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The Practical Use of BI Visualizations in Decision-making

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Authors:

Kevin Larsson
Philip Kaber

Supervisor:

Elisabeth Frisk

Abstract

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Background and problem: Due to the constantly altering business environment, firms are trying to find ways of combining information technology (IT) and decision-making in order to grasp information of the complex and dynamic business environment. As a solution to this strenuousness; business intelligence (BI) systems serve to conduct more efficient and reliable decisions by the means of visualizations. One existing gap in the research of BI concerns the socio-technical effects involved in the decision-making, in which knowledge of how BI visualizations are used and may be used in practice to support the decision-making have remained limited.
Research aim: The research aim of the study is to investigate how BI visualizations are and may be used to support strategic and operational decisions. Further, the study addresses how BI visualizations are used in various decision contexts.
Research questions: The following questions are addressed in order to achieve the research aim: (1) How are and may BI visualizations be used in strategic and operational decisions? (1a) *Which visual elements are used depending on the task and decision category?* (2) How are BI visualizations used in different decision contexts?
Research design: A qualitative study was made through semi-structured interviews. In-depth interviews with six people from the purchasing company were conducted in order to understand how BI and visualizations are and may be used. Two people from the consultancy company were interviewed in order to understand how BI and visualizations may be used.
Discussion and conclusion: The primary purpose of BI systems in the purchasing company is to support decision-making from a strategic perspective by providing the business with new insights and monitor business processes. However, the findings in this study also suggest that BI visualizations are used for operational errands. Strategic decisions are primary based on graphical representations, whereas operational decisions are based on data derived from tables and additional calculations in Excel. By creating more interactive, initiative, and humanizing visualizations, the end-users may discover new patterns of information and enhance the cognitive fit without being overwhelmed by data. BI visualizations may also be used in a larger extent to detect errors in data. The usage depends on the decision situation, in which decisions made in the fact-based contexts domains tend to be based on intuitions and BI visualizations, before responding to the business problem. This differs from the pattern-based management domains, in which actions are done prior to the analysis as there is lack of data. Further the findings indicate that several people are often involved in the decisions. The mental model of the respondents is not entirely fit in a cognitive aspect.

Keywords: Business Intelligence, BI, BI&A, BI Visualization, Decision-making, Decision Contexts, Operational and Strategic Decisions, Management Control

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Philip Kaber
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1. Introduction

In this section the theme and background of the report will be presented, accompanied by a brief overview about the problem discussion. The section then continues with a motivation to the chosen area, research aim, research questions, and limitations. Finally, the thesis disposition of the report's following structure is presented.

1.1 Problem Background

Due to the increased globalization and constantly altering business environment, firms seek to stabilize their technologies to sustain flexible as well as enhancing the efficiency and reliability of the decision-making throughout all levels of the organization (Baars & Kemper, 2008; Sharda et al., 2014). Hence, there has been an increased interest in finding ways of combining information technology (IT) and decision-making in order to grasp information of the complex and dynamic business environment organizations are operating in today (Gorry & Morton, 1989; Granlund, 2011). As a solution to this strenuousness; the methods, instruments, and technologies of business intelligence (BI) systems serve to gather, process, integrate and visualize data in order for organizations to conduct more efficient and reliable decisions (Chen et al., 2012; Lönnqvist & Pirttimäki, 2005; McAfee & Brynjolfsson, 2012; Mesaros et al., 2016; Ranjan, 2008; Sharda et al., 2014; Shatat & Udin, 2012; Yeoh & Koronios, 2009).

As such, the task of BI systems is in fact not something that has been newly introduced, but is rather rooted within classical management support (Baars & Kemper, 2008; Lönnqvist & Pirttimäki, 2005; Mesaros et al., 2016). By viewing a BI system as an information tool, it should provide decision-makers with information in order to coordinate and understand the organizational processes and operations, which should serve as assistance in the decision-making (Rouhani et al., 2016). This as decision-makers may receive better insights of their numbers and business processes, which may improve the internal and external efficiency, enhance the quality, and yield better results in their operations (Davenport et al., 2010)

As the volume, velocity, and variety of data is increasing, the need of on-demand access to information as well as sophisticated instruments to handle the data has increased (Sharda et al., 2014). Hence, one of the fundamental cornerstones of BI systems is visualizations, which may leverage the competitive advantage of a firm (Gendron et al., 2016). The BI visualizations are derived from front-end applications including spreadsheets and dashboards, which enables the decision-maker to grasp patterns in data and track business performance indicators (Chaudhuri et al., 2011). It also tends to reduce the risk of "*information overload*", meaning that the risk of information becoming a hindrance rather than support is reduced (Bettis-Outland, 2012). Accordingly, the cognitive fit theory stresses that a combination of an integrated representation of data and a user interaction approach, where the task, user and technology is sophistically combined; the business users of BI visualizations may be provided with in-depth information on demand without being overwhelmed with an excessive amount of information (Park & Basole, 2016; Pike et al., 2009; Shim et al., 2002). Hence, the benefits of visualizations in management accounting include the communication advantages and enhanced collaborative activities in organizations, but also the advantages of cognition through comprehensive representations of data (Eppler & Bresciani, 2013).

Furthermore, BI and analytics (BI&A) may be described as a separate concept of BI systems. The latter serves to gather, integrate and visualize information while BI&A reflects what the technology enables for the users (Gnatovich, 2007; Lim et al., 2013). The concept of BI&A will henceforth be applied as the combination of analytics experts and technological capabilities of BI systems to support data-driven decisions (Chaudhuri et al., 2011; Chen et al., 2012; Davenport et al., 2012).

1.2 Problem Discussion

The interest of combining information technology (IT) and decision-making has emerged as a topic in both practice and research since the early foundation of computers (Gorry & Morton, 1989; Granlund, 2011). This has resulted in an increased recognition of BI as a concept in both academia and practice over the last years (Gartner, 2012). However, Wieder and Ossimitz (2015) argue that academic research regarding the outcomes of BI systems are still regarded as infrequent even though the topic has been more recognized over the years, merely highlighting the benefits, performance, and effects on competitive advantage. This despite the fact that there is a constant technological development of BI systems in order to leverage the competitive advantages of a firm (Spruit & De Boer, 2014). Some may even argue that the timeliness and quality of BI systems do not only determine the profit or loss of a firm, but rather the survival or non-survival (Ranjan, 2008). Similarly, Chaudhuri et al. (2011) argue that BI systems are becoming more crucial for organizations as information creates competitive advantages. Thus, companies may experience problems in becoming successful and obtaining competitive advantages in the absence of any BI system (Chaudhuri et al., 2011; Spruit & De Boer, 2014).

Contextualizing the concept of decision-making, it is seen as the result of decision support tools and human judgement which ultimately sets the organizational direction (Borking et al., 2011; Frisk, et al., 2014), although some decision support is necessary due to the complexity of decisions (Korhonen et al., 2008). Henceforth, the concept is used from a design approach, in which decision-makers utilize and interpret evidence, examine, test and evaluate different alternatives (Frisk et al., 2014). The characteristic of the decisions may either be strategic or operational depending on the nature of the decision problem; strategic decisions concerns the problems of external character in an organization, whereas operational decisions are focusing on maximizing the operational profitability (Ansoff, 1965). Further, Snowden and Boone (2007) argue that there is not a universal solution to decision-making. Hence, "The Cynefin Framework" was developed, which helps decision-makers to communicate and understand the decision contexts and surroundings in which they are acting. By using the framework, organizations may define the surroundings from historical situations and thus facilitate and enhance the decision-making (Snowden and Boone, 2007). The dichotomy regarding decision-making is evident due to the classification of decision support and data-driven support; decision support refers to the ability to make judgements based on available data whereas data-driven support relates to the transmission of up-to-date and accurate data (Pourshahid et al., 2014). The support is not solely seen as the determinant of decisions, since it is often complemented by subjective decisions (Korhonen et al., 2008). Despite these classifications, decision-makers either

rely on information in terms of prepared reports by people responsible for processing and performing analyses of data (data analysts), or interact directly with presented data such as dashboards or graphs in order to provide more informative decisions (Pourshahid et al., 2014).

For that reason, researchers argue that BI systems tend to improve decision-making in organizations by the means of analytics, as the decisions are based on reliable information rather than intuitions solely (e.g. Lönnqvist & Pirttimäki, 2005; Mesaros et al., 2016; Ranjan, 2008; Yeoh & Koronios, 2009). However, Pourshahid et al. (2014) claim that BI systems often fail to support managerial decision-making. This since the systems are seen as a feature of consolidating data, rather than components of the decision-making environment (Pourshahid et al., 2014). Accordingly, Kowalczyk and Buxmann (2015) contextualize that the realization of the benefits of effective BI&A support is not always assured, due to the very nature and characteristics of organizational decision-making. The reality may often be characterized by an ill-structured process with lack of routines (Kowalczyk & Buxmann, 2015). Information gaps between the data analysts and the decision-makers may also be present, leading to information asymmetries where the data analysts have more information and power than the actual decision-makers; resulting in negligence of analysts' informative advices based on BI visualizations by the decision-makers (Bonaccio & Dalal, 2006; Kowalczyk & Buxmann, 2015; Yaniv & Kleinberger, 2000).

Further, the global developments in IT and rapid changes in the business world have increased the amount of data generated by companies (Yigitbasioglu & Velcu, 2012). Accordingly, Turner et al. (2014) argue that the volume of data in organizations is doubling every second year. As a result, managers are often overwhelmed by reports and other types of information derived from information systems such as scorecards and systems for enterprise resource planning (ERP) and supply chain management (SCM) (Yigitbasioglu & Velcu, 2012). This even though the ability to consume data is, from a business perspective, seen as equally important to collecting data (Bacic & Fadlalla, 2016). Consequently, analyzing vast amounts of data may lead to information overload, resulting in disorientation and ambiguity regarding the decision-making in organizations (Yigitbasioglu & Velcu, 2012).

A way to reduce the risk of information overload, according to Yigitbasioglu and Velcu (2012), is through the use of BI visualizations. Furthermore, Bacic & Fadlalla (2016) state that there needs to be an alignment between the human abilities and visualization techniques in order to facilitate and evoke the appliance of BI systems in the decision-making. This is corroborated by the cognitive fit theory, emphasizing that it is crucial to find the right visualization that supports the mental model of decision-makers, where there is a fit between the technology, the user, and the task (Shim et al., 2002; Vessey & Galletta, 1991). By combining an integrated representation of data with a user interaction approach, decision-makers may interact with BI visualizations in their decision-making to a larger extent without being overloaded with information (Ariyachandra & Watson, 2006; Delone & McLean, 2003; Park & Basole, 2016; Pike et al., 2009; Shim et al., 2002). Hence, visualizations may reduce the use of intuition as a basis for decision-making, as the decisions may rather be done with visualizations of available data (Tank, 2015).

Prior streams of research have predominantly covered the technological and logical aspects of designing information systems. However, one existing gap in the research concerns the socio-technical effects involved in the decision-making, which is the human information processing and interaction with technical systems (Richards, 2016). Knowledge of how BI visualizations *are* used and *may be* used in practice to support the decision-making have remained limited (Bacic & Fadlalla, 2016) or as Richards (2016) states: "*like a proverbial black box*", contextualizing that data-driven decision-making needs to be investigated in a deeper level. As elements of business information visualization should capture decision-making in practice (Bacic & Fadlalla, 2016), this study investigates how BI visualizations *are* and *may* be used as decision support in organizations.

1.3 Research Aim and Questions

The aim of the study is to reduce the gap in research regarding the socio-technical effects of BI visualizations in the decision-making, as it has remained limited (Bacic & Fadlalla, 2016; Richards, 2016). As such, the thesis will use an explorative approach to investigate **the** research questions. The first main question concerns how various BI visualizations are and may be used to support strategic and operational decisions. The thesis also emphasizes which visual elements are used depending on the task and category of decision. The second main question of the study investigates how BI visualizations are used in various decision contexts.

To investigate the research problem, a qualitative study has been conducted. This by interviewing respondents from the purchasing company and the consultancy company. (Collis & Hussey, 2014) By interviewing end-users of BI visualizations, which are involved in different levels and contexts of decisions in a case company, scholars are provided with insights in how BI visualizations *are* used within the organization as decision support. Supplemented information was provided by experts within the field (BI consultants), which aims to contribute with knowledge of how BI visualizations *may* be used in decision-making. In particular, this study investigates the ability to make decisions from a managerial perspective through the use of BI visualizations in order to create more reliable decisions. As result, organizations may receive a better understanding of their financials and business processes and thus enhance the efficiency of their operations (e.g. Chen et al., 2012; Davenport et al., 2010). This leads to the following research questions:

- How are and may BI visualizations be used in strategic and operational decisions?

  - *Which visual elements are used depending on the task and decision category?*

- How are BI visualizations used in different decision contexts?

1.4 Delimitations

In order to study the research problem and answer the research questions, some boundaries are determined for the study. One main delimitation is that the study takes an exploratory approach towards research, as it investigates how various BI visualizations are and may support the decision-making in organizations. The study will also be limited in not exploring the context field of "disorder" in the framework of Snowden & Boone (2007). Furthermore, the report aims to take a user perspective of a social

phenomenon, where qualitative methods of describing the world is used to induce general inference from certain instances (Collis & Hussey, 2014). As aforementioned, BI&A may work as both decision support and data-driven support (Pourshahid et al., 2014). However, the focus of this study is to explore how different visualizations may support the decision-making rather than the data-driven support.

1.5 Thesis Disposition

The thesis will follow this structure:

2. *Frame of reference*: This section presents the theoretical framework. The goal is to define useful expressions and important information that will support the research conducted.

3. *Research approach:* In this section a description of the method used in the research is presented.

4. *Findings:* This section presents the primary data obtained from the case studies.

5. *Discussion:* This chapter analyzes the findings of the report, which is based on the theoretical framework and primary findings.

6. *Concluding remarks:* This section summarizes the findings and answers the research questions. It ends with a discussion of theoretical and practical contributions and suggests further research.

2. Frame of Reference

This section presents associated literature of business intelligence and analytics, decision-making, and visualizations. The chapter starts by defining BI and BI&A, and the architecture of a BI system is explained. Second, previous research regarding visualizations is outlined. Third, the decision-making in organizations is discussed and how it is connected to BI visualizations. It ends with an analytical framework that will be used to analyze the empirical data.

