customers. This is for example possible by approaching the customer by means of posting news about the company on Facebook and by discovering the needs of customers by means of blogs. At the moment the organization knows the needs of the customer on social media, it is possible to close sales through ads on Facebook that will point customers to the website of the organization. After that, post-sales service is possible by following customers on Twitter (Guesalaga, 2016). On the other hand, customers make use of social media and they receive information about products and services of several organizations (Salehan & Kim, 2016). The new possibilities of the Internet and social media have changed the way customers are shopping. These developments provide new sources of data-gathering, resulting in great sources for big data because every status update, posted photo or message on one of these media contains vast amounts of new data and information.

Thirdly, sensors are one of the main sources of big data because a great diversity in the applications of these sensors is available. By the use of sensors in business processes it is possible to measure properties such as temperature, rapidity, weight, and movements (Kolomvatsos, Anagnostopoulos, & Hadjiefthymiades, 2015). Sensors create the possibility to track individual items that pass through a specific area of the supply chain. This creates new data, by which bottlenecks can be traced, and also optimization of business processes becomes possible. It is also possible to create alarms at the moment that specific criteria are met (Brynjolfsson et al., 2011; Kolomvatsos et al., 2015). Besides sensors in business processes, also other sensors are available which can deliver data, for example data for forecasting of weather (Frizzo-Barker et al., 2016; Sharma, 2016). Also these sensors create vast amounts of big data, and this amount is still growing significantly. By means of the different sources of big data, metadata is created in different ways.

Besides the different formats and different sources of data, two ways of processing of data are possible: batch oriented processing and real-time data processing (Kolomvatsos et al., 2015). The first one, batch oriented processing, is based on collecting business event data that is processed in one go.

This because processing data in large volumes is the cheapest and most efficient way. This is related to periodic mode, in which a delay exists between various data processing steps. However, this has the disadvantage of a possible time delay in data, because data is not always up-to-date. In the second method, real-time data processing, this is avoided because data is processed without time delays. This is achieved by immediate mode, in which data updates immediately at the time this new data is created. Disadvantage of this way are the costs of such systems, but the advantage is that in such a system the data is always up-to-date (Dull et al., 2012).

2.2.5 Conclusion

Big data leads to more volume and a higher variety, velocity and veracity of data. This ensures that more data becomes available, for example because more and more business activities are digitalized. This leads to new sources of information and for that reason it also leads to new sources of data, which often can be obtained in a cheaper way than before. Examples of new sources of data are online shopping, sensors in processes, but also social media and mobile phones with GPS signals. In this way everyone has become a kind of data generator (McAfee & Brynjolfsson, 2012). Furthermore, this data becomes available in different forms, no longer just as structured data, nowadays also unstructured and semi-structured data is available, which can be processed in different ways. This development caused many advantages, benefits and opportunities, but it also has led to challenges to become a big-data-driven organization.

2.3 Benefits and challenges

2.3.1 Benefits of big data

Big data and analytics can have benefits for all kinds of organizations. Not only digitally operating companies (for example companies on the Internet), but also traditional firms can benefit from the advantages and features big data provides. Bluntly this means more measuring is possible by using big data and in this way organizations get to know more about their businesses. Literature distinguishes several possible benefits and advantages of big data. Roughly speaking, these benefits/advantages can be divided into three categories: cost reduction and better margins, faster and better decision making, and optimization of processes and products.

Cost reduction and better margins

One of the most mentioned benefit of big data is cost reduction (Assunção et al., 2015; Demirkan & Delen, 2013). One way to achieve this cost benefit is by means of economies of scale and economies of scope, which arise due to an increase in operational size. This is possible because organizations move their data to enterprise warehouses that are specially equipped to produce analytical applications (Davenport, 2014). Moreover, economies of scale and economies of scope also arise because the speed of products and services in the supply/demand chain is expected to increase (Demirkan & Delen,

2013). Another way of cost benefits is possible when employees are trained to use big data. When this is the case and a learning and education environment is created within the organization, it is possible to perform tasks more effectively, resulting in cost reductions (Sharma, 2016).

Apart from cost reductions, also other benefits to increase margins and profits arise by means of big data. A well-known example is dynamic pricing (den Boer, 2015). In this, supply and demand are better coordinated, which is reflected in the price of products and services. On basis of the numbers of visits or the number of purchases, companies can decrease their prices to be cheaper than the competition or increase the prices to obtain higher margins on sales at a moment of great demand for certain products.

Faster and better decision making

By using big data, the collecting, storing and analysis of data becomes easier and cheaper. It also creates greater availability, visibility and transparency of information. These new techniques enable organizations to find new patterns and connections in data on a level that was not possible without big data, which can lead to several advantages for decision making within organizations. At first, these techniques can lead to more precise and predictive managing than before (Frizzo-Barker et al., 2016; McAfee & Brynjolfsson, 2012). For instance, decision makers can obtain more insight into the behavior of customers because every interaction with customers produces data. Another way of collecting information of customers is possible on a voluntary way, this happens when customers provide their personal information to the organization, for example in order to achieve extra discounts or other promotion actions/advantages (Chow-White & Green, 2013). By collecting and analyzing this data, opportunities arise to develop models that predict the future demands of customers. In this way, it becomes possible to predict customers' demand, leading to decisions that are based less on intuition, as previously often happened, but that are based more on data (McAfee & Brynjolfsson, 2012). An example of this can be made by inventory management, in which big data can lead to efficient purchasing. As a consequence of more predictable demand of the customer, it is known at what specific moment there is a certain demand. In this way it is also clear how much stock is required and purchasing can be adjusted. This leads to lower stock costs and less space necessary for the storage of stock.

Secondly, big data provides other possibilities. Besides the possibility to predict future customer behavior, it is also possible to determine the current state of the customer. In this way organizations can gain insights into the fortunes of customers (Khade, 2016). Analyzing patterns of data of a specific customer (for example click behavior on a website) can provide insights into what a customer may need at a certain moment. In such a way the organization can respond to specific customer needs through narrower segmentation of customers, for example by offering special products in the searching category, leading to more effective sales activities focused on the needs of the customer. For instance, when a customer frequently searches for a specific category of products on the

website of the organization, the organization knows the customer is likely to be interested in these particular products. In this way the organization can align sales by bringing these items to the specific attention of the customer, or offering special discounts for the customer. By using this way of working, organizations use big data to improve sales activities (Fanning & Grant, 2013).

Thirdly, this faster and better decision making can lead to better firm performance due to increased efficiency and effectivity of the organization and organizational strategy (Chang et al., 2014). This is confirmed in the research of Brynjolfsson et al. (2011), which states that firms that have decision making based on data and business analytics show higher performance. This is not only based on output productivity, but also other measures of profitability and market value are taken into account. This improved performance is enabled by the availability and use of accurate information for decision making, which is created by big data (Davenport & Harris, 2007).

Fourthly, faster and better decision making is possible because big data increases the opportunities for employees and managers of the organization to ask questions and give answers to these questions, leading to greater accuracy. Big data can provide better and more valid answers, both resulting in a decrease in risk of wrong answers and an increase in right answers to questions (Chow-White & Green, 2013).

Fifthly, by using big data, it is not only possible to improve performance, but it is also possible to measure performance better. This is possible because more accurate and detailed performance information is available about almost every aspect of performance, for example features of inventory, but also absenteeism of employees. Since this information is now better known by the organization, enhanced capabilities are created to make better use of this information. In this way it is possible to make better management decisions (Fanning & Grant, 2013).

Optimization of processes and products

Big data enables organizations to discover which specific products a specific target group needs at a certain moment. In this way it is possible to tune the wants and needs of customers with the processes of the organization, which makes it possible to bind customers longer to the organization. This insight into behavior of customers also allows better serving of customer needs by means of personalized products and services. By measuring these purchase patterns of customers, for example by the use of social media, organizations can determine which methods are most effective to serve customers (McAfee & Brynjolfsson, 2012; Spenner & Freeman, 2012). Furthermore, by means of crowdsourcing, big data can lead to product development or identifying needs of customers for new businesses. In this way organizations are enabled to understand the heterogeneity of customers or personal preferences better (Frizzo-Barker et al., 2016).

Besides this, it is also possible to optimize business processes because more insights emerge about bottlenecks in business processes and the whole supply chain. This can also lead to more insights about at what point unnecessary costs arise. By means of these complex diagnoses, it is

possible to obtain more in-depth insights into the processes to come up with specific solutions for specific problems. This leads to more potential for problem solving and the optimization of processes (Frizzo-Barker et al., 2016).

2.3.2 Challenges of big data

Big data and analytics are trending topics at this moment. However, besides the benefits and advantages which are described in existing literature, at this moment there are also challenges to implement big data in practice. For that reason the added value big data can provide is not always easy to achieve (Assunção et al., 2015). These challenges can be framed as obstacles to become a big data enabled organization with the desired outcomes of big data (Frizzo-Barker et al., 2016), which means that it is not that easy to become a big data enabled organization (Bharadwaj et al., 2013; McAfee & Brynjolfsson, 2012). The challenges of big data can be divided into technological challenges and managerial challenges.

Technological challenges

The first category challenges are technological challenges. Technological challenges are based on IT infrastructure, security and privacy, and other technological challenges.

At first, to reap the benefits of big data, to have possibilities to collect, store, manage and analyze data on a better way, the information technologies in organizations are important. Without good IT infrastructure, it is not possible to achieve the advantages of big data (Demirkan & Delen, 2013). Due to the growth of volume and variety of data, major challenges have arisen for the infrastructure of the organization. The large volumes of big data lead to capacity problems for data storage, data processing and data exchange, which goes beyond the existing database systems or stretches the IT infrastructure to its limits (Assunção et al., 2015; Sharma, 2016; Zhou et al., 2016). As an example, the datasets that become available by means of big data contain amounts of data which are larger than the capacity of a single computer. The datasets consist of large and complex data which may be difficult to unite in a single storage location. This also poses difficulties in the communication of this data within and outside the organization and for that reason it may be time-consuming to communicate (Ma et al., 2015).