2.1 Business Intelligence and Analytics

The technical term of BI systems is seen by scholars as an umbrella term to describe the integrated set of instruments, tools, applications, and technologies used for gathering, integrating, and visualizing information to simplify the decision-making based on more accurate and reliable data (Chaudhuri et al., 2011; Lim et al., 2013; Yeoh & Koronios, 2009; Wang, 2015). BI systems have, from a decision-support perspective, emerged due to the analytical capabilities as well as the possibility to provide an integrated representation of information; which ultimately assist the decision-making (Hornbæk & Hertzum, 2011; Popovič et al., 2012). By enabling access and analysis of both real-time and historical data, using the appliance of BI systems; individuals, departments and divisions may receive a better insight of the business (Sharda et al., 2014; Ranjan, 2008; Yeoh & Koronios, 2009). It serves to assist organizations' information needs by moving beyond the utilization of data towards putting it into a context and presenting the data in usable visualizations (Boudreau & Jesuthasan, 2011). However, due to the complexity of this process, decision-makers often base their decisions on subsets of the available information, leading to biased decisions (Vaiman et al., 2012).

The notion of BI&A, as a separate concept, may be described as the combination of analytics experts and technological capabilities to support the decision-making (Chaudhuri et al., 2011; Chen et al., 2012; Davenport et al., 2012). It derives from the field of database management, relying to a great extent on analysis technologies, extraction and data collection (Chen et al., 2012). BI&A reflects what the technology enables for the user, while the purpose of a BI system is to gather, integrate, and visualize information (Gnatovich, 2007; Lim et al., 2013). More specifically, Chen et al. (2012) categorize the concept of BI&A into three levels of maturity with different capabilities and key characteristics. The first level, referred to as BI&A 1.0, relies on structured data from internal sources which is most common among organizations today (Chen et al., 2012). This statement is corroborated by Baars and Kemper (2008), contextualizing that the systems and applications of today are predominantly processing structured data which may directly be managed by computing equipment.

However, unstructured and semi-structured data may also be important to refine in order to increase the benefits from the analysis of data. By using an integrated approach towards structured and unstructured data, BI systems may provide a more valid insight into the current business development (Baars & Kemper, 2008). This is what Chen et al. (2012) categorize as the second level of BI&A, or BI&A 2.0, where a vast amount of both structured and unstructured data may be extracted, processed, and visualized through different web and text mining techniques. This may among other aspects enable organizations to get a deeper insight of their customers and thus make more reliable and informed decisions (Chen et al., 2012; Lim et al., 2013; Sharda et al., 2014).

The last level, stated as BI&A 3.0, is in its embryonic stage in both academia and practice, which includes mobile and sensor-based data and visualizations. This additional content of revolutionary technology, according to Chen et al. (2012). It enables location-aware, person-entered and context-relevant analysis, which may provide a leveraging effect on the decision-making.

2.1.1 Data Quality

Any BI system is only as successful as the underlying data that it is presenting. Thus, in order for a BI system to be valuable in decision-making; the data must reflect a high level of quality, referred to as the comprehensiveness and consistency of the data (Marshall & De la Harpe, 2009). Furthermore, Isik et al. (2013) and Visinescu et al (2016; 2017) argue that more than 50 percent of the initial BI projects fail as a result of poor data quality, or because the expectations of the outcomes of a system are not met. Hence, if the data that is subject to analysis is not consistent or accurate, it will be difficult to satisfy the delivery of timely, consistent, and accurate information across users (Isik et al., 2013).

2.1.2 The Technical Architecture of BI Systems

The technical architecture of BI systems describes the process from extracting to reporting and visualizing data by the means of a user interface. The first step is to prepare the data using back-end applications to extract, transform, and load (ETL) the data. This is considered as crucial as the data often is provided by various sources and systems (Chaudhuri et al., 2011). The next phase involves storing, querying, and reducing the data into data warehouse servers such as relational database management systems (RDBMS) or MapReduce paradigm (Chaudhuri et al., 2011; Sharda et al., 2014). This is what Baars and Kemper (2008) describe as the first data processing layer in their multi-layer framework. The data is then flowing through the mid-tier servers (Chaudhuri et al., 2011) or a business performance management (BPM) system (Sharda et al., 2014) which analyzes, monitors, and provides the performance with specialized functionality. Baars & Kemper (2008) defines this as the logical layer, which is responsible for analyzing the content and support the knowledge distribution. At last, the access layer enables an integrated interface through visualizations of data from the different sources and systems (Baars & Kemper, 2008). This by the means of BI applications, consisting of visual elements in user interfaces such as dashboards, spreadsheets, and ad-hoc query where the BI visualizations are be allocated (Chaudhuri et al., 2011; Sharda et al., 2014).

BI applications may support the end-users in performing several business tasks (Chaudhuri et al., 2011). One example is to improve managerial decision-making and organize the interrelationships between the organizational structure and BI itself (Audzeyeva & Hudson, 2015). As such, BI applications may improve operational and strategic decision-making in terms of changing processes, work tasks and resource allocations (Audzeyeva & Hudson, 2015; Hsiao, 2012). Other areas of use is tracking key performance indicators using summarized data in dashboards or ad-hoc visualizations to enable exploration of outliers and patterns (Chaudhuri et al., 2011). However, in order for the BI application to be used optimally, the applications need to encourage interaction while still not inhibit an overly complex user interaction (Jooste et al., 2014).

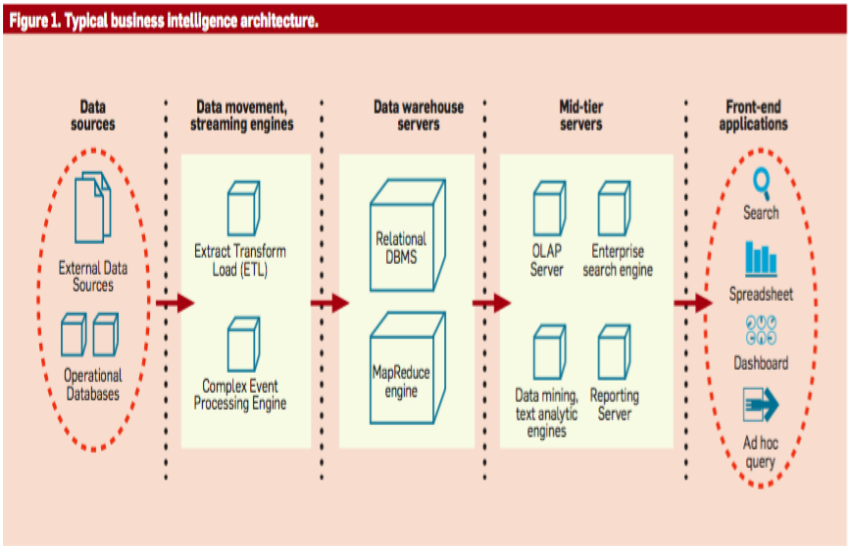

***Figure 1**: Typical Business Intelligence Architecture (Chaudhuri et al., 2011 p. 90)*

2.2 Visualization

Organizations face challenges as a result of the constant developing business environment (Baars & Kemper, 2008). Nowadays, firms do not compete in geographical areas but rather on a global marketplace (Sharda et al., 2014). This globalization has developed into being a matter of survival for many firms, which requires an understanding of the capabilities of BI systems (Ranjan, 2008). One of the fundamental cornerstones of BI systems is data visualization, which may leverage the competitive advantage of a firm as it simplifies the understanding of data (Gendron et al., 2016).

Gendron et al. (2016 p. 2) define visualizations as *"the presentation of data in a pictorial of graphical format. It enables decision-makers to see analytics presented visually, so they can grasp difficult concepts or identify new patterns*". However, in other literature, "visualization" varies into being defined as information visualization, data visualization, visualization (in general), business visualization and visual analytics. The concept emerged during the 1950s due to the arrival of computer graphics and is often referred to as *"the science of visual representation of data"* (Bacic & Fadlalla, 2016 p. 78). The field is moreover described as generating visual representations in order to enhance the cognition of users. It expanded since the 1980s, both in academics and practice, with the aim of providing proper information which may assist users in order to improve decision-making (Hornbæk & Hertzum, 2011).

During the late 1990s, the concept evolved into information visualization which focused on the communication of abstract data through using visual interfaces. This including reporting platforms, dashboards, ad hoc analysis, and visual data discovery (Basic & Fadlalla, 2016). Since then, information visualization has gained an increased attention by practitioners and researchers due to its ability to support decision-making in organizations (Bacic & Fadlalla, 2016; Hornbæk & Hertzum, 2011). Bacic and Fadlalla (2016) further state that business information has, for a long time, been visualized through various charts, graphs, tables, and outlines; while admitting that visualization nowadays refers to presenting business information or data through

multidimensional graphics. The key aspect, however, is to visualize data through computer-supported activities in order to understand behaviour, improve the business impact, and decision-making. (Bacic & Fadlalla, 2016)

Following, "data warehousing", as the traditional focus in research and practice of BI capabilities, has been successively replaced with data consumption to a greater extent. The ability to consume data is becoming more important nowadays due to the need of providing information to support decision-making in firms. (Bacic & Fadlalla, 2016; Pourshahid et al., 2014) The evolution of handling large amounts of data has contributed to the assembling of knowledge from complex data systems while turning it into valuable insights, which may be traced to understanding visual technologies (Basic & Fadlalla, 2016; Lim et al., 2013). As a result, visualizations of data is also becoming significantly important in order to form strategies and attempt to align business with IT. The important aspects include the way to interact and consume data and how technologies of visualization may improve decision-making (Bacic & Fadlalla, 2016). Hence, the user-interaction and simplicity of the representation of data are significant factors in describing to what extent BI visualizations are used by the recipients in the decision-making (Ariyachandra & Watson, 2006; Delone & McLean, 2003).

Similarly, Gendron et al., (2016) argue that there are three reasons behind the importance of visualizations in firms. The first reason is the fact that a majority of the population are visual learners; graphical representations is more understandable rather than text only (Gendron et al., 2016). This as learning and cognitive processing are facilitated by visualizations (Scaife & Rogers, 1996). Recipients may easier elucidate and synthesize information and thus enable enhanced comparisons as the representations are recalled (Eppler & Platts, 2009). As a response, most recent literature is starting to recognize the significance of developing storytelling visualizations in order to make it more understandable, interesting, memorable, and relatable for the end-users (Bacic & Fadlalla, 2016). Storytelling as a concept is described as telling a story regarding the subject of analytics and data, and the reasoning behind how the knowledge was achieved (Kao et al., 2012). Hence, it is an abstraction to conceptualize patterns of data and visualize the results in order to enable and simplify the analysis (Bier et al., 2010).

The second reason for visualization, according to Gendron et al. (2016), is because the process of manually establishing a data archive is seen as time-consuming and unpleasant. Further, the last incentive for using visualization is because of the complexity companies face caused by Big Data (large amounts of data), which provides difficulties in analyzing data relationships (Gendron et al., 2016).

The global developments in IT and rapid changes in the business world have increased the amount of data generated by companies (Turner et al., 2014). As a result, decision-makers are often overwhelmed by reports and other types of information derived from information systems such as scorecards and systems for enterprise resource planning (ERP) and supply chain management (SCM) (Yigitbasioglu & Velcu, 2012). This may result in what Yigitbasioglu and Velcu (2012) refer to as information overload, which may create to disorientation and ambiguity in organizations. A way to prevent information overload, according to Yigitbasioglu and

Velcu (2012), is through the use of visualization and dashboards. Yigitbasioglu and Velcu (2012) further state that there is, however, no clear definition of how a dashboard should function. It can although be generally said that it should summarize, present, and collect information from several sources in order for the user to easily observe and analyze performance indicators (Yigitbasioglu & Velcu, 2012).

2.2.1 Cognitive Fit Theory

According to the cognitive fit theory, it is crucial to find the right visual representation of data that supports the mental model of decision-makers. Thus, the theory provides a theoretical foundation of describing the effects of user interaction in the decision-making (Vessey & Galletta, 1991). Interactions enable the users of BI systems to dynamically explore and manipulate parts of the visualization, which tend to provide in-depth information on demand without overloading the users with information (Park & Basole, 2016; Pike et al., 2009). Shim et al. (2002) argue that the modern challenge is the continuously changing dynamic of business decision problems, which stresses the representation of data to be updated and presented in a timely manner by the means of interaction techniques. In order for the decisions to become more efficient, there has to be a fit between the technology, the user, and the task (Shim et al., 2002). Accordingly, Lurie & Manson (2007) argue that interactive visualizations with better ties between the decision environment and the task may reduce the effort required in the task and improve the quality of decisions as the decision-makers may consider more factors embedded in the task. These interactions need to be initiative and pleasurable, in which smart design, empathy qualities and humanization of visualizations are crucial (Kolko, 2015). Hence, a BI system may support the decision-making by visualizing the right amount of information in an intuitive and simplified manner without overloading the user's cognitive bandwidth (Park & Basole, 2016), meaning "*the number of items that can be held in mind simultaneously*" (Miller & Buschman, 2015 p. 112).

2.2.2 Text and Graphical Representation

There are a large number of ways to visualize information to support decision-makers in order to understand the vast amount of data in organizations (Lurie & Manson, 2007). The task is by no means simple as the representations should be easy to comprehend, while still avoiding the risk of losing information and at the same the aiming to reduce the risk of information overload (Miettinen, 2012). Much of the information decision-makers receive consists of numbers and text, which may be perceived as effortful as it involves rule-based reasoning. Humans also have perceptual abilities of sense-making to detect discontinuities, recognize patterns, and to access information using visual clues (Lurie & Manson, 2007). As a solution, graphical representations aim to make use of these abilities to simplify the understanding of data and make it easier to remember and relate to (Miettinen, 2012).

However, there has been an ongoing discussion for decades regarding the best way of visualizing data – through charts or tables (e.g. Jarvenpaa & Dickson, 1988; Miettinen, 2012; Vessey, 1994). Vessey (1994) use the terms "spatial" and "symbolic" to differentiate between graphs and tables; where graphs emphasize spatial problem relationship in data, while tables highlight symbolic representations of tasks. These may according to Jarvenpaa and Dickson (1988) be beneficial in different contexts and tasks,

where graphs in general tend to create better and faster performance and decisions, as it make the data easier to comprehend by the users and take advantage of humans' perceptual abilities to make sense of patterns. However, Miettinen (2012) argues that one may not claim that one specific graph is better than the other, as it is highly dependent on the cognitive fit between the underlying task and the characteristics of the users. Tables on the other hand may be more beneficial in situations where the users are unfamiliar with graphical formats and each statistical value is of importance (Jarvenpaa & Dickson, 1988).

Further, Vessey (1994) emphasizes that the decision-making in organizations are more efficient when there is a cognitive fit between the visualization, the user, and the task to be accomplished. In tasks associated with simple coherences, the user may solve the problem with either spatial or symbolic visualizations (Vessey, 1994). However, it may be easier for the user to grasp the task and solution using graphical representations as it enables an overview of the task and alternatives (Miettinen, 2012). More complex decisions on the other hand require decision-makers to put more emphasis on analytical processing, in which symbolic representations may be more suitable to handle the task as they are more error prone (Vessey, 1994).

Although graphical representations have many benefits, they carry a risk of creating biases in decision-making (Lurie & Manson, 2007). The additional information the visualizations contain may increase the confidence of decision-makers, but the quality of the decision may nonetheless be worse if the quality of data is incomprehensive and inconsistent (Marshall & De la Harpe, 2009; Miettinen, 2012). Further, graphical visualizations with detailed information of a few alternatives may lead to incorrect evaluations as the decision-makers are not provided with all the information about all the potential alternatives. Hence, it is crucial for the designers of the visualizations to be aware of these potential biases as they may have a negative effect on the decision-making (Lurie & Manson, 2007).

2.3 Decision-making

Decision-making is regarded as the core of any business (Borking et al., 2011). It explains how decision-makers gather and interpret evidence as well as examine, test and evaluate different alternatives (Frisk et al., 2014). By restating Simon (1977; 1996), Boland et al. (2008) clarify three fundamental aspects of decision-making, namely: intelligence, design, and choice. However, this multifaceted idea of decision-making has been reduced to a single concept, that of choice, where the decision-makers often are waiting passively for basis to reduce their choices (Boland et al., 2008). Furthermore, Boland et al. (2008) argue that decision-makers need to put more emphasis on the design aspects, as it accomplishes tasks and goals in ways that have not been done previously.

Organizations engage in various types of decisions (Frisk, et al., 2014), and Ansoff (1965) made an attempt to classify decisions into two categories: strategic and operational decisions, which have been widely used in academia and practice even in present time (Holopainen & Toivonen, 2012). However, research regarding decision-making suggests that the cognition of decisions varies among managers depending on how one chooses to define it and in what context the problem arises (Papadakis et al., 1998). The next two sections explain the categories defined by Ansoff (1965) and in which decision contexts they may arise according to Snowden and Boone (2007). This followed by the

relationship between decision-makers and data analysts in the decision-making.

2.3.1 Categories of Decisions

From a decision perspective, the general problem in firms is to configure the process of resource conversion to enhance the realization of objectives. Since this requires many and various decisions, this "space" is divided into categories; operational and strategic objectives. (Ansoff, 1965) Ansoff (1965) defines strategic decisions as the problems of external character in an organization, whereas the focus of operational decisions is to maximize the operational profitability (Ansoff, 1965).

Strategic decisions tend to require proper analysis due to the implicational importance (Borking et al., 2011). These are seen as crucial for any organization as they consume resources steer direction of future actions (Mitchell et al., 2011) Operational decisions on the other hand are frequent due to the volume of these decisions, which requires monitoring on a daily basis (Ansoff, 1965) These types of decisions may be actual in various situational contexts, which are described in the next section.

2.3.2 Decision Contexts

Snowden and Boone (2007) issue that there is no one-fits-all solution for decision-making, but rather a set of multidimensional contexts defined by the very nature of the relationship between cause and effect. Further, Snowden and Boone (2007) provide a framework consisting of five decision contexts, namely; simple, complicated, complex, chaotic, and disordered contexts. Various actions are required in these contexts, as the simple and complicated domain exist in and ordered universe. This means that the right answers may be determined by the help of facts, and that there are relationships of cause and effect. (Snowden & Boone, 2010) In contrast, complex and chaotic contexts are defined as unordered, meaning that cause and effect relationships are not initially present, although may be determined through emerging patterns. As such; *fact-based management* exist within the ordered universe, and *pattern-based management* is represented by the unordered universe. (Snowden & Boone, 2007) The model explains a place of multiple belongings and the patterns of the framework emerges from the data in a social process. Hence, the model is not used to solve problems or categorize decisions; but as a sense-making framework assisting in how to

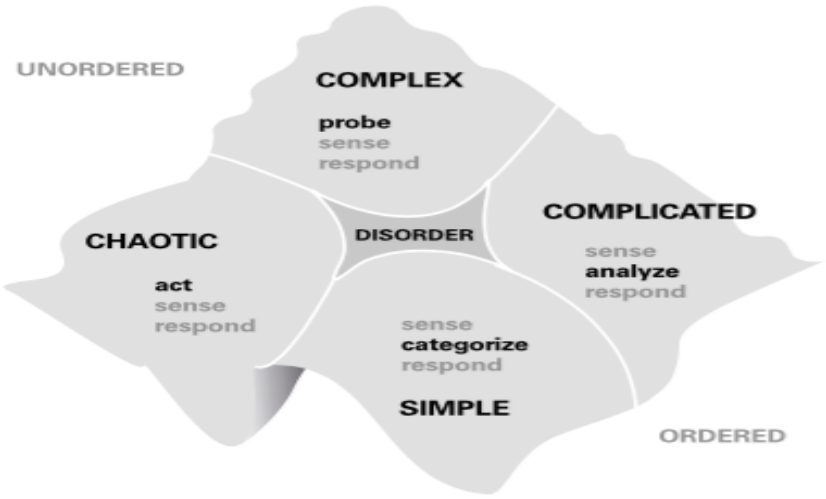

***Figure 2**: The Cynefin Framework (Snowden & Boone, 2007 p. 4)*

deal with problems. (Snowden & Boone, 2010).

The simple context (domain) is recognized by a balanced relationship between cause and effect, in which decision-makers easily sense, categorize, and respond to the decision situations (Snowden & Boone, 2007). The relationship between cause and effect exist, are repeatable, predictable, and the effects of actions are known before the execution (Snowden & Boone, 2010). The complicated contexts may, unlike simple contexts, provide multiple "right" answers where the cause and effect relationship is clear but rather onerous to detect and analyze (Snowden & Boone, 2007). The answers are not self-evident, in which people rely on expertise within that domain to make the right decision. In this domain, *good practice* is applied as opposed to *best practice*. The decision model is to sense, analyze, and respond. (Snowden & Boone, 2010). However, in decisions categorized by complex contexts; at least one right answer exist but it is impossible to determine (Snowden & Boone, 2007). The domain is a system without causality, as cause and effect relationships are only obvious in hindsight, with emergent and unpredictable outcomes. Decision-makers tend to probe, sense, and respond in this context. (Snowden & Boone, 2010). The chaotic context is characterized by absence of stability or as Snowden and Boone (2007 p. 5) describe it: "*The relationship between cause and effect are impossible to determine because they shift constantly and no manageable patterns exists - only turbulence"*. The role of the decision-maker is not to discover patterns, but rather to stop the immediate bleeding (Snowden & Boone, 2007). Hence, the relationship between cause and effect cannot be determined either in hindsight or foresight, leading to a decision model of act, sense, respond (Snowden & Boone, 2010). The fifth and last context applies, in contrary to the other four contexts, only when it is unclear which of the other four contexts to apply (Snowden & Boone, 2007).

2.3.3 Decision-making and Data Analysts

Due to the knowledge-based and competitive economy, there is an increased requiring for firms to be assisted by BI&A (Hedgebeth, 2007; Popovič et al., 2012). By the means of the methods and techniques provided by the BI systems, acquired data may be turned into information and eventually visualized in dashboards, scorecards and other graphical representations (Popovič et al., 2012). These visualizations may in turn come to use in individual business problems, which eventually supports various organizational levels (Visinescu et al., 2017; 2016).

Moreover, Viaene (2013) argues that specialized knowledge among analysts is crucial in order for BI&A to be supportive in decision-making. This often raises organizational challenges in terms of information gaps between the decision-makers and analysts, due to the lack of analytics knowledge by the decision-makers (Viaene, 2013; Viaene & Van den Bunder, 2011). This is also contextualized by Visinescu et al. (2016; 2017) arguing that companies do not know how to make use of the data in a proper manner, mostly due the the constant development of technologies. As a result, this may induce information asymmetries, where the analysts have more information and power than the actual decision-makers; resulting in negligence of analysts' informative advices based on BI BI&A by the decision-makers (Bonaccio & Dalal, 2006; Yaniv & Kleinberger, 2000). Hence, analysts may fail to enhance the rationality of the decisions, ending up with decisions predominantly based on subjective

intuitions. This makes adaptability and rigor to prerequisites for analysts in providing effective BI&A support (Kowalczyk & Buxmann, 2015).

2.4 Decision-making and BI Visualizations

BI systems are used to gather, integrate, and visualize information (Gnatovich, 2007; Lim et al., 2013), whilst BI&A is referred to as the combination of technological capabilities and analytics experts to support the decision-making (Chaudhuri et al., 2011; Chen et al., 2012; Davenport et al., 2012). A fundamental cornerstone of BI systems is BI visualization (Gendron et al., 2016), and has since its emergence gained an increased attention due to the ability to support decision making (Bacic & Fadlalla, 2016; Hornbæk & Hertzum, 2011). This by visualizing computer-supported activities in order to improve the business impact and understand behaviour (Bacic & Fadlalla, 2016).

Decision-making is seen as essential to any organization (Borking et al., 2011), as it explains how to examine, evaluate, and test decision alternatives (Frisk et al., 2014). In order for decisions to be efficient and effective, there needs to be a fit between the user, technology, and task (Shim et al., 2002). As the cognitive fit theory implies, it is crucial to gather the correct visual representation of data which supports the mental model of decision-makers (Vessey & Galletta, 1991). Due to the dynamic business environment, the challenge remains in representing updated data in a timely manner (Shim et al., 2002). As such, BI visualizations may present the right amount of information in a simplified manner in order to improve the decision-making (Park & Basole, 2016). Through visualizations, decisions may be based on available data as opposed to rely on subjective intuitions solely (Kowalczyk & Buxmann, 2015).

Findings by Bacic & Fadlalla (2016) suggest that decision-making should be examined in practice regarding BI visualizations. Since research in this particular area has been sparse, this field is synthesized through an analytical framework. This, in which core essence of this study is clarified.

2.5 Analytical Framework

The merging of BI systems, visualizations, the nature of decisions and the contexts results in the analytical framework delineated in figure 3. The core of the framework is the technology and methods of a BI system, which make use of available data from multiple sources. The output of integrated visualizations serves to support the decision-making as it provides a more reliable piece of truth. In order to operationalize the decisions, the framework derives from Ansoff (1965), stating two categories of decisions; strategic and operational decisions. These categories may in turn be a part of various decision contexts. Hence, the Cynefin Framework by Snowden and Boone (2007) is applied to illustrate these contexts in which these decisions may occur. It is further used in order to study how visualizations support strategic and operational decision-making.

Altogether, the framework illustrates BI systems as the core essences of visualizations, which are further used to support strategic and operational decisions. The framework also differentiates the situational contexts in which the aforementioned decisions may occur.

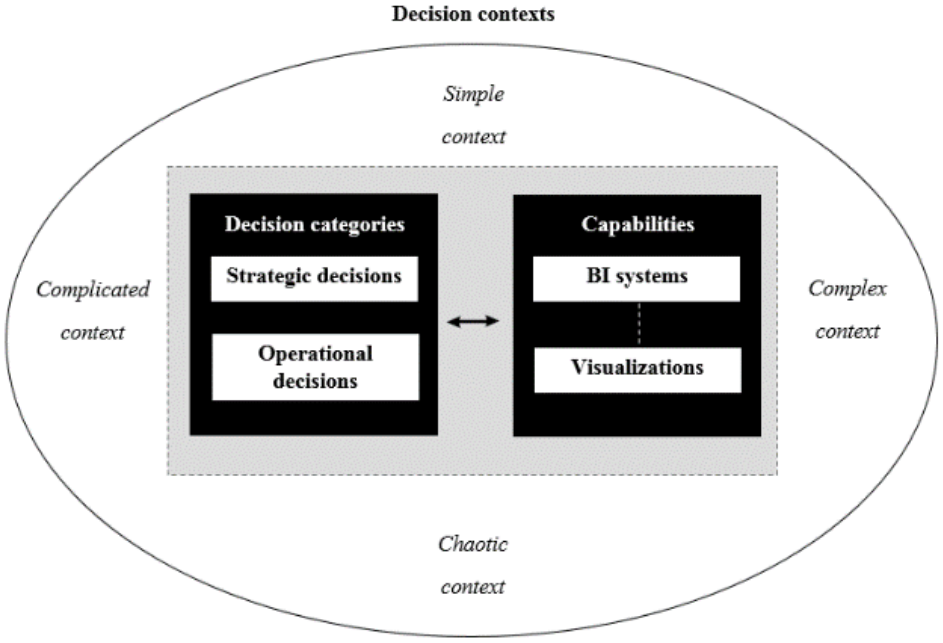

Figure 3: *Analytical Framework: How BI Visualizations Support Strategic and Operational Decision-making in Different Contexts.*

3. Research approach

In this section, the research design to the study is presented. The chapter starts by discussing the chosen method and research paradigm, followed by an overview of the data collection and data analysis. Further, it outlines the content of the research quality. The limitations of the study are finally discussed.

3.1 Method

The purpose of academic research in general is to examine a single, or several research questions with the aim of generating knowledge (Collis & Hussey, 2014). The research questions in this study were designed from the theoretical and analytical framework as it focuses on how BI visualizations *are* and *may* be used in decision-making. Therefore, a qualitative study was chosen in order to collect in-depth data and bypass data reduction for statistical tests (Collis & Hussey, 2014). It is concerned with scientific studies of a reality, which are referred to as 'objective' to some degree (Silverman, 2013). The nature of the study is exploratory, with the aim of obtaining insights and exploring the associated concepts, which will be analyzed at a further stage (Blumberg et al., 2011; Bryman & Bell, 2011). The research was conducted through a case study partially done with an experimental setting. The naturalistic idea of the contextual settings of the interviews, made by an experimental setting, allow the researchers to draw comparisons between the findings. The research approach was open in order to gather a large amount of data and analyze why a particular phenomenon is happening as argued by Collis & Hussey (2014).