An important aspect in the trend of big data is the widespread diffusion of information systems such as Enterprise Resource Planning (ERP), Supply Chain Management (SCM) and Customer Relationship Management (CRM). The use of systems such as ERP in combination with the growth of big data should lead to better organizational decision making and therefore an increase in organizational performance (Brynjolfsson et al., 2011; McAfee, 2002). For example, by using these systems it is possible to make use of Business Intelligence to make more comprehensive analyzes with operational data (Brynjolfsson et al., 2011; McAfee, 2002). Existing literature argues that the use of ERP systems can provide several advantages for organizations. However, it is not that easy to achieve

these advantages, which is caused by the way the system is used by the organization. To achieve the outlined benefits of ERP-implementations and to gain strategic advantages, business process reengineering or business process redesign is required for strategic use of the ERP system (Caglio, 2003). As Bharadwaj et al. (2013) mention, the way organizations obtain increased access to the information that is required to make faster and more effective decisions is important. This means it is important to invest in the organizational processes, not only in the technology of big data alone.

However, in most of the cases, the complexity of the ERP systems, the limitations of the system, and the unwillingness of employees to change may cause that it is not feasible to achieve business process reengineering or business process redesign (Granlund & Malmi, 2002; Quattrone & Hopper, 2005; Rikhardsson & Kræmmergaard, 2006). In such cases, only technical use of the system is possible, in which processes do not change (Scapens & Jazayeri, 2003). This can ensure that systems of the organization cannot fully provide the advantages of big data, because the system cannot go along with the latest developments. For that reason, it is important to have an IT infrastructure which can fully provide the opportunities and requirements for the use of big data.

In other words, organizations need IT systems that make it possible to go along with the latest trends such as big data, which can be achieved by means of strategic use of the system. However, this is not a matter of course, which is confirmed in the paper of Quattrone & Hopper (2005). In this paper, two companies are examined; only one company was able to benefit from the described advantages, the other company only implemented on technical base and had no visible changes in processes. This complicates the ability to reap the benefits of big data.

Besides IT infrastructure, also security and privacy of data is a technological challenge (Goes, 2014). The big data databases contain a lot of valuable (privacy) information and protection of this information is an important aspect in order to protect the data against unauthorized use by third parties. Risks in this aspect are risks about security of intellectual property and liability and risks of data leaks (Frizzo-Barker et al., 2016). In order to prevent this, it is necessary that access to data is only available for employees who need this data for execution of their work. Furthermore, it is important to protect the data against hackers. One way to increase the trustworthiness of the system is by making use of a third-party organization with a good reputation, for instance a provider of software systems such as ERP (Sun et al., 2011).

Lastly, several challenges arise during the data collection, data integration and the processing and analyzing of data. Firstly, challenges arise with the collection of data. The new volumes of data lead to a lot of new, valuable knowledge. However, not all the data is expected to have the same added value. Distinguishing noise information from valid, actual information is an important aspect in big data. But the realization of this is not easy, for example because the unstructured forms of data that are created due to big data (Chang et al., 2014; Goes, 2014). This is further reinforced by the emergence of more sensors and other ways of measuring data, that are often based on unstructured data (Cuzzocrea et al., 2013; Ma et al., 2015).

Secondly, the high variety of big data can cause problems at the time of bringing the data in connection with each other (Assunção et al., 2015; McAfee & Brynjolfsson, 2012). The integration of big data coming from different sources causes many barriers because all these data formats have their own formats which are specified. This diversity has the consequence that effective access to this data is difficult (Ma et al., 2015). Furthermore, problems arise with storage of the data because of complexity. For instance, as a result of large amounts of unstructured data, the number of different dimensions of data has increased in large quantities (Chang et al., 2014; Cuzzocrea et al., 2013). It is also important that data is stored in a way in which it can easily be migrated between different datacenters/cloud providers (Assunção et al., 2015). When this migration is not well arranged, the lack of accessible and well integrated data causes the problem that employees cannot make good use of the data (Zhou et al., 2016).

Thirdly, effective and efficient processing of big data and analyzing the data after processing is important (Demirkan & Delen, 2013). Analysis is the generation of knowledge and intelligence, which is necessary for supporting decision making and strategic objectives (Goes, 2014). However, this effective and efficient processing and analysis is not always possible because big data leads to large amounts of data, collected by various sensors and parameters. This creates various modeling elements, which complicate the interpretation of this information that is required for the decision making (Zhou et al., 2016).

For that reason, to achieve effective decision making by means of big data, it is important to turn big data into smart data. In order to obtain smart data noise information is filtered out, resulting in valuable data. Only in this way it is possible to make the large volumes and variety of big data value-relevant for the organization, which also increases the veracity of the data. For example, this may be achieved by processing and transforming unstructured big data into structured data. If this processing and transformation of data is done, it becomes possible to analyze the data for example through Business Intelligence which generates diagrams and figures, leading to effective and efficient data (Cuzzocrea et al., 2013).

Managerial challenges

Besides technological challenges there also occur managerial challenges. Before big data, many decisions were based on intuition and experience. With the introduction of big data, it becomes necessary to base decision making on data. For that reason, managerial competences become more important, resulting in managerial challenges. Without effective managing of these challenges, it would not be possible to fully take advantage from the benefits of big data (McAfee & Brynjolfsson, 2012). These managerial challenges are divided into leadership challenges, skills of employees, decision making and organizational culture.

The first managerial challenge is related to leadership (Goes, 2014). Organizations do not take advantage of big data simply by having more and better data. Important for big data is to have leaders

in the organization that set goals and define what success is. This because there will always be a need for vision and human insight in organizations. Also of importance is stimulating the search for opportunities, market developments and creative thinking (McAfee & Brynjolfsson, 2012). Furthermore, the changes caused by big data, for example the utilization of new systems, the strategic analytics, the information technology challenges, and the transformation within the organization should be guided by these leaders (Goes, 2014).

Additionally, also some other specific managerial challenges arise. For example, it is important that leaders are asking the right questions. Big data leads to new possibilities to obtain more accurate answers to questions, leading to a decrease of wrong answers. However, this does not exclude the possibility of answering the wrong question with big data. It is not obvious that big data always leads to the best solution. By asking wrong questions, correct answers are found in the wrong direction (Chow-White & Green, 2013). An example of this is Google. If a question in Google is asked in the wrong way (the search term), this leads to answers from Google that turn out quite different than originally was searched for. For that reason, for organizations it is important to ask the right questions because it is possible to set many different questions. This requires managers and employees who are asking the right questions at the right time (McAfee & Brynjolfsson, 2012).

Besides leadership, the skills of employees are a second managerial challenge. According to Tambe (2014), for new adopters of big data skills of employees are an important aspect. Big data leads to valuable data, but also higher volumes of data and more variety in the structuration of data. Nowadays not only structured data exists, and this raises the need for data scientists and programmers who can deal with the challenges of the resulting unstructured and semi-structured data. This can be done by switching from ad hoc analysis to an ongoing conversation with data (Davenport & Patil, 2012). Only then it is possible to create business value within the organization. This means managers need techniques, but also skills to handle these large sets of data to collect, store, analyze and make use of the big data (Chang et al., 2014; Frizzo-Barker et al., 2016). However, it is not always easy for example to precisely identify the most valuable information in these large datasets.

On the other hand the development of big data also results in (the need for) other necessary skills. For instance, the resources available to deal with the high volumes, variety and velocity have improved in recent years. These new technologies require new skills of for example the IT function, which has to integrate all relevant internal and external resources within the organization. To deal with these issues, the organization needs analytics and data science professionals (Goes, 2014; McAfee & Brynjolfsson, 2012). However, it turns out to be very difficult to find managerial talents for this work, due to a shortage in people that have deep analytical skills and people that can make effective decisions (Chang et al., 2014; Chen et al., 2012; Davenport & Patil, 2012; Due et al., 2015).

Additionally, also training in other aspects is important. For example when organizations want to make more use of social media, because big data provides possibilities for this, it is important for organization to create organizational competence and commitment on this area (Guesalaga, 2016).

Only when employees are well trained and know how raw data has to be translated into data and information, the advantages of big data can be achieved. Furthermore, it is important that employees know how this information has to be interacted and communicated within the organization to achieve these advantages (Chen et al., 2012).

The third managerial challenge is focused on information and the decision making based on this information. Of importance is that information and decision rights are present in the same location. People who understand the problems caused by big data should have the availability of the right data, but they also need to have the possibilities to communicate with those employees who can solve the problems. If this is not the case, this can lead to problems with effective problem solving (McAfee & Brynjolfsson, 2012). These problems could arise because the people who create the data do not have enough understanding of how the users of the data in the organization use that information. For that reason good communication between the creators of data and the users of data is necessary, which is not always easy to achieve (Redman, 2013).

This leads to the managerial challenge based on the organizational culture. When data is not appropriate or not reliable, managers fall back on intuition in decision making. This feeling can occur at the moment that employees have to correct the data from errors by themselves. This creates a climate of distrust in data (Redman, 2013). Furthermore, in many companies, decisions are based on intuition. However, this is not desirable because the use of big data creates the need for a change to data-driven decision making (McAfee & Brynjolfsson, 2012). Research has shown that organizations that make data-driven decisions are more profitable than companies that make decisions based on intuition. But in order to achieve data-driven decision making, big organizational challenges arise to achieve a cultural shift, in which changes of structures in the organizations are required. This can be achieved for example by using new workflows that have to be implemented with incentives based on prioritization of data-driven decision making to guide people in their work (Fanning & Grant, 2013; Ross et al., 2013).

Other challenges

Besides these technological and managerial challenges, also other challenges arise. One of these challenges is the cost versus benefits challenge. Analytical solutions such as big data are expensive, and for that reason a cost efficient service is necessary. This is particularly a problem in small and medium businesses due to high investment costs (Sun et al., 2011), but also an cost benefit tradeoff has to be made with the collection and use of the data (McNeely & Hahm, 2014). Big data is not proving its worth when the costs of collecting and using data are higher than the benefits.

Another challenge is related to the job of employees which becomes harder by means of big data and analytics. For example, the data tells the company to increase sales by means of promoting in the last month of the year to achieve the year-goals, but on the long-term the organization has the goal of brand building and by means of promotions this brand image is damaged (Horst & Duboff, 2015).

Such issues arise by using big data, in which a balance must be found between short-term (sales) and long-term (brand building). Employees and managers have to deal increasingly with such issues caused by the development of big data.

2.4 Summary and expectations

2.4.1 Summary

The literature review contains the current knowledge that is available about the concepts of management control and big data. With regard to the definition of management control, this study follows the definition of Alvesson & Kärreman (2004) and is referring to management control as the specification, monitoring and evaluation of actions of individual employees and the collective organization. This definition of management control has been chosen because expectations present in existing literature suggest that big data affects all the described aspects of actions, both the actions of individual employees and the collective organization. Moreover, in this study also the difference between enabling and coercive control is taken into account. To be able to make a distinction between these two types of control, four design principles are taken into consideration, which are repair, internal transparency, global transparency and flexibility. This distinction is taken into account because existing literature expects that in case of organizational changes such as big data, the form of control in organizations affects the potential of big data for organizations.

Big data and analytics is one of the new technologies in information technology. Within this thesis, big data is described on the basis of the 4V's. These 4V's are the volume and variety of data which have grown explosively the last years, the velocity of data that has risen which leads to more real-time information, and the veracity of data because reliability and quality of data is becoming more important. In this study, this approach by means of the 4V's has been chosen because it is difficult to formulate one uniform definition of big data and this approach provides insights into all substantive aspects of big data. At the same time, big data also has some other characteristics. At first, big data consists of structured, unstructured and semi-structured data. Secondly, by means of the Internet, social media and sensors, different forms of big data arise. Thirdly, both batch oriented processing and real-time data processing is possible.

Within existing literature, various benefits of big data are described. These benefits are focused on the area of cost reductions and better margins, faster and better decision making and possibilities for optimization of processes and products. However, from the literature review becomes clear that also several challenges arise when implementing big data in practice. This is caused by technological and managerial challenges. Technological challenges are focused on the (IT) infrastructure, security and privacy, and the collection, integration, processing and analysis of data. Managerial challenges are focused on leadership, skills of employees, decision making and organizational culture. Furthermore, several other challenges arise, for example the cost versus benefits challenge and the jobs of employees which become harder by means of big data and analytics.

2.4.2 Expectations

The findings from the previously described literature lead to expectations for the results of this study. Firstly, based on theorization of the concept of big data, expectations of big data are present in existing literature. These expectations are primarily based on the positive aspects that big data can provide to organizations. However, this literature review has pointed out several challenges that make it questionable if the benefits of big data can be achieved and for that reason the question can be raised to what extent organizations can successfully implement new information technologies such as big data and can take advantage of the benefits outlined in literature. According to the literature review, these challenges seem to be obstacles for organizations to become a big data enabled organization. It is therefore expected that organizations in practice still have difficulties in implementing big data, with the consequence that that big data has not yet been realized in many organizations.

Secondly, because of this expectation it is also expected that the impact of big data on management control is limited. Due to the various challenges, the impact of big data in organizations is hardly visible. Therefore it is expected that the expected effects present in existing literature, which are also related to accounting and control, are not always realized in practice. For example, the literature review shows that in order to gain the strategic advantages of big data, business process reengineering or business process redesign is required for strategic use of the systems, while because of several challenges this is not easy to achieve. The consequence of this is that in fact no changes occur in the processes of the organization, something that is needed in order to achieve the benefits of big data, which is also required to see changes in management control. Besides this IT challenge also other technological and managerial challenges arise, and therefore it is expected that the influence of big data on management control is limited in practice.

Thirdly, despite that no direct effect of big data on management control is expected, existing literature argues that using a more enabling form of control (in contrast to a more coercive form of control) can contribute to achieve the potential of big data better. This because implementing big data requires a lot of organizational changes, and a more enabling form of control can contribute better to this because of the high flexibility, transparency and repair-possibilities this provides to employees. Furthermore, in current literature it is expected that developments such as big data lead to more efficiency. However, it is also expected that during developments such as big data organizations also needed some flexibility in operations in order to obtain the potential of big data. For that reason existing literature argues that an enabling way of control is necessary in order to achieve both efficiency and flexibility in organizations. Therefore, in this study it is expected that organizations which make use of an enabling way of control can attain the potential of big data better.

3. Research method

This chapter discusses the research method of this study. Because big data is a relative new phenomenon in scientific research, most of the studies on big data are primarily focused on theorization and formulation of expectations. For that reason, only a few studies have been focused on the application of big data in practice. Also the relation between big data and management control has hardly been investigated. For those two reasons, the goal of this study is to gain more insights into big data in companies, especially focused on the role it has on management control. In this, a connection is made between previously described theory and the practical insights of this study.

3.1 Research design

In this study, a qualitative research methodology has been chosen. This qualitative research methodology has been chosen because existing literature has only focused on theorization and formulation of expectations and insights from practice about these theorization and expectations are missing. This means that only limited qualitative research has been done that have led to practical insights about big data and the relation between big data and management control. This research examines the expectations present in existing literature and in this way it provides deeper insights attained from practice. Qualitative research focuses on collecting specific information from a small group. Based on this, one theory is clarified to give an illustration and an explanation of the influence that big data has on management control. Qualitative research focuses on the socially constructed nature of reality, in order to rule on patterns and processes which underlie this phenomenon, and stresses the situational constraints that may constitute the research (Bleijenbergh, 2013; Denzin & Lincoln, 2011). The goal of qualitative research is not to adopt general laws, but to investigate different effects. However, as a result generalizability of qualitative studies is lower (Abernethy, Chua, Luckett, & Selto, 1999).

Important is to choose a research strategy that makes it possible to answer the research question and objectives of the research (Saunders et al., 2009). Therefore this study is an interview study, in which the benefits and challenges of big data and the form of control in organizations are examined by means of interviews in different organizations. A qualitative approach such as interviews is suitable for studies in areas in which limited research has been done and qualitative research is suitable in studies that investigate and explain complex situations (Bleijenbergh, 2013; Boeije, 2012; Saunders et al., 2009). Therefore this approach is appropriate for this study because within existing literature the influence big data has on management control has received only minor attention, and the relation between the benefits and challenges of big data may be difficult to be examined in practice. Furthermore, also the relation between big data and management control seems to be complex in practice, because due to the benefits and challenges of big data it is difficult to determine to which extent companies are able to successfully use big data.

In this study multiple interviews are held in different organizations. This is different from interviewing in only one organization and has the advantage that it is possible to examine whether results in one organization also occur in other organizations, which increases the generalizability of the research (Bleijenbergh, 2013; Saunders et al., 2009). By comparing the different organizations with each other, it is possible to examine what similarities exist in the various organizations, but it also examines where substantial differences occur in the various organizations. This broadens the research of big data and provides more insights into the influence big data has on management control.

3.2 The organizations

Many of the existing studies are primarily focused on theorization and formulation of expectations and often focus only on the positive aspects of big data. However, these expectations are hardly examined in existing studies and for that reason there is a lack of practical understanding of big data and the influence of big data on management control. In order to expand upon existing knowledge and to gain new insights into these topics, interviews are held with five employees from five different companies. These employees are members of the management team or closely involved with data and the developments of data in their organization. In this way it is possible to achieve insights into multiple companies in one research. All the companies are located in The Netherlands.

Despite this similarity, there are still many differences between the companies. Moreover, the aim of this research is to interview a wide range of different companies, in order to get a broader view of big data and the influence big data has on management control in organizations. For that reason, there are large differences between the companies in terms of the area of industry, technological development and size. Both manufacturing firms and service firms are taken into account, some which use advanced systems such as ERP, but also some which do not use advanced systems. Furthermore, employees from small firms with less than 75 employees are interviewed, but also employees from bigger companies that have more than 450 employees are interviewed.

Furthermore, all companies are in a different stadium in the field of the use of (big) data in their organization. At the time of research, one of the organizations studied was just doing a master data project in order to make better use of data in the future. They see the possibilities data can provide and have embarked on a long project in order to achieve more strategic benefits with the aid of the ERP system. One of the studied organizations was already advanced further. They already have implemented a renewed version of their overarching ERP system in (nearly) all entities of the organization and this enables them to achieve more strategic advantages by using the system in the field of data. In contrast, two other organizations were studying the potential of big data, but came to the conclusion that it was difficult for them to exploit the potential of big data at this moment. For the first organization that was because at the moment of interviewing they were busy with the first stages of the implementation of a new ERP system, in which they were aware of strategic advantages that are possible, but which due to the complexity of the implementation is not achieved at this moment. The

organization sees this as an opportunity of the future. The second organization could not achieve the benefits of big data because according to them the investments to realize this are enormous. The last organization was at an even earlier stage. They were aware of the fact that they first need a new ERP system before they can exploit the potential of (big) data better. For that reason, they are orientating with regard to a new system because they could make only limited use of data in their current systems.

However, besides these differences, during the interviews no distinction is made between the various companies, so all companies are treated equally. The purpose of interviewing managers of different companies in different industries, with different technological developments and different sizes, is to gain more insights into big data and the impact big data has on management control. Appendix I provides an overview of the five interviewed employees and gives more information about the five companies.

3.3 Operationalization

Previous literature has shown several benefits and advantages of big data. However, in this literature the emphasis is on explaining what big data is and the benefits implementing big data can provide. As a result, the challenges of big data are often neglected. Furthermore, in-depth practical insights are missing into which way companies deal with the benefits and challenges of big data. For example, because of the challenges it is questionable if companies can fully benefit from the described benefits in literature. Therefore, the focus in this study is on gaining more insights into big data and the challenges of using big data in practice.