The study has an interpretivist approach in order to provide a perception of a social phenomenon derived from social actions (Bryman & Bell, 2011; Collis & Hussey, 2014). It is based on the underlying assumption that the social reality is multiple, subjective and exists in our minds (Collis & Hussey, 2014). Investigating the subjective meanings, which are formed in a natural world, allows the meanings to be understandable and reconstructed in order to be used as cornerstones in the theorization (Goldkuhl, 2012). As such, the theories that concerns reality are ways to obtain a clearer view of the world, in which it is tested and applied in a social reality (Walsham, 2006 & Goldkuhl, 2012). As the findings are derived from qualitative methods of describing the social world which are accurate and reliable through verification; the findings may be generalized from one setting to similar settings (Collis & Hussey, 2014).

The theoretical framework was compiled intuitively and critically prior to the data collection (Bryman and Bell, 2011). Literature were obtained early in the research process, specifically in the areas of under study, which enhance the significance of the study (Bryman & Bell, 2011). The literature refers to the existing knowledge regarding the topic, which predominantly consists of peer-reviewed articles published in academic journals. The analytical framework was formed after the literature research was conducted, in which The Cynefin Framework (Snowden & Boone, 2007) and the categories of decisions by Ansoff (1965) are used. This as various types of decisions and decision contexts are involved, making the framework compatible to the study (Bryman & Bell, 2011).

The literature was accessed through databases at the School of business, economics, and law at the University of Gothenburg. When the collection of relevant literature was analyzed, a thematic approach was used to categorize the content into themes which facilitates the

process of analyzing key aspects (Collis & Hussey, 2014).

3.2 Collection of Data

The method of collecting primary data was based on semi-structured interviews conducted to explore the respondents' understandings of reality. This as the interviews enable reflection of the respondents' experience and opinions in a time-efficient way (Bryman & Bell, 2011). Moreover, in order to investigate the holistic characteristics of a single real-life phenomenon, a case study was conducted in order to obtain in-depth knowledge (Collis & Hussey, 2014). The next two sections describe the data sampling and the conduction of the interviews.

3.2.1 Data Sampling - Case Organizations

A proper sample is defined as representing the characteristics of the population to a high degree (Blumberg et al., 2011). Firstly, the choice of the consultancy company was resembled in the fact that one of the researchers had previous connections to the company. The company solely focuses on BI solutions from Qlik, which enables in-depth investigations within a single BI solution provider. Two interviews were made with the consultancy company; one with a UX-designer (Consultant 1) and one with the team and project leader of the BI application (Consultant 2) under study called "Verge".

From the BI consultancy company, judgement samples were made in order to find a company working with applications from the software QlikView. A purchasing company and sample respondents at various organizational levels were selected by the consultancy firm based on this criterion. This enables the researchers to gather data from members with specific experience and knowledge (Blumberg et al., 2011). From the purchasing company, six distinct respondents with different organizational roles were interviewed within one of the business segments. As such, respondents from the BI consultancy company were interviewed to investigate how BI visualizations *may* potentially be used, whereas participants from the purchasing company were interviewed to investigate how visualizations *are* used in practice.

The consultancy company was founded in 2007 and has a turnover corresponding to approximately 60 million SEK. It has currently 45 employees and are supporting over 100 active customers yearly (Consultant 2). The purchasing company is a listed Swedish company founded in 1999, with a turnover corresponding to 850 million SEK. It has around 450 employees in the Nordic, ninety unique end-users, and 30+ QlikView applications in the organization. Furthermore, the company has a BI team consisting of four full-time employees and two consultants from the BI consultancy company mentioned above (BI Manager).

3.2.2 Interviews

A way to collect data regarding how participants think or feel is through interviews. This as the concern of interviews is to obtain opinions, feelings and understandings of a particular topic (Bryman & Bell, 2011). In this study, eleven interviews were conducted which according to Silverman (2013) falls within the limits of sample size in qualitative studies. Prior to the interviews, the researchers were provided access to the application in order to be familiar with the layout and functionality. A summary of the interview lengths is presented in table 1.

Title	Organization	Type of interview	Date	Length
Consultant 1	Consultancy company	First	2017-04-05	50 min
Consultant 2	Consultancy company	First	2017-04-05	55 min
Back-office manager	Purchasing company	First	2017-03-31	60 min
Back-office manager	Purchasing company	Second	2017-04-11	50 min
Controller	Purchasing company	First	2017-03-29	55 min
Controller	Purchasing company	Second	2017-04-11	55 min
Product manager	Purchasing company	First	2017-04-03	45 min
Product manager	Purchasing company	Second	2017-04-13	35 min
Segment manager	Purchasing company	First	2017-04-13	65 min
BI developer	Purchasing company	First	2017-04-11	51 min
BI manager	Purchasing company	First	2017-04-11	55 min

Table 1: Interview Details

The questions of the interview were semi-structured, allowing the respondents to develop additional thoughts and questions about the topic (Collis & Hussey, 2014). The underlying question had an open character and were partly prepared in beforehand through an interview guide. This in order to encourage the interviewees to talk freely within the reasonable limits of the investigation.

The interview guide consisted of ten main questions for each interview and a brief description of the study (Appendix 1), ensuring that relevant topics in the study was covered and highlighted. However, the researchers also had the possibility to ask additional questions if some questions were excluded, or if the respondent was discussing aspects beyond the framework of investigation. This structure was used to obtain an understanding of the personal constructs of the person interviewed to get deeper knowledge of their basis of opinions and beliefs, which may increase the validity of the research (Collis & Hussey, 2014). The

interview guide was sent to the interviewees prior to the interviews. In this way, attention is drawn to what is relevant in the study, thus reducing answers with an extemporaneous character. This is complemented by more spontaneous answers from the additional questions asked in the course of time.

The interviews took place in the respondent's natural environment in order to make them feel more comfortable in the situation and to increase the reliability of the study (Collis & Hussey, 2014). Another action to increase the comfortability of answering the questions according to Collis and Hussey (2014) is to start asking classification questions (such as age, gender, job title) before advancing the interviews to more specific questions, which was also done initially in each interview. Moreover, the interviews were performed by both researchers through the traditional face-to-face approach, viewed as an advantage since more comprehensive data can be collected and observations can be engaged simultaneously according to Bryman & Bell (2011). This is considered useful in this case as the questions are rather sensitive for both the company and the respondents (Bryman & Bell, 2011).

Before the interviews started, the respondents were asked about permission to record the interviews. This in order to enhance the data quality and facilitate the data analysis (Blumberg et al., 2011). The recordings of the interviews were translated and transcribed into English simultaneously, since they were conducted in Swedish. This to reduce the risk of the language becoming a barrier for the respondents in expressing the actual thoughts and opinions (Collis & Hussey, 2014). The respondents also had the possibility to receive the transcriptions for confirmation, which increase the reliability of the study as the respondents were able to correct potential misunderstandings of the observations (Collis & Hussey, 2014). Due to classification reasons concerning the business itself and the BI application; both companies chose to be anonymous. The honesty in the responses may increase due to this anonymity, since the findings from this study are useful to the purchasing company as the current solution may be improved from the obtained results. The details of the respondents are summarized in Appendix 2.

The interviews at the purchasing company were conducted on two occasions. This applies to every respondent except the segment manager due to lack of availability. To compensate this, the researchers had 90 minutes to dispose for the interview. In general, each interview was conducted in approximately one hour, both for the purchasing company and the consultancy company. The first interviews at the purchasing company outlined the respondents' daily work, what type of decisions that are made, and the information required to ground these decisions. The first interviews ended with a dialogue concerning how each respondent use BI visualizations to support these decisions. After the first interviews with the purchasing company, interviews with respondents from the consultancy company were made. In these interviews, the present BI application of the purchasing company (Verge) was discussed, and the consultancy company provided input to areas which could be improved for a consultant's perspective. This both in terms of functionality of the solution, how to visualize elements, and how BI systems and visualizations may support decision-making on a strategic and operational level.

The second interview at the purchasing company was of a different character. It was formed as an experimental design, where the

conditions and prerequisites for each decision context provided by Snowden and Boone (2007) were explained in beforehand to the respondents. The respondents were then allowed to describe practical experiences, what information was required to ground the decisions, and how they obtained data as basis for the decision in these specific situations. At last, the respondents had the opportunity to describe their beliefs of the positive and negative aspects of the present BI application and how it may potentially be improved from an end-user perspective. Hence, the aim of the second interview was to gather a holistic perception of the decision-making and how the respondents use BI visualizations in different decision contexts.

3.3 Analysis of Data

The data analysis was an iterative process, as the analysis and data collection were conducted simultaneously and repeatedly back to one another (Bryman & Bell, 2011). The data was analyzed in and intuitive way, by reducing, selecting, and analyzing the data in order to avoid analytical bias (Collis & Hussey, 2014). After the transcriptions were completed, the results were compared with the theoretical framework. This allowed the researchers to draw comparisons and analyze differences and similarities between theory and the findings.

The data was subject to coding, meaning that data was disaggregated into smaller components and grouped into categories that shared common characteristics (Bryman & Bell, 2011; Collis & Hussey, 2014). The codes, e.g. categories, were predefined by the researchers, providing a link between the analysis and interpretation of the data (Collis & Hussey, 2014). As such, the codes emerged from the interpretations of the researchers and was in practice conducted through open coding, as the data was disaggregated, compared, examined, conceptualized, and categorized (Bryman & Bell, 2011). To conclude, the data was analyzed from the perspective that the internal experiences and external realities of the respondents were described and analyzed (Silverman, 2013).

3.4 Research Quality

Reliability stresses the significance of precision and accuracy of the measurements in a study, where replications with the same results are essential. Validity, on the other hand, emphasizes the accurate reflection of the phenomena under study and the generalizability in other situations. (Collis & Hussey, 2014) Despite the benefits of case studies, there are still doubts about the reliability and validity. As such, validity and reliability tests of qualitative data are used to determine the stability and quality of the data collected (Riege, 2003).

However, Flick (2007) argues that validity and reliability becomes obsolete in this case as it is non-standardized and situation specific. As a substitution in evaluating the research quality; the criteria of credibility, transferability, and dependability are used. Credibility concerns the subject of inquiry of the study, in which the acceptability of others is determined (Collis & Hussey, 2014). To enhance the credibility of the study, respondents were validated in order to ensure that the respondents had the required and necessary knowledge of the topic (Bryman & Bell, 2011). The transcriptions were also sent to the respondents in order to reduce the risk of any misrepresentations. Since the study investigates a social phenomenon, one may argue that there is a high degree of credibility since the social actions are derived from observations from the participants.

Transferability refers to if the findings may be applied if a similar setting was conducted

(Collis & Hussey, 2014). The aim was to provide rich accounts of the details regarding the topic, whereas the richness of data and details allow judgements to be made whether the research may be applied in a similar setting (Bryman & Bell, 2011). As the findings describe a social world and are reliable through verification; the findings may be generalized to other similar settings in this study.

The last criteria, referred to as dependability, concerns whether the research process has been rigorous and well documented (Collis & Hussey, 2014). The dependability of a research should be approached from an "auditing" perspective, ensuring that all phases of the research process are captured throughout the study (Bryman & Bell, 2011). Hence, an attempt to increase the dependability was by recording and transcribing the interviews as it creates a process of evidence. Another way of enhancing the dependability of the study was by explaining the procedures of data collection and analysis in this chapter, which are based on traditional methods of research (Bryman & Bell, 2011). This since the collection of data and data analysis were made simultaneously during the research process.

3.5 Research Limitations

Despite being regarded as a traditional research method, qualitative research has been subject of criticism in regards of being too subjective and impressionistic (Blumberg et al., 2011). Firstly, although the number of interviews are within the sample size limit of a qualitative study, it may be difficult to generalize the findings. The results are however providing rich descriptions of the use of BI in decision-making and might be useful in other comparable settings.

The findings are also exposed to the risk of own interpretations, bias and subjectivity. This considering two aspects: the application (Verge) is developed by the consultancy company, and used by the purchasing company. It should also be noted that this study has investigated the software QlikView only. Taking this into consideration; choosing a different software supplier might have provided different results.

As the interviews were conducted by both researchers, it may affect the dynamics of the interview. Further, as the answers were translated to English, there was a risk of own interpretations. (Collis & Hussey, 2014) To reduce this risk, the English versions of the transliterations were sent to the respondents subsequently, where the interviewees had the possibility to confirm or reject the statements to prevent any misinterpretations.

4. Findings

In the following chapter, the findings from the consultancy company and purchasing company are presented. First, the findings from how BI systems and analytics are used are presented, followed by how visualizations and BI systems are and may be used in decision-making. It ends with an outline of how the aforementioned parameters are used in each decision context.

Before implementing the BI system, the company was having troubles in controlling their business as they were not able to monitor their numbers on a regular basis or base their decisions on data, but were rather waiting for the financial statements for each month (Segment Manager). Hence, the initial targets of the BI applications were predominantly those on a strategic level in the organization (BI Manager). Further, the BI manager describes that this approach came to change and has successively included more detailed information on transaction level to support the operative processes of regulation rather strategic management control. This has called for more list boxes and tables which are simpler to export to Excel, as reporting from the original system of raw data was perceived to be inefficient. Hence, the end-users have increased, which has generated problems in finding ways for all end-users on different organizational levels to coexist in a single BI application (BI Manager).

4.1 Business Intelligence and Analytics

The primal purpose of a BI system is according to consultant 2 to support organizations in the decision-making by providing them new insights of their business. However, BI systems have come to be used for many different purposes in organizations today. One aim may be to reduce the manual efforts by employees and automate internal processes, while other use it to combine information from multiple sources and presenting it in an interactive way to support the decision-making (Consultant 2). This is consistent with the both the opinion of the BI manager and the BI developer at the purchasing company, declaring that a BI system aims to support the decision-making by enabling the end-user to observe the business progresses and hence control and obtain insights through new and historical data.

"*A central function of BI is to enable the end-user to monitor the business process and know if they are heading in the right direction in order to take actions and then be able to look at whether it was better or worse for the organization.*" (BI Manager)

Consultant 2 describes that today's organizations produce an extensive amount of data in different systems, but that the utilization of data is rather poor in general. The BI consultancy company is mostly working with structured data from ERP systems, which consists of tables with some form of valid logic. This is deeply depending on the maturity level of BI&A in the organization, where most companies have not advanced at the same pace as the technology and do not understand the real value of data discovery. However, it does not only concern the utilization of data, but also the visualization of data. This implies a role of BI consultants to guide the customers towards a more visual approach, designed similar to a dashboard, where the end-users may engage and interact with the visualizations to discover patterns in the data (Consultant 2).