The data of the study is gathered by doing face-to-face interviews. Face-to-face interviews is one of the methods to perform a qualitative data collection. The goal of interviews is to obtain opinions and perceptions from the interviewees and has the advantage that it can go into detail. The more interviews are conducted, the higher the generalizability becomes (Abernethy et al., 1999). For that reason, this study contains five interviews with five different companies.

By doing interviews, three kinds of interviews are possible. These are structured, semi-structured and unstructured interviews. In this study has been chosen to use semi-structured interviews. Semi-structured interviews are chosen because using this way of interviewing can provide deeper insights into a particular subject, and this depth is lacking in existing studies on big data (Saunders et al., 2009). When using semi-structured interviews, the interviewer has a list of pre-prepared themes and questions that have to be recovered during the interview, which ensures that during the interviews it is possible to add or omit some questions when this is desired (Bleijenbergh, 2013). By pre-planning some themes and questions, the researcher prevents that certain aspects are not captured or underexposed during the interviews. By adding sub-questions during the interviews, deeper insights into certain aspects are obtained when this is possible. By using pre-prepared topics, a valid picture of the situation can be secured because all relevant aspects of the study are included in these topics.

This study makes use of the deductive approach in the operationalization and analysis of the research. In this approach, research is based on clear theoretical expectations which are determined prior to the data collection. This was the case in chapter 2. Based on this literature, a coding scheme has been drawn up, which is leading in the research (Bleijenbergh, 2013). In order to achieve this, prior to the interviews the dimensions of the research are broken down into indicators that are studied (see appendix II). These dimensions were based on topics that focused on general questions about (big) data, the form of control in organizations, the benefits of using data and the challenges of using data. On this basis, guidelines for the interviews by means of interview questions were created in appendix III. This guideline included the basis during all the interviews.

Considering that all companies studied are located in The Netherlands and the spoken language in all these companies is Dutch, all interviews were held in Dutch language. In this way it is prevented that biases arise because employees are not able to carry forward exactly what they are thinking, or that the interviewer interprets the essence of the message incorrectly. Therefore the interviews are transcribed in Dutch, with the disadvantage that therefore all results have to be translated into English. As a result, situations arise in which the essence of the results sometimes may be distorted. Furthermore, all interviews are, with permission of the interviewee, recorded in order to let the interviewer focus on the interview and the data that is gathered in the interview. This allows the interviewer to give less consideration to writing notes during the interview (Boeije, 2012).

3.4 Data analysis

After the data has been gathered, the records of interviews are typed out and transcribed in order to be able to analyze the data. Analyzing is the unraveling of data on a particular topic in several categories, the naming of these categories through terms, and applying and examining various relations between these concepts, focused on the problem of the research (Boeije, 2012).

Transcribing the data has been carried out in order to get a clearer view of the data that has been collected. Transcribing ensures that not only the content, but also the social interaction during the interviews is carefully recorded. This improves the analyze capabilities of the research (Bleijenbergh, 2013). Furthermore, in the operationalization the interview questions are divided into four dimensions, which are subdivided into various indicators (Bleijenbergh, 2013). The distinction in these four dimensions ensures that the data that has been investigated is disaggregated into separately distinguishable units. After this, relations are sought within and between these dimensions (Saunders et al., 2009). In the first dimension, general questions are drawn because it is important to obtain more background information about the use of data within the organization and the thoughts about it. In the second dimension the benefits of the use of data are examined and this dimension is also considering what disadvantages the interviewee experiences by means of the use of (big) data in the organization. Furthermore in this dimension the future expectations about the use of data in the organization are examined. In the dimension based on challenges, the focus is on assessing the challenges that

according to the literature may arise by using data in practice. This dimension is divided into technological and managerial challenges. In the last dimension based on enabling and coercive control, the focus is on figuring out what type of control exists in the organizations.

3.5 Reliability and validity

Quality is important in studies; this is divided into reliability and validity issues. Reliability focuses on the question whether other researchers would disclose the same kind of information with this research, and it is therefore aimed at replicability of the findings in the study (Easterby-Smith, Thorpe, & Jackson, 2008). At first, reliability is reduced because the interviews reflect a reality at the time the data was collected and during the time this situation may change. Furthermore, asking open questions in the interviews reduces reliability when the interviewee has a wrong interpretation of the question.

However, the reliability is also affected in positive ways. At first, this occurs due to the fact that five different companies were studied. The result of this is that results are less based on coincidence in one organization. Secondly, reliability is increased because of anonymity of the interviewee. Before the start of the interviews, the interviewees are informed that all results of the study are processed anonymously. This is done in order to create a climate of trust between the interviewer and the interviewees. For that reason, names of companies, names of interviewees or other information that may reveal some anonymity is not mentioned. Thirdly, reliability is increased by means of operationalization with dimensions and indicators, because in this way theory is well-connected to practice.

Validity focuses on the question whether the interviewer can get access to the knowledge and experience of the interviewee. In this, it is important that the interviewer actually measures or explains what he wants to measure or explain (Boeije, 2012). It is important that the interviewer gets this knowledge about and experience of the interviewee clear by means of what the interviewee says in the interview (Saunders et al., 2009). At first, validity is increased because questions have been set up in advance, resulting in less variation in questions. Secondly, validity is positively affected by using open questions. Despite that this reduces the reliability, validity is positively affected because in this way the interviewee is not limited in its answers which for example would be the case with closed questions. Thirdly, validity is increased because the questionnaire is mailed to the interviewee before the interview. In this way, the interviewee gets more time to think about the relevant topics.

4. Results

This chapter shows the results that have emerged from the interviews with five employees of five different companies. In the first section, the general trends that originated in terms of data in companies are discussed. After that, the second section focuses on the possible improvements that companies have observed from the trends in data, while the third section focuses on the issues that companies face during developments in data. Lastly, section four provides an explanation for the visible changes that occur in management control.

4.1 Trends in data

The interviews with the five different companies suggest that in all companies employees and managers make increasingly use of data. Furthermore, the interviews show that all interviewed companies have been engaged in developments in the field of data. To achieve this, all companies have started with different projects to give data a more important role within the organization. Company A has observed that their current ERP system actually fails in the processing of data and information because the design of the system is insufficient for this. For that reason they are orientating with regard to a new ERP system, so that more possibilities may arise to store data in the system, which allows them to obtain more data and information from the system in the future. Also company B has seen that the current structure of their system was inadequate. Because they have observed that their system offers more possibilities for this, they have decided to renovate their current system. At this moment they are updating and cleaning up the master data in their organization, later in the project they are also going to optimize (the design of) the processes in the organization. This for the purpose to ensure that data becomes more uniform and that it becomes better to combine and in this way data is becoming increasingly important within the organization. Within company C, an overarching global ERP system was lacking. However, the organization saw the need for such a system, because they wanted to capture more data for the whole organization. For that reason the organization started with the rollout of a global ERP system for the entire organization one year ago. Furthermore, they are also simultaneously implementing CRM across the entire organization. All this together will take several years, but it means the organization is actively engaged and is heavily investing in data possibilities. Also Company D has been able to implement new CRM systems in their organization. Furthermore, they are working towards one central database for the organization, which brings together and combines data from different systems that the organization has used in the past. This serves as a base to grow in the use of more (big) data in the future. Finally, also company E has observed that their old ERP system was not sufficient for the use of more data. Therefore, they have performed a complete re-implementation of their system in which they connect all entities of the organization into one system. Now this is as good as realized for the whole organization, they are going a step further and are working on making Business Intelligence and data analyzes suitable for

their organization. This should provide one way of working for the whole organization in the area of data and data analysis.

Reasons to engage in data projects

For most of the organizations, these projects signify large and drastic changes within the organization. However, the organizations have seen the need for these changes, because they have noticed that data is becoming increasingly important and that more and more data becomes available. According to them, it is a progression of developments and that means that there are changes observed in the market and organizations simply have to respond to this. For example, they have seen that competitors make increasingly use of data and that causes the organization to have no choice. When organizations are waiting too long, this can cause serious problems for the organization:

“You have no other option. It is becoming increasingly important. There comes more and more data available and also competitors are going to use data. So if you do not go along with the latest trends in the area of data, then you are lagging behind in no time.” (Company E, 03-06-2016).

The consequences for organizations can be significant when they do not go along with these latest developments. This because there are always parties that emerge as a reaction on the opportunities that arise in the markets. This may have considerable effects for organizations and therefore organizations are forced to go along with the latest developments:

“I think they all have no choice. Because at a certain point there always will emerge and will be parties in the market who see these niches and anticipate to this, caused that your market share otherwise will be snatched.” (Company D, 31-05-2016).

Other trends in recent years

Despite the recent trend of the increased importance and use of data in organizations, there have long been other trends in organizations. Several years ago organizations experienced a lot of pragmatic work: they produce, and the systems were only needed to support. Nowadays this is completely reversed and the systems of the organization are the basis of the organization and production is in response to the data and information coming from the system. This has led to various visible changes within organizations. For example this means organizations have changed from using computer printout lists in support of production, towards a digital environment which has become the basis of operations in the organization. In the past, this created a lot of searching in the available information leading to evaluations that have to be done manually, something that was enormously time-consuming because also the collection of data and tying together this information had to be done by hand. Through the developments that have already taken place this has been improved in many companies. This is also because employees and managers within the organization are better informed about the possibilities what is available and what they can do with it:

“I think that everybody knows that data is important. But I think that there now is increasing

clarity in all departments of the organization about what is available and what we can do with it. And I think that it has not always been clear what always was available, where it came from and what data exactly is.” (Company E, 03-06-2016).

This growing awareness in organizations about what is available and what is possible with data ensures that organizations gain insights into the great opportunities for them in the use of data. These possible improvements are discussed in the following section.

However, it should be realized that this is not just easy and quickly achieved. In most organizations, the projects have a long duration of several years. Furthermore, it is important to note that data is no information yet. This means that data alone in the first instance is still worth nothing and that processing of this data is necessary to be able to achieve a particular purpose. Important in this is that the companies indicate that data should be no target in itself, but it is only a mean to achieve the goals:

“And so what you see is that there is a huge trend towards: ‘We have lots of data, but data is no information yet.’ So how can we use that data to gain insights into the business, so that we know where we need to focus on?” (Company E, 03-06-2016).

“Because data is, by definition, no information yet. Initially it is still nothing. [...] Processing of it is necessary in order to achieve a particular goal. So big data has no purpose in itself, but it is a mean.” (Company D, 31-05-2016).

4.2 Possible improvements

Despite the fact that all companies are in a different stadium in terms of possibilities and capabilities of data usage, all companies recognize that several advantages may arise within the organization by the use of data. Except that they know that the developments are needed in order not to lag behind on competitors, they think that the benefits and future possibilities can be infinitely. These possible improvements are related to benefits for decision making in operations, the processes of the organization, and better possibilities to align with customer needs. These are discussed below.

Improvements in decision making

The interviews with the five different companies make clear that companies see possible improvements for the decision making within the organization. One of the benefits the companies foresee is more uniformity, for example in reports. This should lead to higher reliability of reports:

“What helps of course, is that the reports are uniform and that they are comparable to earlier reports, so without the need for a lot of hacking, doctoring and other things that have to be done. [In this way,] the reports across departments become more reliable.” (Company B, 26-05-2016).

Apart from making these reports, also the collecting of data can be faster by means of more advanced data systems. As a result of these systems, employees no longer need to collect all data manually and they no longer have to put this data into formats by hand. These actions can be

performed with one button press by the system. At first, this can increase reliability because manual work is more vulnerable to mistakes and errors. Secondly, it also provides the advantage that these activities can be carried out faster by employees because this gives them less work. The advantage this caused is that employees have more time available for the next phase of data, namely the analysis of data. Previously situations arose in which there was often no time for this because collecting and processing of data to reports took so much time that the organization did nothing with the insights the data provided. Now that information is available with one push, it is possible to respond faster to the insights provided by the data and employees also have more time available for this:

“And soon it is the other way around. If you have information with one push on a button, giving you just the time for ‘what are we actually going to do with these insights?’” (Company E, 03-06-2016).

“Two and a half to three hours of work a day, with ease, that I am working on analyzing data. At the moment we can simply extract that [data] from Business Intelligence systems, then that is going to save us a huge amount of time. Then we can go much more rapidly to sources, we can draw conclusions much quicker and can also take actions on it. We can simply go more quickly to a higher level within our entire company, I think.” (Company A, 23-05-2016).

Moreover, the use of data can also bring benefits to a more operational level in the organization based on the daily work and daily decisions. The advantage of greater availability of data is that executives can faster draw conclusions. In this way, for example, it is possible to undertake faster collective and preventive actions within departments. When data is more quickly available and executives get to see this information in real time, they can control this faster and can take actions more quickly:

“At the time I just see every day on my screen what the reasons are why my department is not performing well, then I can take actions more quickly. At this moment I am running behind the facts. I see one day later, when the runs are available in the system, that a department has not performed properly. Actually, then I am already too late and then I think ‘okay, what could have happened’, instead of being preventive and the system indicates that something is threatening to go wrong.” (Company A, 23-05-2016).

Improvements in processes

Besides improvements in decision making, companies also see possible improvements for processes of the organization. At first, data can improve communication between various entities of the organization. Formerly many organizations had separate systems for each different entity. As a result, the systems of the different entities of the organization were not connected to each other, which caused that entities totally had no understanding of the operations in other entities. From the interviews becomes clear that by using more data and better systems, the communication between these entities improves. In this way it is no longer necessary to contact other entities for example to know what their

inventory is and no mail traffic is necessary between the entities. At the moment this communication improves through better availability of data, the organization can act more quickly on data from other entities.

Besides better communication between entities, also better communication within the organization and better communication with customers and suppliers is possible. This happens when more uniformity occurs in the communication with external parties. Where previously a lot of communication went through texts, by means of data it is possible to establish better communication:

“[Previously, we worked] with order texts, supplier texts as: ‘Beware, delivery address has changed!’ Instead of arrange this nicely with partner roles.” (Company B, 26-05-2016).

By arranging this in a different way with data, it becomes possible to make the supplier aware of the fact that something has changed, for example by means of standard codes in the communication. That this can provide benefits is outlined by the project manager of company B:

“You do not need to call after. Nowadays about 80% is being called back by phone or is checked by employees. I expect that this is going to be about 20% in the future.” (Company B, 26-05-2016).

Secondly, besides better communication, also more standardization of processes can arise by making use of data. By using big data it becomes possible to analyze data more accurately, but data analyses mainly become more intelligent. This ensures that data can be better funneled and analyzed, which enables the system to analyze a large part of the data by itself. This means that the system can automatically come up with certain solution-variants for standard situations. In this way the system can ensure that the arrangement of processes can be more uniform, in which intervention only is necessary for special situations. As a result of this, also the settlement of processes is simplified and unified:

“That analysis of data, as that can be done more precisely and primarily more intelligent, then at the end of the process you have your data increasingly funneled, making it possible that an X-percentage already has been analyzed and also has been solved by the systems themselves with solution variants. [...] This ensures that and the end you only have the special offers, the special products, left.” (Company D, 31-05-2016).

Lastly, by the use of more data also more comparison opportunities arise. In this way it is possible to compare the way one unit is performing in contrast to another unit, thus giving the opportunity to learn from each other:

“In any case, in this way you can compare how one unit is performing relative to another and you can learn from each other. So by comparing the data you see differences. And you can investigate those differences.” (Company C, 26-05-2016).

Improvements towards customers

Lastly, the use of data can also lead to benefits for better opportunities towards customers. The aim of

this is to obtain more understanding about what is going on in a customer's mind. By means of for example CRM systems it is possible to gain insights into who are strategic customers. In this way it becomes clear where most of the value-advantages related to customers for the organization are, but in this way it is also possible keep customers more satisfied and preserve them for the company. Through increased use of data, there are interesting opportunities possible for organizations in the services towards the market. An example of this is anticipating based on customer, sales or purchasing behavior, to match better with the needs of the market:

“If you would turn it around and ask: ‘Customer, what are you searching for?’ And if the customer says: ‘I am searching for this and this...’ Then that outcome, that customer requirement, should be able to be bent, so that the company says: ‘We have consulted our database; you were searching for this, and based on your behavior (or whatever) we find that and to what extent connects this with what you are really looking for? Is this correct?’” (Company D, 31-05-2016).

The example above shows how data systems are able to support to prejudge on customer needs in the future. Moreover, this can also be translated into internal processes for organizations. By using more data and the bigger opportunities it provides to organizations, for example it would be possible for organizations to gain more insights into the processes in advance. This gives the possibility to steer earlier in processes through which processes can be improved more easily:

“At the moment that we have possibilities to prejudge, if we really can go to take the lead and know in advance for example through a message in the system like ‘watch out, here it is not going as planned’, [...] then we can already see in advance what can be done in a different way and in this way we can improve our processes much easier.” (Company A, 23-05-2016).

4.3 Issues in data usage

Besides all possible improvements the interviewees have described, companies also face several issues to become a data enabled organization. It appears that (a combination of) these issues can lead to difficulties when organizations want to give data a more important role within the organization. During the interviews was found that these issues roughly can be divided into issues based on the (ERP) systems of the organizations, issues based on managerial level and issues based on other disadvantages of features of (big) data.

4.3.1 Systems of the organization

Firstly, during the interviews with the five different companies it becomes apparent that the majority of companies have realized that their (ERP) system is not sufficient enough to fully achieve the advantages of (big) data. However, the interviews show that it is not easy to simply attain these advantages. This goes back to the implementation of the (ERP) system as this has taken place in the past. As evidenced by the following quote from company B, at the moment of implementation only existing processes are copied and integrated into the system:

“In 2005, quite a lot was stuck together to resemble its predecessor. That instead of taking into account the forces of SAP.” (Company B, 26-05-2016).

For that reason, a disadvantage is that it is not easy to achieve strategic advantages with the ERP system. In company B they have realized this and they now have a project to improve this. However, this is a big project that will take several years, in which master data have to be cleaned up first, after which subsequently processes can be optimized. Only in this way it is possible to support the use of data by the systems of the organization.

Also company E has realized that they have to pay attention to their systems before they could achieve more benefits from data. For that reason they have opted for a re-implementation of their ERP system. Now this is completed, it appears that they can indeed explore more options in the use of data, for example the potential for Business Intelligence:

“Within the organization we are busy with one SAP implementation. And now we have almost completed this, we can of course also build Business Intelligence tools so that they apply to everyone, so that we can really make the investment in Business Intelligence and data analysis. [...] Nowadays there are so many entities already shifted to the new SAP system so that now more and more focus is put on that Business Intelligence project.” (Company E, 03-06-2016).

However, that it is not easy to attain this level with the ERP system is proved by other interviewed organizations. For example company A, which makes use of a relatively old and simple system, is still far away from that level. They still work with a relatively old system that only limited supports the use of today’s opportunities of data. Partly for this reason they are currently orientating with regard to a new ERP system that has to support them in these opportunities:

“That is actually the reason why we are engaged in negotiations for a new system since a while, because we have seen that the possibility to process information in our system is too limited.” (Company A, 23-05-2016).

However, it will take several years before they attain the level of organization E. This becomes evident from the ERP project of company C, which is one step ahead of company A. Company C has already begun with a project in order to achieve the implementation of an ERP system, and this project suggest that it is a long process that is estimated to take several years.