"*Those organizations that use BI in the best way are those who develop their BI solution from an analytical perspective so the employees may actually play with the data to drive new insights instead of just having it as*

a questionnaire to collect answers. Companies using unstructured data and text analysis such as data from social media have a very high maturity level and are relatively rare. Companies utilizing this sort of data are understanding the greater picture of what we and Qlik are trying to convey." (Consultant 2)

Currently, the purchasing company have some applications which are integrating multiple systems, while some only extract data from one system due the vast amount of data (BI Manager). The BI developer describes that the applications are a consolidation of all end-user's perspectives and requirements, meaning that it is not divided by the end-user's role or position in the organization. The company has a priority group, which are responsible for assembling and prioritizing which information that will be developed and added to the applications based on the prerequisites of the end-users, making it a user-driven process according to the BI developer.

"*The process is user-driven in the sense that the end-users come with their specification what they want to visualize. Sometime it can be quick fixes or more acute visualizations we need to solve, which explains why some parts of the applications are less elaborate than others.*" (BI Manager)

4.1.1 Data Quality

"*The data quality is one of the greatest obstacles in creating a good BI environment. What is making it interesting is that it is often the first implementation of a BI system which causes companies to evaluate their data quality for the first time.*" (Consultant 2)

Consultant 2 continues by explaining that BI systems enable companies to visualize and detect errors in data and thus adjust the internal processes so it may be maintained and accurate over time. As this may be rather time-consuming for organizations, it often ends with BI consultants validating the data and making temporary adjustments in the data extraction by transformations.

"*Data preparation often tend to be one of the largest costs when purchasing a new BI system as the BI consultants have to clean up the mess.*" (Consultant 2)

The data quality is a part that the end-users also mention as an important function in BI systems. However, there are some consistencies regarding the accuracy of the data visualized in their BI application. Both the controller and the product manager assume that the data is correct and reliable, even though the product manager doubts that he would acquire exactly the right information due to his lack of skills in QlikView. The back-office manager is describing her role as more operative as she prints reports to customers based on data in the BI system, which calls for an increased necessity of reporting the exact amount. As the back-office unit is a relatively new user of QlikView, the employees have found it difficult to get accurate data as they define some KPIs and measures in a different way than what has become issued earlier in the BI application (Back-office Manager). Although the BI team has tried to adapt the application, many employees in the back-office unit rely more on the old system than QlikView. Further, the back-office manager describes that one reason for this may be the lack of education within QlikView, which has created concerns about how to make accurate choices and where the data has originated.

4.1.2 Architecture and Verge

Henceforth, the research aims to describe and analyze one QlikView application within the purchasing company called "Verge", named after the underlying source system. The application is currently extracting data from a single data system and aims to support

decision-making within one of the business areas in which it operates (BI Manager). The data is then transformed using connections and definitions provided by the purchasing company (Consultant 2). Finally, the data is visualized and distributed on a consolidated level to all end-users using a "DAR" (Dashboard Analysis Reporting) logic, meaning that it starts with a dashboard to provide an overview of the current situation and then continues with spreadsheets for analytics and reporting (BI Developer; Consultant 2).

The dashboard consists of comprehensive information regarding the amount of customers, purchases, net volume, and top five customers within each country it operates. The next sheets provide insights for analytics and reporting regarding the organization's customers, profitability, and information about their partners. In each of these spreadsheets, the end-users are able to make certain selections including which business area, product, customer, sales person, sales country, and time frame they want to observe and analyze. Furthermore, some visualizations are dynamic in the sense that the end-users are able to select different measures in order to support their specific task. Each of these measures are defined in the end of the application.

4.2 Data Visualization

Most of the visual elements consist of graphs and tables, which are often used through standardized visualizations from the application. In some cases, these elements may be adapted and adjusted depending on the end-user. This depends on the degree of knowledge, maturity level, and what elements are needed for analysis (Consultant 2). According to consultant 1, the presentation of data is important since it is involving the possibility of tweaking data, and how people are affected by data. The notion of how people perceive data may be influenced by the way of visualizing. Thus, presenting data in a certain order may impact the way the data is processed and how conclusions are reached (Consultant 1). Another factor highlighted during the interview is the colour scheme in BI visualizations. According to consultant 1, this should be uniformed throughout the entire application with free white space between the objects to accentuate how to process the information.

QlikView is used to a large extent as a visualizing function according to the segment manager. It is further argued that there are always attempts to analyze through visualizations. In most cases, this regarding if e.g. revenues are decreasing for a specific country. The important aspect is then to visualize to what degree revenues are decreasing, and the reason to why (BI Manager). It is however difficult to conduct proper analysis without disaggregating data through e.g. a table. In those cases, the controller becomes involved. The difficulties in visualizations are highlighted by the segment manager:

"It is an art to visualize data in a good way. It is required that you almost understand the implications in order to visualize in a good way." (Segment Manager)

Consequently, the visualizations may be presented in an incorrect manner due to missing parameters or dimensions. It is further described by the segment manager that the application contains a lot of data, but that complete reports are not used in decision-making due to the lack of availability. These reports are usually made by the controller, whereas the BI team is involved if statistical analyses are needed (Segment Manager).

The end-users are highly involved in the evaluation process of how elements are visualized, with the development being based on the end-users demands according to the BI manager. This is however mainly brought out by the controller and product manager, due to the high degree of use by both parties. The BI developer further explains that the operational staff may not care about the visual aspects, as the most important part is to retrieve a specified list from Excel. It is further described by the BI manager that when employees want to analyze a certain table, a graph is often implemented only for aesthetic reasons. This is although regarded as complicated, mostly since it is difficult to determine what is required as a basis to the visualizations (BI Developer)

"You are able to do a lot of fun with visualizations, you may be able to put it on a higher level with staples representing revenue and costs, and lists of the performance, e.g. trends." (BI Manager)

Consultant 2 describes that the work of reducing information overload is difficult, since it is both subjective and depends on to what extent one cares about design elements. It is described that some people want more and some want less elements presented. Dashboards and visualizations that were developed a couple years ago may not be produced in the exact same way today, due to technological advancements and new ways of improvement. When building QlikView applications nowadays, consultant 2 mentions that there is a focus to design them from a dashboard perspective. This includes top-level of data which may be disaggregated into smaller components in order to compare time periods and the performance.

Another way of reducing the risk of information overload is through the DAR logic (Consultant 2). According to consultant 2, the aim is to initially obtain an indication or trend which displays the current status of the business from a holistic perspective. From the overview, the end-users should then be able to dive deeper through analysis reports (e.g. drill-down). Furthermore, the application should be completed with the basis for performing different types of reporting based on the end-users needs and tasks (Consultant 2). Consultant 2 continues by arguing that the most popular method of presenting data in general is through straight tables and pivot tables with thousands of rows and columns. These are usually preferred by controllers, although not providing anything other than numbers. Consultant 2 further states that the numbers are used in order to steer future organizational performances as it is mostly used as a reporting tool, not necessarily to analyze how and why certain events have taken place.

Something that has been touched upon by all end-users is that the Verge application is unstructured and presents too much information at the same time. Nevertheless, certain dimensions are still lacking for certain tasks. This is also problematized by both the BI manager and the BI developer. As the application is consolidated and versatile, the BI team is having trouble in finding a way to get all end-users to cooperate in the same application. As a result, many have begun creating their own visualizations for specific tasks as they do not have the prerequisites for making decisions with the visualization available in the standard range. Consultant 2 emphasizes the risk of allowing end-users to create their own visualizations if they do not possess enough knowledge. By making incorrect calculations, the tool may hinder rather than helping the end-users in the decision-making (Consultant 2).

4.2.1 Cognitive Fit

The fit between user, task, and technology is not entirely universal at the purchasing company, as it differs between the respondents. Visualizations are often subject to trial-and-error with end-users due to the difficulties in determining a "proper" visualization technique initially (BI Manager). The parameters that are subject to calculations have been adjusted to the application, but there has been raised thoughts since these parameters have not been correct due to the use of the previous IT system.

"Instead we may want to disaggregate some parameters and work with then in order to do it quicker and more efficient. There is a lot of information being presented at the moment, and you don't really know where to start. We have started that process and are having a dialogue in order to know where the application is collecting the data, and then we know that we are able to use it in various aspects. I still wish that it had been more user-friendly." (Back-office Manager)

According to the product manager, these parameters may be presentable, but the difficulty remains in choosing the right parameters. If five parameters are chosen, there may be a risk of excluding important parameters such as number six or seven:

"Every occasion is unique. You may want X for one occasion, and Y for another occasion. The next time it may be Z. In summary, different parameters. I can't see how that would work." (Product Manager)

This merely highlights the benefits of working in an application such as Excel, due to the convenience and efficiency according to the respondents. The purchasing company has not shifted the focus entirely to QlikView, since a lot of focus remain in analyzing the data through Excel. Hence, differences in user, task, and technology regarding visualization still remain.

"I build a lot of my own objects, which creates a lot of ad-hoc. It usually ends up with my whole screen full of visualizations or objects. It might have been proper for me at that time, but I do not need all of that information right now." (Controller)

The controller further adds that the reason for building own visualizations is because some dimensions may be missing, e.g. how it differs between various countries. It is then more efficient to look at a holistic picture, as opposed to one object at a time. This also reduces the risk of information overload according to the controller.

"Reducing information overload is about removing everything and then add what is supposed to be there, and present it in a way that the information is clearly presented." (Consultant 1)

Hence, removing redundant elements and adding elements successively if it is needed. If the company wants to analyze a trend, it should be done through a line chart and not a bar chart. Whereas a pie chart would be optimal in order to analyze proportions between different departments. It is all a matter of the type of information that needs to be presented (Consultant 1). At last consultant 1 emphasizes that a major concern is to keep it simple; making sure that there is a lot of white space so that the focus is retained on the object, without interrupting elements.

4.2.2 Text and Graphical Representation

As a BI system, there does not seem to be a universal use of visualizations through the application, this no matter the role in any organizational level. The visualizations are predefined in QlikView, hence standardized

to all the employees working in the application. The BI manager continues by declaring that the there is a wide spread of text and graphical representations in the application. Visualizations may serve various purposes, thus be used in multiple ways unequally frequent. Similarly, the product manager states:

"It depends on if it is something I should do specifically or in general. I think it is good to combine graphs and I want to use it more, then you are able to compare and it is easier and more pedagogical to show it to someone who may not be familiar with the system. When I present it to people who know the system today it is easier to grasp what I am talking about using tables, but if you want to show the business value to someone at a higher organizational level; you want some form a graph that shows this value or how it looks like today. Then I think QlikView is a convenient way because all the data is in the software." (Product Manager)

Correspondingly, the controller and back-office manager argue that they often work with tables in the daily operational work as it contains more detailed information and is easier to export to Excel for reporting. However, when presenting the information to the team and product managers, graphical representations are more favourable as it is simpler to get a grasp over the current situation and find patterns in the data.

"I develop a lot of own visualizations, then I export the data and do calculations in Excel. I need a lot of detailed data, but regarding the strategic decisions; it is enough to look at a dashboard." (Controller)

The segment manager, working on a more strategic level in the organization, argues that graphical representations always are favourable from his point of view. Hence, the segment manager uses the dashboard and the graphs presented in the other sheets most frequent, while the text representations are more uncommonly used. The product manager describes the use of dashboards as infrequent, e.g. several times a month. The primary focus is to optimize the products from classical Excel calculations, which are made in collaboration with the controller. As a result, a lot of data is obtained from the controller and by asking for help. The product manager further states that the pre-made functions available through the software facilitates the process, while highlighting the possibility to create a dashboard on your own.

4.3 Decision-making and BI

The segment manager describes that the organizations has an underlying philosophy concerning decision-making in general. Decisions should be taken in the business, meaning that all employees should be involved in the decisions which are closely related with their daily work. The business managers are hence gathering information regarding the decisions that has already been made and disseminate it across the organization, rather than making all the decisions themselves. Further, the segment manager declares that the organization is team-controlled to the highest extent where the various departments work across the borders in different projects and subprojects. This in order to enable information and knowledge sharing across the organization and see all the interests from a more holistic perspective (Segment Manager).

"We work very closely with teams – we barely have departments here. We try to have an agile and action oriented decision process, which makes it important to coordinate with other people who are concerned rather than working in departments separately. It is more about gathering information, build arguments, evaluate what needs to be done, and then present it to

the team manager or the product owner of that area. Then, of course, if there is a larger project, someone on a higher level in the hierarchy with a more strategic responsibility needs to set the priority." (Back-office Manager)

Those responsible for each business area and project arrange weekly meetings to discuss which projects to prioritize where there are lack of resources (Controller). Hence, these meetings tend to have a more detailed and operative characteristic as all participants have detailed knowledge in the field. The controller further describes that monthly reports are conducted to the board of directors, which involves more strategic matters and cost-benefit-analyses. Thus, a more holistic perspective of the business is essential to get a grasp of all products and how they interrelate.

The segment manager explains that some decisions have a clear decision process, while others are more fluid. In general, decisions with a more operative character have a clearer process. This statement is supported by the back-office manager, declaring that the decision process is relatively clear:

"*The decision process is not bureaucratic or complex in that sense. It is rather the decision in general and the way we are cooperating that is complex."* (Back-office Manager)

Accordingly, by dividing the responsibility on the employees and teams respectively, the segment manager tries to allocate the decision-making on the one who has most experience and information instead of having a strict decision hierarchy for each decision (Segment Manager). The segment manager still believes that the organization is in general too bad in making decisions based on data from BI systems. This due to missing dimensions that are broadening the level of perspectives and thus enabling deeper analyses. One example of a missing dimension according to the segment manager, is the opportunity to investigate customer insights such as qualitative data of customer needs and customer satisfaction. By including parameters that allow closer contact with the market, the organization may base complex market decisions on data to a greater extent than just testing different alternatives (Segment Manager). However, the segment manager is critical to just basing these complex decisions on data as one may be caught in a "data trap", where you do not know what you want to visualize anymore.

"Currently, the reports are based on what you think you need to see in order to make decisions. What is of interest is what type of decision or support you need to create more informed decision-making." (Segment Manager)

The BI developer is however elucidating that the company is currently working on integrating systems to enable new dimensions of analytics, while still trying to decorticate it by making it more personalized for each end-user.