Secondly, it becomes clear that software of the systems appears to be an issue. For instance, the storage capacities of the data systems of the organizations may cause problems:

“Due to the vast amount of information that our system has to process, we just have to wait until the system is ready. And that can of course be a very big disadvantage. At the moment that we want to process more and more information in the system, then at a certain point of time the system cannot handle this anymore.” (Company A, 23-05-2016).

Therefore this means that the processing power of the system becomes a leading element in organizations. The possibilities of data can be enormous, but at the moment that the system has reached its maximum capacity, then the organization has reached its top. This ensures that the

organization also has to take into account the maximum capacity in the design of its information system.

Thirdly, also security and privacy issues may emerge. A problem in this privacy of data occurs when a company collects specific data for example from customers. At the time an organization stores this customer data and uses it again later, the question arises at which time violation of privacy occurs. It is important that organizations on the one hand commercialize this information for them in the right way, while on the other hand respect the privacy rights of their customers. Furthermore, the interviews reveal that it is relatively simple in most organizations to get access to the systems in which data is located. This relatively simple access is possible because in most of the organizations only a login name and a password is required to log in to the relevant systems. At the moment an employee knows someone else's login and password, he/she has immediate access to a lot of, possibly sensitive, information. Additionally, it also appeared that in some of the organizations authorizations for various functions in the system were not well appointed. Reason why they are not well appointed in all organizations is because in practice it has been difficult to arrange these authorizations well, with the consequence that it is not always clear who needs access to exactly what rights. The result is that certain employees should not be able to have access to certain data from their job profile, but still have access because of wrong design.

Fourthly, it is also important that employees have access to valid and reliable information. This means that it must be properly checked where data is derived from. Otherwise situations may arise in which employees make use of data that simply is not correct and not valid:

“The disadvantage of working with data is that you need to know for sure that it is good. Because if you do not know where it comes from and you do not know if the sources where you get it from are good, then there is the risk that you are going to make decisions based on inaccurate data. And that is a big risk.” (Company E, 03-06-2016).

Fifthly, it appears that many organizations make use of many separate systems from the past. This means that organizations may have a lot of information available, but it appears to be difficult to combine this data from the old systems the organization has. To be able to solve this problem, companies have to make certain conversions to ensure that they can connect these separate systems into a comprehensive database. However, that it is difficult to combine this data is evidenced by the following quote:

“They have a lot of information, but it is still very difficult to combine the data from the old, traditional systems. [However, the organization] has noticed that the traditional separate systems are no longer sufficient in the large market developments to collect qualitative information and to use this information in the organization.” (Company D, 31-05-2016).

This is in line with the last system issue, which is based on separate systems for processing and analyzing of data. In many organizations, the capabilities of the ERP systems to retrieve data are well equipped. However, the actual processing and analyzing of this data by means of the ERP

systems is less straightforward. Despite a comprehensive ERP system, in most of the organizations many of the analyses of data are processed external from the ERP system through self-developed sheets such as MS Excel. The reason why organizations use separate systems for the analysis of data is because the tools that the ERP system provide, do not offer enough flexibility in order to adapt to the organization so that employees can work well with it.

Moreover, often real time information is lacking in tools such as Business Intelligence. Such professional systems for data analysis often update their information only once a day, causes the data is already outdated during the next day, because there have already been new modifications in operations:

“It just did not work. It was too slow. You always run one day behind, because the system is updating at night. I cannot do anything with information that is one day old. That is just as bad as 10 years old. That does not make me any wiser. I need to know it now.” (Company B, 26-05-2016).

The consequence of this is that employees need much time for processing and analyzing data because they have to work with multiple, separate systems. However, this is also highly error prone because a lot of manual work is required. Moreover, separate tools such as MS Excel do not have enough capabilities to carry out in-depth analyses that are desirable for big data. For that reason, many organizations do not have analytical systems that are intelligent enough to meet the requirements for (big) data. For example by means of these systems it is not possible to make analyzes based on complex calculations such as algorithms:

“I think the software packages are not intelligent enough to make analyzes from algorithms by itself, which then at a certain point can give certain direction to that big data, to those outcomes.” (Company D, 31-05-2016).

4.3.2 Managerial issues

From the interviews it appears that stimulation from the management is important in order to support the achievement of the advantages that (big) data can provide. It turns out that in company C, which is implementing an ERP system, the rollout of the project is on schedule. According to the interviewee in company C, this is due to the commitment of the top of the organization and the urgency which they have given to this project. This policy is also conveyed in the vision of the organization, which has an explicit focus on the ERP project. Also company D has realized the importance of commitment of the top:

“Yes. Yes it is definitely supported. [...] Because they now recognize that the improvements in automation are necessary to continue, to survive on the long term. [...] They realize that if these improvements are not made in the short term, the organization really misses opportunities and possibilities.” (Company D, 31-05-2016).

However, from the interview with company A becomes clear that this support is not always obvious. This organization has a clear dichotomy in their management about the ideas of the use of

data. The interviewee in company A is aware that this could cause more problems in the rollout of their future, new ERP system:

“On one hand management says: ‘Yeah this is going to bring us a lot, this is going to bring us a lot of money.’ But on the other side there are some who say: ‘Just focus on our core business, the producing of products, that is the most important thing and we do not have to know in detail what is happening in the organization when it goes well.’ [...] So there is some friction between opinions in the management. You obviously feel that this still can give resistance to the actually rolling out of the new system.” (Company A, 23-05-2016).

Also in company B management is not fully convinced. The feeling within this organization is that management is holding back the project, they have the feeling that management does not want to hear the necessity to develop because it does not concern them. As evidenced by the above quote, lack of commitment from the management can cause problems in the execution of project. This also means that management poorly supports the use of more data in some organizations. However, all interviewees indicate that commitment from the top is desirable to be able to exploit more opportunities of data.

Except from a dichotomy in management, there also appears to be a dichotomy in the thoughts of employees about the use of (more) data. This has two causes. At first, there appears to be a significant difference between older employees and relative young employees in organizations. It seems easier to make young employees skilled to deal with the latest developments than the older employees:

“The older employees, who for instance already work 20-30 years within the organization, have the thought: ‘Let me do my work, but I do not want to go thinking too much into systems, because I know much better how to do it by myself.’ I do see a real dichotomy in this.” (Company A, 23-05-2016).

This happens because the older generation of employees has adopted a certain way of thinking, doing and acting from the past. In practice it appears to be difficult to get these employees fully proficient in the latest trends due to their past experience. Due to this, generation gaps appear within organizations.

Second, this difference also arises between different departments of the organization. This is because employees in one department, for example finance, are more skilled to deal with the data than employees in another department. As a result, differences between various departments arise which are often remains difficult to bridge. For that reason, in practice making (more) use of data is not always easy to accomplish for the entire organization, because not all employees have affinity for working with data:

“Finance of course often obviously knows very well what they need, where to get it from, and how they should gain insights from it. But if you give only numbers to someone in sales, then that person drops out: ‘Yes whatever, but I am not skilled with numbers so forget about it.’” (Company E,

03-06-2016).

Moreover, making more use of systems and data appears to be a real business change. Most of the organizations have realized that it is therefore necessary to provide training to employees about the new systems and methods. By means of these training, organizations try to create more support for data and data systems by employees:

“Every time when serious changes occur in those systems, [...] [then you see] that they spend effort to give training for several times. Just to attain more support for those systems.” (Company D, 31-05-2016).

Finally, the interviews suggest that intuition still has a major role in operations. However, there are drawbacks in utilizing intuition. One of the interviewees argues that the use of intuition can make it difficult to oversee everything. Furthermore, decisions made on intuition have the disadvantage that they are partly based on emotions. This means that these decisions may not always be made on a rational level. In recent years, organizations have seen that the level of intuition has already gone down. This has arisen because employees did a lot of standard work by hand in the past, which nowadays already is being implemented by the system. This has the consequence that intuition in this standard work is already reduced. Despite this, the companies have realized that the degree of intuition in their organization should become even lower:

“More routine means fewer errors and less work. That means you can handle more work. And that is where we need to go to [in the future].” (Company B, 26-05-2016).

Although this, according to the companies interviewed, some intuition is always needed. At first, this is needed because current systems sometimes have limitations, which can only be solved by using intuition. Company A gives an example of this, in which the system performs the scheduling based on backward-scheduling. This backward-scheduling causes gaps in the schedule at the moment that there are fewer orders. Manually adjusting this based on own judgement then is required to distribute the capacity of the production department equally. Furthermore, the organizations indicate that it is important that employees do not lose feeling for the business, something that can happen by completely trusting data and it will always be necessary to assess whether outcomes are true. Moreover, the interviewees think that people will always keep searching for confirmation of how they think about something:

“You can make a good analysis of any result, but often you see in the final conclusion: ‘What do you think?’ Where people still look for confirmation of how other people think about their opinion.” (Company D, 31-05-2016).

Furthermore, own experience and insights are always necessary to interpret data from the past, but also to decide if that data is also applicable in the future:

“Of course I try to make use of data, but also experience plays a role in the results you see from the data, in order to interpret these data. You will do this also from a bit of personal experience. You see results of data, but you also try to look at the past and also to the future, if the information you

get is also usable one-on-one in the future.” (Company D, 31-05-2016).

Another advantage of intuition is that it is easier to respond to unexpected, abrupt and inexplicable situations. According to the interviewees, this is important because at the moment there is no intuition possible, the organization is too rigid to deal with such issues. Therefore, the complete exclusion of intuition in the organization is not possible.

4.3.3 Other disadvantages

Furthermore, the interviews suggest that companies have some other issues in making use of data. At first, organizations are aware of the fact that they have to be careful that work does not become too complex by means of using more data. Through data, a large amount of information becomes available, but it is too much work to process all that information:

“It is definitely interesting to be able to do all kinds of analysis from your data, but I think that we must guard against the fact that we are going to put too much information into the system so that we can no longer distinguish major and minor issues. You have to know where the boundary is. And we are still exploring in this, you know. We can start analyzing all information, but what is at any given time important and where should you focus on?” (Company A, 23-05-2016).

Therefore organizations need to properly figure out what they want to analyze and what they do not want to analyze, because it takes a lot of time to make things visible in a readable format. For example, some things are simply not interesting enough to analyze:

“For instance, someone needs to go more often to the toilet. I would not go so far to incorporate all that kind of things in the ERP system. There must be a line drawn somewhere between what is relevant waste [and what not]. [...] And yes those little things... It is very difficult to determine how far we go.” (Company A, 23-05-2016).

Lastly, although companies sometimes know what they want in the area of data, they also realize that the costs of investments for this could be huge for the organization. Because this could hinder organizations, it is not always possible to exploit all possible opportunities of data:

“To a large extent they know where they like to go to with it, but they know they can hardly achieve this because of cost considerations, because it required huge investments.” (Company D, 31-05-2016).

4.4 Visible changes in management control

The results of this study suggest that companies notice the importance of data. Therefore the companies have launched various projects to be able to exploit more possibilities of using data. The interviews suggest that in the field of control, during these projects organizations are shifting from the use of a coercive form of control to a more enabling form of control. This means that organizations attach more importance to knowledge of employees about operations, processes and systems. Moreover, it can be seen in many organizations that employees increasingly get freedoms in their

operations. Furthermore, insights and ideas of employees are increasingly appreciated by organizations in these projects, which have to ensure that the organization gets more opportunities to reap the benefits of using more data.

At first, the interviews reveal that organizations are convinced that it becomes increasingly important that employees understand the systems and processes of the organization. This is related to internal transparency, the extent to which employees have knowledge of the processes and systems they work with, as well as to global transparency, the extent to which employees know how their work is related to the activities, processes and goals of the organization as a whole. For that reason, during the data projects they pay attention to this in different ways. Company D for example has developed a tool that provides insights into the processes of the organization. Moreover, they have seen that employees have recently gained more insights into the goals of the organization:

“It is hard to say whether every employee can oversee the coherence of the goals of the organization. I think previously not, especially when they are really directed at those processes, then they acted on those processes, and if the process was handled properly, then it was considered okay. Then it was in accordance with the rules. And we are seeing a move from rules-based to principle-based. And in this more entrepreneurship is expected.” (Company D, 31-05-2016).

To achieve this entrepreneurship, more knowledge about the integral processes and goals of the organization is needed. Also company E has made the processes and systems of the organization clear, which makes it visible which systems have an interface with each other and how the processes appear within it. Therefore, employees understand how the primary processes takes place in the organization. However, also other organizations have seen the importance of insights into processes for employees, but did not fully realize this yet. Therefore, in these companies the defining of processes is included as a focus of attention in the projects. For example within company B, employees have sufficient understanding of the processes and activities within the department, but they have only limited knowledge about how processes pass between different departments. The organization has already recognized this gap in knowledge, and in a subsequent stage of the project they do take this into consideration to raise awareness among employees and managers. However, that this is not easy to achieve for all organizations is evidenced by the following quote:

“The defining of processes is a real challenge for people, for the employees here. The employees do not have the habit of thinking in processes. And then the step to define a process has turned out to be a real challenge. I think that after the introduction of ERP that will be better, but at this moment this is quite a challenge.” (Company C, 26-05-2016).

In order to create more awareness of employees in the processes and systems, company C provides various trainings to employees to make them aware of the processes and systems of the organization. Also company A provides training to employees, for the purpose of a refresher course of the ERP system because many employees lack the basic information about the system. Furthermore, in

recent years several developments have taken place in the system, with the consequence that employees are not always up to date:

“We are doing a refresher course of the ERP system for a couple of months with the entire company, because we see a lot of people that still lack basic information. In addition, quite a lot of variables within our company have changed. [...] So we are busy with a course, because we saw that this knowledge was inadequate by many employees.” (Company A, 23-05-2016).

Besides internal and global transparency, also flexibility appears to be an important aspect during the data projects in the organizations. The interviews reveal that flexibility has only played a limited role in the past. In most of the companies was limited freedom to deviate from standard steps/procedures as they are drawn in the past. However, during the projects this has changed or is going to change. For example, in organization D it is visible that they previously had a rules-based approach in operations, while during the projects they are making a move towards more principle-based entrepreneurship in which employees get more space in their operations:

“You see that the organization is again creating mitigating circumstances. [...] What the organization is focusing on, is that employees substantiate from a kind of entrepreneurship why they want to do something on such a manner. So in this way it creates space to evolve entrepreneurship yourself. So yes, you can make certain decisions at its discretion, as long as you can decent justify these decisions.” (Company D, 31-05-2016).

In organization A, employees have the possibilities to deviate from steps and procedures. They are allowed to do this if they have the feeling that this is necessary. In practice this is seldom done due to the fact that when an employee makes a decision outside the system, the employee can be held accountable to this when it turns out that this was not the best decision. As a result, employees are mainly thinking about themselves and blindly follow the system because they are afraid that they make an error themselves:

“There is very often said to us, when we decide something and it goes wrong, then you can be held accountable yourself. And then people think: ‘An error made by the system does not matter to me, at least it was not my fault.’” (Company A, 23-05-2016).

However, this organization has not yet started with the implementation of the new ERP system. The interviewee expects that by means of the project, employees get more insights into underlying information in the organization, which ensures that they can make more decisions based on their own discretion, as they get a better understanding of the underlying information:

“Especially because you have more background information you also know more about what happens and you can make decisions based on something you understand the idea behind. I think that in such a way, it becomes easier to follow the system and perhaps it also becomes easier to make your own decisions because you know then why you make these decisions.” Company A, 23-05-2016).

Lastly, the results of the study suggest that during the several data projects the organizations attach greater importance to the repair possibilities of procedures, processes and systems. To achieve

this, company D has developed a system in which employees can report failures or ideas. Also company B has involved their employees more. In this organization, employees can report for example comments and possible improvements to key-users in the organization. In the past, complaints of employees were often not picked up because key-users had no time for this. However, during the project these key-users are freed up from their daily work, so that they have time to investigate repair-ideas from other employees. This freeing up of key-users has been done because the organization has realized that the ideas of employees can serve as valuable input to the project. Also company E has realized the importance of the ideas of employees. Despite the fact that the re-implementation of their system has already taken place, the organization will have an evaluation moment about the system with the employees several months after the re-implementation, in order to define and make improvements.

5. Conclusion

5.1 Conclusion and discussion

The aim of this study was to obtain more insights into the influences big data has on management control by means of a qualitative research. This research is adding to existing literature because previously most studies on big data are primarily focused on theorization and formulation of expectations. Furthermore, existing literature often focuses only on the positive aspects of big data and does not take into account the challenges to become a big data enabled organization. Additionally, within existing literature the influence of big data on management control has received only minor attention.

The main question formulated for this study was:

“What is the influence of big data and analytics on management control systems?”

From the results of this study can be concluded that the expected impact of big data and analytics on management control is not attained in the different organizations. This is the result of the fact that the interviewed organizations in this study are not able to implement big data in their organization yet. All five organizations have realized that they have to go along with the developments in the area of (big) data because it is a progressive development in the market. They have notice that not going along with these developments could lead to adverse effects for the organization. Therefore all interviewed organizations are engaged in various data projects in order to support the potential of data better, with the result that data gets a more prominent role in the organizations. However, taking advantage of the several benefits, which are also related to accounting and control, still seems to be limited because of several challenges that arise during the projects.

The results of this study provide new insights into the area of possibilities of big data and changes in management control. The results from this study differ from expectations present in existing literature, because in contrast to existing literature the emphasis in this study has been on the challenges of big data. Moreover, a lot of existing literature focuses on theorization and formulation of expectations, whereas in this study the challenges of big data and the influence of big data on management control are examined in practice by means of interviews that go more in depth.

All interviewed organizations recognize that several advantages may arise within the organization by the use of data. In line with the expectations present in other studies, these improvements are focused on improvements in decision making, improvements in processes and improvements towards customers. Despite this, organizations cannot take full advantage of big data at this moment. This is

mainly derived from the fact that these organizations are in a preliminary stage of the use of big data and the fact that various challenges occur in the data projects within the organizations. At first, the interviews show that in many organizations the systems of the organization were not sufficient to support the use of more data. The organizations have realized this and have already started with several data projects to improve this: one organization is implementing a new ERP system on a technical base and one organization is renovating their current system by updating and cleaning up the master data. Furthermore, another organization is linking together systems of the organization, but also still faces several challenges, and the fourth organization has successfully re-implemented their system, but is in a too early stage to see strategic effects. The last organization is at an earlier stage and is orientating with regard to a new ERP system, but recognizes the advantages a new system can provide.

However, both literature in the field of ERP systems and literature in the field of big data pay limited attention to the fact that systems of organizations are often unable to directly achieve the strategic benefits big data can provide. This study shows that systems are a major challenge for organizations, because in many situations often major projects are first required before the system is suitable to achieve strategic benefits. These projects are very large and based on the long-term, which makes it impossible for organizations to realize the benefits of big data in the short term.

Additionally, also technological issues in the field of data storage, security and privacy, valid and reliable information, and separate systems for the processing of data can cause that the possibility to make use of data is difficult to achieve for organizations. Besides this, from the interviews becomes clear that support from management is important during the various data projects in the organizations. Furthermore, there appears to be a dichotomy between employees, which makes it easier for young employees to deal with the latest developments than the older employees. Also differences appear between different departments. The support of management is in line with expectations present in existing literature, which states that leadership is important in the development of data and that it is important that employees develop enough skills in order to be able to deal with data. However, existing literature does not notice that it is more difficult for older employees to improve in the use of data than younger employees.

Moreover, according to existing literature, the use of data creates the need for a change to data-driven decision making. To be able to achieve this, organizations need to eliminate intuition in the decision making of employees. However, this study shows that in the opinion of the interviewees complete exclusion of intuition is not possible because of limitations in current systems, because feeling in the business is important, and because organizations have to respond to unexpected situations. For that reason the expectations present in existing literature are too short-sighted in this issue and do not take into account the above described specific situations in which intuition of employees is necessary.