"Setting up multiple systems is something we are trying to establish in general. More and more BI applications we develop are rather a combination of multiple sources of data, which creates an increased value for the end-user by allowing further exploration from multiple dimensions. We are constantly trying to move from dump pipes and hence be able to follow a process throughout one application rather than shifting between three QlikView applications and yet export the data to Excel to get a sensible decision basis." (BI Manager)

4.3.1 Operational and Strategic Level of Decision-making

The purchasing company differs between operational and strategic decisions in terms of

the time frame. Operational decisions are made on a daily basis, whereas strategic decisions are often discussed on a monthly basis. The strategic decisions are often analyzed at an interval of three months, whereas the operational decisions are revised after six months.

The back-office team is relying on QlikView in daily decisions (Back-office Manager). It is further described to be used in order to ensure that one may trust the data; that it is reliable and qualitative. The data is used in order to improve processes and act as a base to decisions, which are made by collaboration with others at a later stage. The ability to obtain core data in an efficient manner becomes the driving force to the decisions. It facilitates the decision-maker's ability to make decisions, as the priorities are set when the business value is clear from a strategic perspective (Back-office Manager). The back-office manager further states that the main reason as to why decisions are not made is due to a lack of resources and not data.

The communication with the board of directors is handled through the segment manager, but is often discussing with the product manager. The product manager base decisions on customer insights, which are used to analyze and evaluate the progression and how to align product strategies. The data has a more qualitative character in that sense, complemented by classical Excel calculations derived from QlikView. Furthermore, the product manager states that there is no universal "right" decision. This since what was correct one year ago may not be correct in present time. Thus, the purchasing company always strive to focus on one alternative since several alternatives may prove to be equally wrong. Similarities may be drawn between the back-office manager and the product manager; both stating that there is no right universal answer to decisions. Hence, the product manager highlights the importance of not analyzing historical data only:

"It does not necessarily have to be prognoses, but if we want to change our pricing model, it's not interesting to see how it has been historically. It's more interesting to see how it will be in the future." (Product Manager)

The BI manager states that the overall goal is to use the BI application on a strategic level, whereas the use of the application is mostly on an operational level. The use has progressively expanded from the strategic into also including detailed operational tasks. The desire has been to separate the areas depending on the user and role, as the end-users have experienced difficulties in navigating through the application in its current state (BI Manager). The BI manager further states that there are levels of operational differences, with the objective to not use tables or lists in any form of operational process. This since the purchasing company is relying on one person to produce the list, and others to perform actions based on this list. The purpose of a BI system is to be able to create something beyond regular lists (reports) according to the BI manager. There is a danger in only focusing on these reports, since it is often not the correct base to a major decision (BI Manager).

"In an ideal world, you should not be stuck in anything operational that has an impact. If we would shut down the QlikView application today and turn it on in a week: it should not affect the business. We may miss to make some decisions of an analytical character, but the business cannot fall because of this." (BI Manager)

The BI manager concludes by claiming that the purchasing company has challenges in terms of the operational aspects. There is a tendency to focus too much on this, since there is no other option. There is no other way to produce the operational lists, which are mostly used by the back-office team. If these lists were made from data extracted from two systems, it would be easier and feasible. The idea is to not use lists at all, but an exclusion of lists may affect the work process of other team members (BI Manager).

4.3.2 Experimental Setting – Decision Contexts

This section presents the results from the experimental interviews, where the respondents were asked about how decisions are made within different decision contexts. The conditions for each context were explained in beforehand to the respondents. The respondents then had the opportunity to provide a practical experience to each context.

4.3.2.1 Simple Context

The back-office manager explains that most decisions in the daily tasks relate to situations where the context is rather simple. The decisions are based on data from the BI visualizations or in some cases other sources of information, when the data is not available in QlikView. Further, the back-office manager relies to some extent on reasonableness based on intuition.

The controller highlights a smaller adjustment of the product offering as an example of a simple decision context as it is easy to forecast the outcomes. The controller would base the decision of data presented in QlikView and make the forecasting in Excel. In addition to this, the controller points out that these decisions are based on some form of intuition, which most often occurs to be correct.

Similarly, the product manager highlights that decisions are often based on simple assessments of profit and loss regarding product changes:

"This is a situation where it is easy to calculate the volume and cost today and compare it with the calculated outcome of tomorrow." (Product Manager)

The decision in this context are based on facts from QlikView as the application contains all relevant data (Product Manager). However, the product manager is exporting the data to Excel to simplify the forecasting. Whether other employees are involved in the decision depends on whether the data is easy to access (Product Manager).

The segment manager describes the simple context as signing up a new deal. This is regarded as one of the most formalized and structured decisions processes, where the task for the segment manager is simple and repetitive. Further, the segment manager describes that he does not use QlikView directly in these decisions. They are rather based on information provided by the sales team, which may however be based on data from BI visualizations. As this is argued to be rather inefficient despite its simplicity, the organization is aiming to increase the automatization to avoiding these decision situations as they become a bottleneck in the process (Segment Manager).

The segment manager also emphasizes that there is a risk that decisions in this type of context will be perfunctory, which may lead to lack of quality in the decision. This is again one reason for attempting to build systems

and processes for handling these decisions rather than base them on the human factor in this context (Segment Manager). This risk is emphasized by the back-office manager as well, concretizing the processes of generating reports to be sent to the customers.

"By systematizing the process, we can reduce the risk of people filling in different criteria and parameters, resulting in the customers receiving different information." (Back-office Manager)

4.3.2.2 Complicated Context

As described by the back-office manager, decisions in complicated contexts is much about making sure that the numbers are correct to ensure accurate analyses. It is explained as simple automatic, but it is important to incorporate the plausibility judgement. This in order to know what is plausible and how it has been historically. The calculations are supposed to be made by QlikView, so it is more about demanding what type of data should be in relation to other data. If the process is not correct, the back-office manager evaluates the BI system, talks to the people in charge of the BI system or the report. By that time, the source to the problem may be found.

In terms of analysis, the degree differs between the back-office manager and the controller, as this context is described by the controller regarding how revenues are gained from customers. Some customers are more demanding and require special solutions to their businesses. In these cases, the pricing structure is evaluated and may be configured, which may lead to the consequence of a decline in trust towards the customer. Various departments are involved in these decisions in order to make judgements and analyze if any changes in processes are needed. These processes may be adjusted in order to e.g. reduce costs, which have been done gradually by the purchasing company (Controller).

Instead of focusing on an already existing product and revenue gaining, the introduction of new products or when an existing product is introduced to a new target group, is highlighted as an example by the product manager. If the purchasing company has worked with a product towards the consumer market, and the same product is applied towards the corporate market; it is unknown whether the behavior is similar according to the product manager. Hence, it is difficult to know the outcome. Modulation is often required to analyze best and worst case scenarios. The product manager continues by stating that data from QlikView and the specific application would be used in these cases, although modified in order to make assumptions and create some form of case. In that sense, QlikView is merely used to export data which is analyzed through Excel. Due to the cases being different at every occasion, it is difficult for the product manager to have all the data in QlikView, since every existing parameter is needed. During the work process, similarly to statements by the controller, the product manager involves other departments of the business. Usually, the controller is involved in order to verify the assumptions and thoughts made by the product manager. However, the data analysts may vary depending on the case as concluded by the product manager. .

In similarity to the controller, the segment manager argues that a complicated context occurs when pricing structures are made in new deals; the levels of pricing and various components which may build the pricing structure. As exemplified by the segment manager:

"Then it is easy to use Excel to provide a pre-calculation on the deal, and then we use QlikView in order to ensure some type of data." (Segment Manager)

Afterwards, the purchasing company calculates different scenarios and values the reasonable pricing structure for the customer. In that sense, data is used to understand if there is a risk connected to what is expected by the customer. In these decisions, the controller is usually involved. However, the sales team is often conducting the calculations if the decision is of a less complicated character. This in order to ensure that some parameter is not missing or to gain customer perspectives (Segment Manager).

4.3.2.3 Complex Context

The back-office manager highlights situations where processes are set up for new major customers as an example of a complex decision context. This calls for ways of trying to adapt the product to fulfil the demands and requests which have been promised by the sales team. Hence, a complexity is present, where uncertainty about how it is depleted reflects the situation. The back-office manager describes that these decisions are based on information from multiple sources, where QlikView may be one of them, which is exported to Excel for further analysis. This also calls for project teams with a spread of expertise. In the end, the back-office manager points out that it is often the case that you learn from the decisions afterwards, through "learning by doing", in which experience and then intuitions are founded.

The statements from the back-office manager are aligned with those of the controller; as the introduction of a new large customer is highlighted as an example. The controller further states that these customers know that they have a lot of power, leading to negotiations regarding prices. In these cases, the controller is collaborating with the sales team and it may be difficult to know how the customer will react. Hence, the purchasing company tries to module likely scenarios regarding what may happen. Due to the competition, it is important for the salespersons to be good at finding the customers' needs, but it is also important to have correct calculations so that the salesperson may provide deals beneficial for both parties. The controller further claims that the trust may decrease to a high degree if the customers are informed that the deal is not working for the purchasing company, since the word is easily spread in the business.

The product managers are usually involved if the solution is specially designed to the customer, judging the feasibility and the necessities required. It becomes a form of check-list that specifies how the offer is supposed to look like. Apart from the product managers, IT is involved since an IT solution is being implemented. A lot of aspects may be improved due to the commonness of realizing improvement areas gradually. The controller concludes by stating that it is difficult to know whether the right persons are involved or if the amount of people involved is sufficient.

The product manager describes business situations where there is a relationship between cause and effect, but where the solution to the underlying problem cannot be predicted, often occurs in situations with a more strategic character. It may also appear in business situations which one have not encountered before, such as product launches, introducing new customers and implementations of new systems.

"We invested in a CRM system many years ago, in which we could not realize the actual complexity. How much evaluation and data we had, we would never have understood it due to its complexity. The implementation was rather based on someone's intuition and earlier experience in the system. After two years, no one worked in the system anymore." (Product Manager)

The segment manager provides an example to the context as introducing a product to a new customer group. The segment manager further explains that it is possible to analyze that customer group and evaluate behaviour and demographical information too much, while simultaneously knowing that there will no progress until the purchasing company tests the product. The fundamental approach described by the segment manager is: *"let us try and see"*. This is however a challenge to the majority. Sometimes, the company needs to dare to make decisions without a lot of facts in some cases. When complex decisions are made, the role of the segment manager is to ensure that team members have learnt from bad experiences (Segment Manager).

4.3.2.4 Chaotic Context

A chaotic scenario is exemplified by the back-office manager through the introduction of new merchants. Once new merchants are introduced to the purchasing company, the demands or requests are settled. Thus, it is more about meeting the demands, but there is an uncertainty whether it will work or not. There may be some form of complexity in that matter, since the outcome is uncertain. After two or three months, however, the solution becomes clearer and the organization may focus on finding a long-term solution to the drawback (Back-office Manager). The back-office manager further explains that this is the general view of the business; what was said from the beginning might not be delivered in the end. The notion of time and feasibility also differs, which is the main reason to why chaos occurs. The calculations need to be based on data that is reliable and accurate. If data is sent to the customers which both is unreliable and different to the customer's data, the trust may decrease to a level where it is merely impossible to repair. That is the most chaotic part according to the back-office manager, while concluding that positive things may arise from chaotic environments.

Interestingly, the controller argues that this is a difficult situation, due to the lack of experience in this field. There is often something which has a relationship to other parameters. The controller concludes by stating that the purchasing company sees the chaos in the situation, and then tries to analyze what is needed to improve the situation. Thus, there is not a complete stop to the problem once it arises.

In contrast, this scenario is easy to describe according to the product manager: stating that there was an experience involving a confidential business situation that the purchasing company thought was proper for their customers. The authorities interfered since the way to enter agreements was not according to regulations. It was then necessary to change systems and processes, which eventually led to a manual process of dealing with agreements. At the same time, a team was put together with the objective to find the long-term solution. When these situations occur, the first indication becomes acute and the information needs to be communicated to the customers. Afterwards, the problem is evaluated in terms of what went wrong and why. The product manager further elaborates and explains that in this context there is no analysis from QlikView data. This because the purchasing company is

missing that sort of data in the application. Instead, the focus is to analyze what has happened through the primary source. Once the problem arises, a team is put together, in which the decision is made (Product Manager).

There are similarities in the consequences of the example provided by the segment manager, although the example is not identical as the one provided by the product manager. The segment manager describes that the purchasing company handles decisions in a proper manner, even though it is difficult to predict whether it is right or wrong. It is a natural part to fix wrong decisions, but also to be flexible and agile in these situations. He continues by providing an example related to the chaotic context. The purchasing company expanded their customer target group, not only focusing on larger customers. At a later stage, the purchasing company realized that there was a need to work with smaller customers through a quicker and more collaborative process. The consequences became a complete stop in the process of signing new customers, since there was an overload of newly-signed customers every week, and the requirements were too high. The decision was conducted, but the purchasing company realized the need to tweak the solution since it did not work. Eventually, everything needed to be adapted in order to satisfy the needs of smaller customers. Since then, the segment manager explains that the purchasing company has moved towards the middle: creating automatic processes to handle these customers. At first, the purchasing company did not know about the consequences since it was supposed to work originally (Segment Manager).

4.3.3 Decision-making and Data Analysts

According to the respondents in the purchasing company, it is rare that only one person is involved in making decisions. The problems are often discussed daily in the project teams or during monthly reconciliation meetings. This often requires the involvement of people that may have an interest or expertise in different areas that are involved. Among others, this may be legal advice from legal practitioners and data experts and analysts from the IT and BI team.

The back-office manager describes the organization as agile, where projects are being undertaken by persons affected by the specific decision. It often requires some form of expertise and judgement before decisions can be made. Similarly, the product manager states that experts are involved if any product changes are made, which usually involves discussions with the segment manager. Hence, the involved person helps to bring up the facts. If there is any need of functionality changes, IT is presenting information and proposals which helps in determining the decision. This is also consistent with the opinion of the controller, arguing that there are mostly several people involved in the decisions.

The role of IT has however changed during time. Initially, the BI manager and BI developer were more involved in teams responsible of analyzing data in specific projects. Thus, it was a greater focus on supporting and explaining to other team members how to use the data to make more informed decisions. This has gradually shifted since the controller started at the purchasing company according to both the BI manager and the BI developer. Nowadays, the controller coordinates with the BI team when new aspects are added to the decisions, but is

responsible for the daily analyses in QlikView. The BI manager is also involved in decisions whether parameters and dimensions should be added or removed from the BI applications (BI Manager). This facilitates the workload of the BI manager and BI developer since the controller may cover a lot of the questions being raised. This resulting in more time available for BI system developments, while at the same time providing less insights in how the BI system is used in practice (BI Manager; BI Developer)

The controller views the information gap between knowledge and IT as more of the opposite, since the priorities are made together with people from IT. The controller describes that the exchange of information is communicated to a great extent, although it might sometimes be difficult to know exactly why it could take more time than expected. It is often because the people at IT are working on different projects or subprojects to the solutions that are not visible. The purchasing company further adds that the legal department is an important supporting function in the decision-making. Stricter rules are successively implemented to the business from authorities, which requires expertise in order to make the solution future proof.