Due to all the previously described issues, this study suggests that the benefits of big data and analytics are not easy to achieve yet. For that reason, this study reveals results that are only partially in line with expectations present in existing literature, because these expectations are primarily based on the positive aspects that big data can provide to organizations. However, they pay limited attention to the technological and managerial challenges that may arise in the process towards the use and possibilities of more data. This study examines these technological and managerial challenges more in detail and the various interviews show that these challenges may be major obstacles for organizations to become a data enabled organization. The organizations have launched several projects in order to attain the potential of big data and it has been found that these projects, partly due to these challenges, take quite a long period of time. For that reason, the results suggest that at the moment no changes related to big data exist in organizations. This result is in line with the hypothesis drawn in chapter 2. The consequence is that the in existing literature expected benefits of big data, which are also related to accounting and control, are not achieved in the organizations. Therefore the results of this study suggest that big data does not have a significant effect on management control, which is also in line with the hypothesis drawn in chapter 2.

Despite the fact that the results suggest that big data currently has no direct influence on management control simply because big data has not been realized in organizations yet, an indirect effect on management control is suggested to exist. This indirect effect suggest that during the data projects organizations may shift from the use of a coercive form of control to a more enabling form of control.

This shift occurs because companies are convinced that it is important that employees gain insights into the processes of the organization. This because during the data projects it becomes increasingly important to be aware of the processes within the organization: the data is expected to increasingly be driven by processes and the processes may need adjustments during the projects to make this possible. For this reason the results suggest that during the data projects it is important for organizations that employees have a good understanding of these activities, processes and goals of the organization as a whole. Furthermore, by means of using more data also the systems of the organizations, which allow employees to obtain data, are becoming increasingly important. That means it is also important that employees get better understanding of the systems of the organizations. For those two reasons, both internal and global transparency are shifting towards a more enabling form control.

Also in flexibility changes are visible. Prior to the data projects in most organizations only a limited degree of flexibility was visible, which is increasing nowadays. First of all this is due to the changing market, which supports more entrepreneurship. Secondly, flexibility improves because due to more data possibilities employees obtain more background information, so they can make better decisions based on this information. This allows that more flexibility can arise in operations because employees can add their own insights in decision making. Lastly, also the repair possibilities of

employees increase during the data project, because organizations have realized that inputs from employees can serve as valuable improvements in the projects.

By means of the various data projects in the five studied companies, increasing centralization occurs through one way of working in the area of data and data analysis. This way of working aims to achieve increased efficiency in organizations. Moreover, the results of the different interviews suggest that flexibility in operations is becoming increasingly important and is encouraged by the organizations. For that reason the results of the interviews thus suggest that organizations make use of a more enabling way of control in order to achieve both efficiency and flexibility. Furthermore, the results of the interviews suggest that the use of this more enabling form of control enables the organization to better attain the potential of this new organizational development in the area of data, which is in line with the expectations present in existing literature and the hypothesis drawn in chapter 2.

5.2 Limitations and suggestions for future research

The results of this study should be seen in the light of some limitations. At first, the results of this study are not generalizable because this research has a qualitative focus and qualitative results are not generalizable (Abernethy et al., 1999). However, this qualitative study shows that qualitative research gives deeper insights into benefits and challenges of big data and the effects big data has on management control.

Secondly, in qualitative studies some challenges may arise in the area of reliability and validity. In this study only interviews have been used as evidence. In order to assume that the results are reliable, it must be assumed that the interviewees gave honest answers to all questions. Additionally, in all five studied organizations only one interview is conducted. A disadvantage is that in this way only insights have been obtained from one perspective of the organization.

Thirdly, in this study no distinction has been made between different industries. The five investigated organizations are operating in different industries. It is possible that organizations in one industry may already be further in the developments of big data than other industries, but this study provides no insights into this because by means of one organization it is difficult to obtain an image for the entire industry. However, this factor is left out of consideration during this research.

Lastly, this study has only focused on five organizations and the five investigated organizations are chosen randomly, which could possibly lead to not achieving representativeness. For example, it is possible that results are specific for one organization in such a way that situations and/or opportunities occur which would not be found in other organizations. By means of such a qualitative study this cannot be ruled out.

One of the possibilities for future research in order to counteract this problem is to further expand upon this research by doing a survey on this subject. By investigating at this manner, it is possible to investigate to what extent organizations are able to cope with the developments in data. In

this way more insights can be gained into this subject and greater generalizability can be achieved. However, in this it is important to obtain a representative sample in order to meet representation in the research.

Future research can also focus on the limitation of not taking various industries into consideration. This can be achieved by focusing on organizations that are operating in the same industry and comparing them with other industries. However, this distinction could also be made between profit and non-profit organizations. In this study, only profit organizations (production and financial services) are taken into consideration. It is possible that within non-profit organizations also changes arise in the use of data, which may be based on other situations and/or opportunities than in profit organizations. However this is not taken into consideration in this research.

Lastly, the results of this study suggest that during data projects organizations may shift from the use of a coercive form of control to a more enabling form of control. However, it was not the main purpose of this study to explore this phenomenon in detail. Therefore, this result is only broadly examined and not further analyzed in detail in this study. For that reason future research can focus on this switch more in detail in order to find more arguments and reasons for this change in organizations. In this way more background information could be obtained about this result.

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Appendix

Appendix I. Company overview

Company	Industry	Employees*		Function
Company A	Production	± 300	± 2.300	Proces Engineer / Supervisor Assembly & Packaging
Company B	Production	± 450	± 1.300	Project manager data + Manager Purchasing & Manager Plant Equipment
Company C	Production	± 150	± 2.800	IT director
Company D	Financial services	± 125	± 27.000	Consultant Financial Logistics and Treasury
Company E	Production	± 75	± 22.000	Customer Development Finance Manager

* At interviewed location and world wide

Appendix II. Dimensions and indicators

Dimension	Indicator	Concretization	Question
General	Use of data*	To what extent within the organization	G I
	Changes*	Are there noticeable changes	G II
	Thoughts*	Advantages and disadvantages	G III
Benefits (big) data	Benefits from literature	Cost reduction/margins	B I
		Decision making	B I
		Optimization processes and products	B I
	Disadvantages*	Open question	B II
	Future benefits*	Thoughts on future use of data in the organization	B III
Challenges (big) data	Technological	IT infrastructure	CT I
		Other technological	CT I
		Privacy/ security	CT II
	Managerial	Leadership	CM I
		Skills of employees	CM II
		Decision making/culture	CM III, CM IV
	Other	Open question	O I
Enabling control / coercive control	Internal transparency	Do employees know how equipment works	C I
	Global transparency	Do employees know their operations in the bigger picture of the organization	C II
	Flexibility	Flexibility in using systems	C III
	Repair	Are employees allowed to resolve defects in processes	C IV

* No aspect of literature review

Appendix III. Interview questions

The interview questions are the guideline that has been used during the interviews. Depending on the answers given by the interviewee, the one aspect is discussed more in detail than the other aspect during an interview.

Questionnaire interviews data

General

- I. To what extent do you make use of different forms of data or information in your daily work?
 - a. What kind of data do you use in this and where does this data comes from?
- II. Have you seen changes in the use of these data/information in the past few years, and if so what has changed?
- III. How do you think about the use of data in the organization yourself?

Benefits

- I. What benefits do you see for the use of data in your operations?
 - What could the use of more data provide to your organization?
 - a. To what extent do you think that data can contribute to faster completing of operations and processes in the organization?
 - b. To what extent do you think that data can play a role in the decision making of employees?
 - c. To what extent do you think that data can play a role in improving/optimizing processes and/or products?
 - d. To what extent do you think that the use of data can contribute to better opportunities towards customers?
- II. What disadvantages do you see for the use of data in the organization?
- III. To what extent do you think that data can play a role for the organization in the future?
 - What developments are possible herein for the organizations?

Challenges

Technological

- I. To what extent are the possibilities and the use of data in the organization supported by the current systems of the organization?
 - a. When focusing on the collection of data, how do you ensure that you make use of reliable, valid information?
 - b. To what extent is rapid access to data in the organization possible?
 - c. To what extent are systems available in the organization to analyze data?
 - What role plays the ERP system in this? Are systems equipped adequately to promote the use of data?
- II. To what extent is access to this data protected/secured?

Managerial

- I. To what extent is the use of data stimulated/inhibited by management/supervisors?
 - a. What is their standpoint about the use of data?
 - b. How do they support/stimulate that employees make more use of data analyzes, make

more use of data systems etc.?

- II. To what extent are employees able to handle data?
 - a. Can they get the right information from the systems, can they deal with the large amounts of data, etc.?
 - b. Are there people in the organization that are specifically focused on the data?
- III. To what extent prevails a culture of making use of data in the organization?
 - a. How does communication of problems with data with the people who can solve these problems take place?
- IV. To what extent is intuition still important in operations?
 - a. To what extent are activities of employees (e.g. decision making) based on intuition, and what role does data play in this?
 - b. Have you seen changes in the use of intuition in operations in recent years?
 - c. What advantages/disadvantages do you see for the use of intuition in operations?

Other

- I. Do you see other challenges in making use of data in the organization?

Control

- I. To what extent do you know how the systems you work with are constructed and work, do employees have insight in the processes, and do they know what the utility of the rules is?
- II. To what extent do you know how your work is related to the activities, processes and the goals of the organization as a whole?
- III. To what extent are employees able to deviate from standard steps/procedures as they are drafted?
 - Do they have to comply with organizational rules or are they allowed to make choices based on their own understanding of their work?
- IV. To what extent are employees able to restore/improve shortcomings/practical problems in procedures by themselves? Are they free to suggest improvements?
 - At the moment someone sees flaws in procedures/systems, can they solve it by themselves, can they report it somewhere, or something like that.