"If I know the facts I need to obtain, I choose the right person to bring the facts." (Segment Manager)

Further, the segment manager states that the involvement of IT or other data analysts depends on the need in the specific decision situation, in which it may be some form of data modulation or calculation. The people from the BI team assist with deeper analyses, understanding of behavior, and ensuring the data from a statistical aspect. There is a need for technical competence in order to understand how elements are designed and how much work is required. The segment manager concludes by stating that in regards to decisions based on data, it is often obtained through some form of data source.

4.3.4 Data vs. Intuitions

All respondents in the purchasing company describe the significance of combining both data and intuitions in decision-making, rather than only one of the solely. Both the back-office manager and controller argue that decisions are often based on some form of "gut feeling" or experience, in which one attempts to obtain support from BI visualizations. However, the product manager stresses the danger in only relying on intuitions as the historical truth may differ from today's truth.

"BI is necessary in order to not only focus on own intuitions. If there is no BI system, it is easy to say that the intuition is correct, because there are no counterarguments." (Consultant 2)

Consultant 2 continues by arguing that intuitions are important to formulate hypotheses, which may be tested against data. It is through intuitions that end-users may find new aspects based on experience in how the organization works. This is consistent with the opinion of the BI manager, stating that intuitions and logical thinking in combination with data is a necessity in finding the optimal way of making decisions.

Regarding basing decision on intuitions or data, the segment manager is critical in just basing decisions on data as one may be caught in a "data trap" as explained earlier. There must be a balance between these features, in which the partition may differ depending on whether the decision has an operative or strategic characteristic. However, the segment manager still believes that the

organization in general is too bad in making decisions based on data derived from BI systems due to missing dimensions of analysis.

5. Discussion

This chapter discusses the findings and the theoretical framework derived from the research questions. First, how BI visualizations are and may be used in various decision categories are discussed. Next, how BI visualizations are used in different decision contexts are outlined. Finally, the role of data analysts is addressed as a complement to the BI visualization in the decision-making.

5.1 BI Visualizations in Strategic and Operational Decision-making

Aligned with statements suggested by (Frisk, et al., 2014), the purchasing company engages in various types of decisions. Similar to the classifications made by Ansoff (1965), the decisions conducted by the purchasing company are usually on strategic or operational level, highlighting the wide use in both academia and practice (Holopainen & Toivonen, 2012). Operational decisions are frequent and require monitoring on a daily basis, with a focus of maximizing profitability according to Ansoff (1965). Accordingly, the back-office manager and controller are working with tables from QlikView in the daily operational work, as it is easier to depict more detailed information. This information is subsequently extracted to Excel for reporting purposes. In cases when the information needs to be presented to the senior management for decisions with a strategic character, graphical representations are preferred in order to grasp patterns in data.

In contrast; strategic decisions are problems of external character in the organization which often require proper analysis (Ansoff, 1965; Borking et al., 2011). These decisions are usually analyzed in depth by the purchasing company after three months, including how to work on a strategic level in general (Product Manager). In these decisions, historical data is a prerequisite to conduct forecasts of future events. Similarly to the literature, these decisions are crucial since it will guide the direction of future actions (Mitchell et al., 2011).

The primary purpose of BI systems for the purchasing company is to support these decisions with a strategic character by providing the business with new insights and monitor business processes (BI Manager; Segment Manager). This is corresponding with the literature, meaning that BI systems should provide organizations with information to simplify the decision-making based on more accurate and reliable data (Chaudhuri et al., 2011; Lim et al., 2013; Yeoh & Koronios, 2009; Wang, 2015). However, BI systems are also used for operational purposes in the organization to e.g. automate internal process and reduce the manual efforts by employees. This is problematized by the BI manager as the requirements and requisites differ radically between strategic and operational tasks, which calls for new adaptations of the current BI application. These adaptations may cause complications as the basis for decision-making need to be implemented expeditiously, while still include the right calculations and visualization for the specific task.

All respondents emphasize the significance of data quality, in which is there are some consistencies regarding how they perceive that the BI application visualizes the accurate data aligning with their task, definitions, as well as expectations. This depending on whether the end-user has been a part of setting the requirements for the visualizations and how frequent they use QlikView. Hence, it may be difficult to satisfy all end-users in providing data that should be used for analytics to support the decision-making (Isik et al., 2013).

Consultant 2 argues that data quality is a highly essential prerequisite for a BI system in order to generate a value for the end-user. This corresponds to Marshall and De la Harpe (2009), contending that BI systems must reflect a high level of comprehensiveness and consistency of data in order to be valuable in the decision-making. Even though data quality is an inevitability in providing sufficient BI visualizations, it may also be one step for organizations to detect errors in data so it may be maintained and accurate over time (Consultant 2). This may in turn lead to more proactive and reliable decision-making over time.

The BI application is currently based on structured data, which consists of tables with some form of valid logic. This is most common in organizations today according to the consultant 2, explaining that it is rare to find companies using an integrated approach of data processing which also includes unstructured data and text analyzes. This statement is corroborated by Baars and Kemper (2008) and implies that the company or application falls within the level of maturity referred to as BI&A 1.0 (Chen et al., 2012). The company is however working on integrating new dimensions and parameters in the application (BI Manager), which is a step in the right direction of understanding the real value of data discovery (Consultant 2). This may result in what Chen et al. (2012) categorize as the second level of maturity, where vast amount of both structured and unstructured data is visualized to get deeper insights of the organization and its business processes. However, this is not only concerning the data extraction, but the visualization of data as well. By creating more interactive, initiative, and humanizing visualizations, the end-users may discover new patterns of information and enhance the cognitive fit without being overwhelmed by data. This enables the purchasing company to discover new patterns and conduct deeper analyses and thus base more decisions on data as opposed to intuitions solely, which may lead to improved decision-making.

The purchasing company always strives to analyze situations through visualizations in order to conduct proper analysis. The end-users are highly involved in the evaluation process of how parameters are visualized, but the degree of use of the application varies between the team members. Important factors in determining the extent to which the application is used includes the user-interaction and simplicity of the visualizations (Ariyachandra & Watson, 2006; Delone & McLean, 2003). This differs to some extent to the findings, since the aim is to work from a holistic perspective and because the end-users claim that the application may be complex and unorganized at times.

5.1.1 The Use of Visual Elements in Different Tasks and Categories of Decisions

The purchasing company describes that visual elements are used through the application. These consist mostly of standardized multidimensional visualizations which may be accessed by all departments, usually in the form of graphs or tables. Accordingly, visualizations may be depicted in various forms according to Basic & Fadlalla (2016), claiming that the traditional use of visualizations has been through graphs and tables, but has shifted to multidimensional graphics. The degree of use in terms of graphs and tables differs at the purchasing company, mostly depending on the end-user and role in the organization and the underlying task.

The purpose of BI visualizations of the purchasing company is to obtain a clear understanding of the current business state and analyze what is happening and why, hence indicating that visualizations are used in order to support decision-making as argued by Basic & Fadlalla (2016). However, there is a tendency that the BI application is currently focusing too much on the operational aspects according to the BI manager. Products are optimized from Excel calculations made collaboratively by the controller; leading to implications which may hinder the future prospects of the purchasing company.

Accordingly, consultant 2 claims that the most popular method of presenting data on an operational level is through straight tables and pivot tables with thousands of rows and columns. These are usually preferred by controllers, although not providing anything other than numbers. Consultant 2 continues by stating that these numbers are used in order to steer future organizational performances as it is mostly used as a reporting tool, not necessarily to analyze how and why certain events have taken place which is the initial purpose of BI visualizations in the organization.

In contrast to operational decisions, graphical representations are favorable on a strategic level according to the segment manager. This as dashboards and graphs are more frequently used as opposed to textual representations in strategic decisions. The literature states that graphical representations simplify the understanding of data due to the perceptual abilities of understanding and recognizing patterns (Lurie & Manson, 2007; Miettinen, 2012), which is one feature of visualizations according to Gendron et al. (2016). Similarly, the point of view of the segment manager is that graphical representations are always favourable as it simplifies the understanding of patterns in data. This in order to obtain an overview of the current situation and comprehend the outcomes of various decisions.

The literature further describes that end-users may be overwhelmed due to an excessive amount of information derived from multiple information systems (Yigitbasioglu & Velcu, 2012). This applies to the purchasing company, since several sources are used to obtain additional data through other applications and the underlying source system. Further, Yigitbasioglu and Velcu (2012) state that organizations may prevent information overload by the means of BI visualizations. This may be viewed as a paradox to some extent, since Yigitbasioglu and Velcu (2012) state that the use of BI visualizations may hinder information overload, while simultaneously claiming that there is no clear definition to how e.g. dashboards should function. The difficulties of information overload are stressed by consultant 2, stating that it is subjective and depends on the care of visual design elements from the end-user as well as the underlying task. Some end-users want more visual elements and some want less. It may then be perceived as more difficult to reduce information overload as opposed to observe and analyze performance through a dashboard as claimed by Yigitbasioglu and Velcu (2012).

Hence, the use of graphs and textual representations do not only depend on the whether the decision is made on an operational or strategic level. Other important factors are the underlying task and the mental level of the end-user, aligning with the cognitive fit, which makes it difficult to determine if a specific graph outperforms another (Miettinen, 2012).

The cognitive fit discusses the importance of finding the right BI visualization which is supposed to be on the same mental level as the decision-makers according to Vessey & Galletta (1991). It suggests that the decision-making is supported when visualizations are presented in a simplified manner in order to not overload the end-user's cognitive bandwidth (Park & Basole, 2016), although this seems to be the case as suggested by the findings. This mostly since it is difficult to determine a proper visualization technique, and since most of the visualizations are tested through trial-and-error (BI Manager).

The literature further describes that the visual interactions are supposed to enable end-users to explore visualization elements in order to reduce the risk of information overload (Park & Basole, 2016; Pike e al., 2009). This somewhat aligns to the purchasing company, since the ability to manipulate visualizations exist although this is often done by the controller through e.g. creating own visualizations. The modern challenge is to cope with the changing business dynamics which requires the data to be presented and updated in a timely manner (Shim et al., 2002).

The theoretical arguments do not seem to be entirely aligned with the practice of the purchasing company due to the non-user-friendliness of the application, the technical underlying complexities, and the remaining difficulties in choosing right parameters to present. This is corroborated by claims from the back-office manager, arguing that there is an excessive amount of information being presented which leads to information overload and concerns in knowing where to start. Consultant 1 argues that redundant visual elements should be removed in order to present and elevate the important aspects. The current state of the application presents all the information in an integrated manner, with the aim of a holistic perspective. Similar to the literature: the interactions need to pleasurable, initiative and humanizing in order to enhance the cognitive fit (Kolko, 2015). This may be achieved through DAR (Dashboard Analysis Logic) according to consultant 2, which focuses on obtaining analyses through drill-downs of information from a holistic perspective. As a result, difficulties for the BI developers may arise as the end-users need to get a grasp of patterns in information from a holistic perspective, which due to the vast of amount of data may increase the risk of information overload.

5.2 The Use of BI Visualizations in Decision Contexts

Snowden and Boone (2007) emphasize that there is no one-fits-all solution for decision-making, but rather a set of multidimensional contexts defined by the very nature of the relationship between cause and effect. Accordingly, the respondents describe a variety of problems in these situations, with different characteristics, consequences, and actions to cope with the underlying problem. This resulting in distinctive decision models, in which BI visualizations are used for different purposes and tasks.

The simple context is recognized by a balanced relationship between cause and effect where the actions are repeatable and predictable, leading to one "right" answer to the business problem (Snowden & Boone, 2007; 2010). Hence, after providing the respondents with this information, all exemplifies situations where the outcomes are simple to forecast. These decisions are often initially based on some form intuition, which is used to formalize a hypothesis to be tested against data. However, how to acquire the data differed between the respondents.

The back-office manager and the controller predominantly use QlikView, if the data is available in the data model, to visualize and categorize the information. Otherwise, data is accessed directly through the underlying data source (Back-office Manager). The extraction of basis for the decisions differs somewhat for the segment manager and product manager. They mean that QlikView is rarely used directly to extract data in these situations. Instead they are provided with the information from someone else with a supporting function e.g. the controller, which in turn based the underlying material on data from the BI visualizations. This is corresponding with Snowden and Boone (2007) describing the decision model as: sensing the problem, categorize it based on facts, and then respond to the decision situations.

In complicated business contexts, the respondents describe situations which require more analysis, as it is more difficult to predict the outcomes. In order to ensure the data quality and making the "correct" answer given the prerequisites, experts of various areas are involved in the decisions and each project team. Similarities may be drawn to the framework provided by Snowden and Boone (2007), arguing that there is a relationship between cause and effect, but is rather onerous to detect and analyze. Experts are thus involved in sensing, analyzing and responding to the decisions, where fact-based management is an essential part of the decision process (Snowden & Boone, 2010). As such, all responds argue that BI visualizations are used to export data into tables in Excel, where further calculation are made. This as the current BI application does not encourage forecasting in a simple way as Excel. Consequently, tables may be converted back to graphical representations and then presented to co-workers on a strategic level in the organization.

Snowden and Boone (2007) recognize the complex context domain as a system without causality between cause and effect. This makes the outcomes of decisions unpredictable in beforehand and thus only obvious in hindsight (Snowden & Boone, 2010). All respondents exemplify the complex domain by discussing scenarios of relationships with new customers. These often occur when the business situation has not been encountered before, which results in lack of data as a basis for the decisions (Product Manager). Consequently, decisions in this context are usually tested before evaluating and executing the actions fully, in which more data is available for the analysis. This also encourages "*learning by doing*", in which experience and intuitions are founded through patterns which may be used in similar situations (Back-office Manager). Parallels may be drawn to Snowden and Boone (2007), explaining the decision model as testing the action to get a sense of the situations based on patterns in the data and then respond to the problem.

Although the examples of chaotic decision contexts provided by the respondents in the purchasing company are not the same, there are similarities in their characteristics, consequences, and actions. Time and feasibility is lacking, which requires agile processes of handling the problem quickly (Back-office Manager). Hence, it is impossible to determine the actual effect in both foresight and hindsight (Snowden & Boone, 2010).The respondents further argue that the first response is to stop the most acute bleeding and then find a way to solve the long-term situation correctly. Resemblances exist between the respondents' explanations and The Cynefin Framework

presented by Snowden and Boone (2007), in which the decision-making model is described as first acting in solving the immediate problem and then sense and respond to the drawback. The respondents conclusively explain that the BI application does not extract the type of data that is required to make decisions on how to proceed in such situations. However, the segment manager emphasizes that BI visualizations may be used in a larger extent, once the data has been collected.

5.3 Decision-making and the involvement of Data Analysts

This particular area is not the subject of a research question, although it has been emphasized as an important topic of discussion. As such, these findings are worth highlighting in the analysis due to the amount of information obtained from the respondents.

The involvement of experts or analysts is common since decisions are discussed daily in project teams or during monthly meetings. Some form of expertise and judgement is often required depending on the area of interest according to the respondents. Furthermore, the segment manager and product manager state that it is also common that they ask the right people to bring up the facts for decisions. The right person in these cases often refer to the controller or co-workers from the BI team if deeper analysis is required, but may also be other analysts e.g. the legal department or IT. This corresponds with Viane (2013), arguing that data analysts need to be involved in the decision-making to a higher degree since the decision-makers do not always have the knowledge of data analytics.

Viane (2013) further argues that expertise knowledge may result in challenges regarding the information gap that may arise between the analysts and decision-makers, due to the lack of analytics knowledge from the decision-makers' perspective. In this sense, analysts obtain more power and information than the decision-makers; resulting in information asymmetries which may lead to negligence of the advices made by the analysts (Bonaccio & Dalal, 2006; Yaniv & Kleinberger, 200). Although stated in literature, it differs in this study. The controller does not think that such a gap exists, since the priorities are made in collaboration with coworkers from IT. It is further described that the degree of information exchange is high between people from IT and other team members.

As such, relying on BI visualizations is not always enough. This since decisions often need the involvement of analysts or experts to make sure that the priorities are set, and to ensure that the underlying data for decisions are accurate and reliable. Table 3 summarizes the findings from the interview and synthesizing the analytical framework.

Visual elements	Strategic decisions	Operational decisions	Simple context	Complicated context	Complex context	Chaotic context
How visualizations *are* used	Graphical representations, dashboards.	Tables, easier to export to Excel for a more detailed analysis.	Information derived from a supporting function, in which the material is based on BI visualizations. Fact-based management.	BI visualizations used to export data into tables in Excel. Fact-based management.	”Learning by doing”, as more data is needed due to evaluations and tests of decisions in order to search for patterns. Pattern-based management.	Visualizations are not used, since the application does not extract the type of data that is required to make decisions on how to proceed in such situations.
How visualizations *may* be used	Pre-made visualizations through QlikView, highlighting the possibility to create own dashboards and graphical elements.	More focus on the use of QlikView. The possibility to conduct calculations should outperform the need for Excel.	N/A*	N/A*	N/A*	N/A*

***** Not applicable

Table 3: Synthetization of the findings from the interviews and the analytical framework.

6. Conclusion

This section concludes the study by addressing the research questions. Additionally, theoretical contributions are emphasized, followed by a discussion of the managerial implications. The section ends with suggestions of future research directions.

Prior research has identified BI systems as an information tool used to extract, integrate and visualize information in order to increase business insights and thus support decision-making in organizations. By aligning the human abilities and visualizations provided by BI systems, decision-makers may interact with extensive amounts of data without being overloaded with information. However, as the socio-technical effects in the decision-making has remained rather unexplored, this study investigated how BI visualizations are and may be used to support strategic and operational decisions, and how they are used in various decision contexts. This was achieved using three guiding research questions, operationalized in the analytical framework developed in section 2.5. The analytical framework helped investigating the main questions of how BI visualizations are and may be used in strategic and operational decisions defined by Ansoff (1965), and how they are used in different decision contexts as recognized by Snowden & Boone (2007).

The findings in this study suggest that BI visualizations are used both to support decision-making from a strategic perspective and for operational errands. This by providing the business with new insights, monitoring business processes as well as enhancing the efficiency of operational processes. However, the findings indicate that the usage depends on the decision situation, in which decisions made in the fact-based contexts domains tend to be based on intuitions and BI visualizations, before responding to the business problem. This differs from the pattern-based management domains, in which actions are done prior to the analysis as there is lack of data. BI visualizations may be a part of these analyses in some cases, but is mostly derived from "*learning by doing*", in which experience and intuitions are founded through patterns of similar situations. However, the organization sees the possibilities of using BI visualizations in these decision situations to a higher degree, but that there is a need of more data integrated in the system. Regardless the category and context of decision, the decisions are often supplemented by the support of data analysts.

The findings suggest that the involvement of data analysts was a topic worth emphasizing, due to the amount of information obtained through the study. It suggests that data analysts are highly involved in the decision-making. This particularly in the complicated context domain as these decision situations require a higher degree of accuracy and understandability of data, as well as more parameters considered in the analysis. The role of the BI team, as an example of data analysts, has changed due to the recruitment of the new business controller, who is partially responsible for answering basic questions regarding data and visualizations in QlikView. As result, the BI team is involved in more statistical calculations. Despite this expertise knowledge, the controller does not recognize any information gap between IT and the other departments since the priorities are made in collaboration within the teams.

As for how BI visualizations may be used, consultant 2 argues that it can be used in a larger extent to detect errors in data. This as it may imply internal processes to be adjusted and corrected over time. The utilization of data may involve more unstructured sources

of data and hence enable the end-users to include more dimensions and parameters in the the decision-making. However, this is not only concerning the data extraction, but the visualization of data as well. By creating more interactive, initiative, and humanizing BI visualizations, the end-users may discover new patterns of information and enhance the cognitive fit without being overwhelmed by data. The study also implies that the cognitive fit of the purchasing company differs. This since visualizations are subject to trial-and-error, and difficulties still remain in deciding the proper visualization techniques.

Hence, as emphasized by Snowden and Boone (2007); there is not one-fits-all solution for decision-making. This also in regards to the practical use of BI visualization in order to support the decision-making. Organizations may therefore find difficulties in visualizing data to satisfy all end-users in the decision-making, as it is highly subjective and depending the underlying purpose and task.

The findings also suggest that strategic decisions are primary visualized through graphical representations and analyzed in an interval of three months. The dashboard and other graphical representations from the BI application is used to monitor and obtain a holistic overview of the current situation and to find patterns in data. However, when conducting forecasts, both graphical and text representations in QlikView is exported to Excel where the calculations are made before being presented again by the means of graphs enabled by Excel. The operational decisions are usually revised after six months and the data often consists of tables and calculations. This since more detailed information may be obtained and is easier to export to Excel for reporting purposes.

6.1 Theoretical Contributions

This study contributes to the existing literature in various aspects. It contributes to the existing gap of visualizations supporting decision-making, as put forward by Bacic & Fadlalla (2016), as well as the need for data-driven decision-making claimed by Richards (2016). The findings indicate that there is no one-fits-all solution for decision-making and BI visualizations. It is rather derived from the cognitive fit, that is the end-users' role, tasks, decision, and underlying purpose. Aligning the human capabilities and techniques of visualizations may facilitate the use of BI&A in the decision-making. This through the cognitive fit theory; stressing the importance of finding a visualization method that suits the mental model of decision-makers as new patterns may be identified (Bacic & Fadlalla, 2016; Gendron et al., 2016; Yigitbasioglu & Velcu, 2012; Shim et al., 2002; Vessey & Galletta, 1991).

The study also indicates that the mental level of decision-makers differs, highlighting the risk of information overload due to the excessive amount of information, as well as the technical complexities and choosing the right parameters to present. It also draws on the outcomes of BI systems, initially stated as infrequent in academic research by Wieder and Ossimitz (2015). This not only in terms of performance, benefits and competitive advantage effects; since the potential outcomes of BI systems could be more utilized by using it to a wider extent.

Another theoretical contribution to BI literature is the identification of the gap regarding information asymmetries between the decision-makers and data analysts. The findings imply that data analysts and experts are highly involved in the decision-making, since BI visualizations alone are not always sufficient to make these decisions. This may

in turn result in negligence in the analysts' advices (Bonaccio & Dalal, 2006; Kowalczyk & Buxmann, 2015; Yaniv & Kleinberger, 2000). Nevertheless, the purchasing company do not experience this risk of information asymmetries due to the organizational structure of multidimensional teams in which the information exchange is well established.

6.2 Managerial Implications

The study also has managerial implications as the findings present suggestions how BI visualizations *may* be used. Firstly, the findings indicate that it is necessary to take a step back and think about the actual purpose of BI visualizations, whether it should be used to support strategic decisions, increase the internal efficiency through automated processes or perhaps both. The study also implies that organizations need to put emphasis on educating the end-users in the BI application to obtain a greater understanding of its capabilities, which may lead to better visualizations required to the BI developers and thus improved decision-making. Either way, the aim is to systematize the internal processes to reduce the involvement of Excel for both reporting and analysis as BI systems embrace these capabilities as well.

Highlighting the notion of cognitive fit establishes a possible way to redesign the application. It suggests that since the task, user, and technology varies between individuals; any BI application need to be designed so that the cognitive fit is aligned. This may in turn improve the decision-making in organizations. As companies tend to rely on IT to a wide extent, it is also necessary to align IT and business in order to understand the technical aspects and thus facilitate the cognitive fit.

Finally, integrating multiple sources of data in the BI applications on a general level may allow the purchasing company to reach a higher maturity level in both utilization and visualization of data. Hence, deeper insights of the business may follow through increased data discovery.

6.3 Future Research Directions

As one may not generalize the findings based the characteristics of this study, further research may be proposed of how BI visualizations are used from a multi-case perspective. Hence, deductions may be drawn from multiple organizations to find similarities and variances in end-users' perceptions of how BI visualizations are used to support the decision-making. One may also investigate how end-users of BI visualizations interact with various visualizing elements. This by the means of data from logs provided by the BI system, which may be used to inspect how users move through and between BI applications and how they interact with the visual elements to make analyzes.

Another finding of the study is that interaction with BI visualizations differs between the end-users' maturity in the software. Hence, one may investigate how BI visualizations are used depending on how frequent the end-user interact with BI systems and how knowledgeable they are in the software. As the software under investigation is limited to QlikView, an additional suggestion for further research is to compare how BI visualizations are used depending on the underlying BI software.

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Appendix 1

Interview Questions

Questions interview 1 with the end-users at the purchasing company

1. Initial question regarding, name, age, working role, assignments etc.
2. What types of decisions are you involved in? Strategic or operational? May you describe these decisions?
3. May you describe how these decisions are made and how the underlying basis of information required is determined?
4. What information do you considered is necessary in order to make these decisions?
5. What role do BI visualization play in these decisions?
6. Which visual elements do you interact with in order to make these decisions?
7. How do you interact with these visual elements in the decision-making?
8. How are you considered to be involved in the process of issuing new BI visualizations?
9. What are the pros and cons with the current BI application according to your options?
10. Something else you would like to discuss?

Questions interview with the BI team at the purchasing company and the consultants at the BI consultancy company

1. Initial question regarding, name, age, working role, assignments etc.
2. How is the underlying basis of information determined for the decisions?
3. What is the purpose of BI in various decision situations according to your opinion?
4. Why do you think visualizations are an important part of the BI solutions?
5. What is the purpose of the visual elements?
6. Which visual elements do you think the end-users interact with in order to make decisions?
7. How is the end-users involved in the role of issuing new BI visualizations?
8. What do you think is the solvation in satisfying all end-users need of information, while still considering the risk of information overload?
9. What are the pros and cons with the current BI application according to your option?
10. Something else you would like to discuss?

Questions interview 2 with the end-users at the purchasing company – experimental setting

Scenario 1- Imagine a situation where you know the relationship between cause and effect, meaning that you are aware of the underlying problem and the solution is obvious. Best practice may also be applied in this decision situation. May you describe a practical example of this in detail? Can you also describe:

1. the extraction of information as the basis for the decision?
2. the information required to make this decision?

3. how the decision like this is made? who are involved?
4. how BI visualizations are used to support these decisions?

Scenario 2 - Imagine a situation where there is a relationship between cause and effect, but the solution to the problem is not obvious. In this situation, only good practice may be applied. Hence, deeper analysis is required to find various alternatives to the underlying problem. May you describe a practical example of this in detail? Can you also describe:

1. the extraction of information as the basis for the decision?
2. the information required to make this decision?
3. how the decision like this is made? who are involved?
4. how BI visualizations are used to support these decisions?

Scenario 3 - Imagine a situation where there is a relationship of cause and effect, but the solution to the problem is impossible to predict. No matter how much you analyze the problem, it is impossible to identify the risks and predict the solution to the problem on beforehand. This is only possible to identify in hindsight. May you describe a practical example of this in detail? Can you also describe:

1. the extraction of information as the basis for the decision?
2. the information required to make this decision?
3. how the decision like this is made? who are involved?
4. how BI visualizations are used to support these decisions?

Scenario 4 - Imagine a situation where there is no relationship between cause effect, neither on beforehand nor in hindsight. A major problem has occurred, and you do not have any idea of the solution. The chaos is overwhelming in the sense that you need to "stop the bleeding". The initial solution may not be the best, but works as long as the problem is temporarily fixed. Once the bleeding is stopped, you are able to think of a more "proper" (well-functioning) solution. May you describe a practical example of this in detail? Can you also describe:

1. the extraction of information as the basis for the decision?
2. the information required to make this decision?
3. how the decision like this is made? who are involved?
4. how BI visualizations are used to support these decisions?

Appendix 2

Title	Organization	BI Role	Work Tasks	User Frequency
Consultant 1	Consultancy company	UX-designer	Designing the user experience in BI solutions.	Medium
Consultant 2	Consultancy company	Team Manager	Developing BI solutions	High
Back-office manager	Purchasing company	End-user	Coordinate payments, balance book-keeping accounts. Increase the internal processes on an operational level.	Medium
Controller	Purchasing company	End-user	Support to business managers, monitoring profitability and adjusting product abnormalities.	High
Product manager	Purchasing company	End-user	Analyze insights and evaluate product profitability and product strategies.	Low
Segment manager	Purchasing company	End-user	Responsible for one of the business areas.	High
BI developer	Purchasing company	Developer	Develops BI solutions.	-
BI Manager	Purchasing company	Management	Manages the BI solutions.	-

Appendix 2: *Details of the respondents*