UNIVERSITY OF TURKU

ABSTRACT

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Abstract

This thesis describes the implementation process of a business intelligence-based dashboard in a Finnish mid-sized company. The company is going through significant change, as the company is internally reorganizing, and the business environment is normalizing after years of exponential growth. The company's new management team needs a clearer picture of the current business to make well-informed decisions going forward and to improve the company's performance.

The thesis relies on design science research, where an artifact is designed to meet the business problem on the case company. The artefact creation process is grounded in existing theory, utilizing available knowledge, and expanding it during the design process. Business intelligence proposed the most suitable alternative to information gathering, processing and dissemination. The most visible part of the solution is the designed business Dashboard, which displays key information on internal processes and company performance to the management team.

In order to create the business dashboard, a business intelligence process had to be established first in the case company. The adopted process model was modified from existing models, whereby the model had already strong evidence of usability based on the literature review. The modified process model suited the company's needs and combined best practices and insight from several proposed frameworks in the academia.

To evaluate the problem relevance and validate the artefact design, the artefact was created in close co-operation with the management team. Formal interviews were held to determine the information needs of the managers, as suggested in the theory. Once the design process was finished, the dashboard was introduced to the management team, receiving positive feedback. To ensure that the artefact was taken into routine use and answered the given business problem, a second round of interviews was to collect feedback on the design and usability after three months of experience with the artefact. The results were again very positive, as the managers signaled increased visibility and understanding of the company's current performance through the dashboard.

The contribution of the thesis is giving insight into the business intelligence implementation in mid-sized companies, as well as confirming earlier theoretical findings on business intelligence, dashboards and utilizing design science to tackle business problems. Additionally, the business problem in the case company was to a large degree solved, as is the target in design science research.

Key words	Business intelligence, business dashboard

UNIVERSITY OF TURKU
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MEASURE TO SUCCESS?

Business dashboard implementation in Finnish mid-sized company

Master´s Thesis
in International Business

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1 INTRODUCTION

1.1 Motivation and background

Decision-making without data has become an oxymoron. In an ever faster altering business environment, timely and well-informed decisions-making proposes a major challenge for all executives. Especially during uncertain times altered by a global pandemic the need for holistic insight is crucial. Drucker expressed already back in 1968 that our society is more and more transforming into a "knowledge society". This statement appears more relevant than ever.

Much of today's economy relies of data flow, and the reliance is expected to increase. The first automated business processes emerged in the 1960s, with Decision Support Systems (DSS) becoming popular in the 1970s (Sharda et al. 2014, 13). The goal of these systems was to support decision-makers in solving unstructured problems utilizing data and models (Sprague 1980, 1).

Information is the key ingredient in all of decision-making, but the vast amount of data has made it increasingly difficult for the decision makers to identify relevant information to take into examination. According to IDC the current amount of data in the world is approximately 50 zettabytes of and the amount will increase to 175 zettabytes by the end 2025 (Reinsel et al. 2018, 6).

The continual decrease in cost of data storage and transfer has led companies to gather immense amounts of data, both internal and external. Simply gathering a large amount of data adds no value, if the company cannot transform it into knowledge (Pirttimäki 2007, 109). Therefore, the identification of information that adds value and insight into the decision-making process is key for a company to be able to reach its targets.

Business intelligence has been gained attention of both business and academia, as it proposes solutions to effective information management and decision-making support. One definition of business intelligence is that it describes processes, concepts, and technologies that improve decision making through fact-based information systems (Wixom & Watson 2010, 13; Shariat & Hightower 2007, 42; Trieu 2017, 2). The synthesis of managing increasing amounts of data with the improved visualization capabilities promises more effective decision-making support through business intelligence systems.

The goal of this thesis is to increase the case company's management's ability to make informed decisions within a significantly changing business environment. In order to do so, the management's information needs must be first identified. Once the information needs are defined, the collection and processing of relevant data takes place. Finally, the information will be communication via a business intelligence dashboard, which features filters and drill-down capabilities to dive deeper into the data and metrics.

Business intelligence adoption has been foremost studied in relation to large scale enterprises, but small and medium sized companies (SMEs) have received little attention by academic research. An earlier quantitative study on business intelligence utilization in Finnish SMEs (Nykänen et al., 2016) received only a small number of responses, but was able to indicate reasons for BI implementation and use in contemporary organizations. This study will shed more light on the implementation process of BI tools into medium-sized companies.

1.2 Research theme, objective, and limitations

The objective of this thesis is to develop a centralized solution to gather and display relevant business information to the newly formed management team of the case company. The research will be conducted following closely the design science research framework, which ultimate target is to create an artifact to solve critical business problems (Hevner et al. 2004, 83). The artifact will be a business dashboard, which aims to combine relevant internal and external business information. The relevant information will be determined by studying academic research and discussions with members of the management team. The dashboard also aims to support the company's strategy implementation by linking the management team's routine information dissemination to performance indicators. The main research question addressed within this thesis is as follows:

How can business intelligence be utilized to gather, process, and disseminate needed information for managerial decision-making?

To be able to create an artifact to address such a broad target, the below listed research questions are aimed to support the process towards the final artifact by guiding the theoretical literature review:

- What is the relation of business intelligence and managerial decision-making?
- How can managerial information need be identified?
- What is business performance measurement?

To be able to keep the research objective clear through-out the thesis some limitations to the scope must be made. As the target company is a medium-sized, internationally operating enterprise, research on public and non-profit organizations will not be reviewed. Additionally, operative leadership and project management are not deeper analyzed within this thesis. The objective is to create a platform to support, analyze and control these actions, but the act itself is not of particular relevance to this thesis. When analyzing business intelligence, a managerial viewpoint is highlighted, as the perceived value of the artifact is of high importance to the successful implementation of this thesis.

1.3 Case company introduction

The case company is a Finland-based component supplier to the LED lighting industry. The initially two-man engineering team has grown to more than 100 employees with subsidiaries in North America ja Asia. The majority of employees are still located in Finland, including product development, supply chain management and administration.

The timing of the company's market entry turned out to be excellent, as the LED-industry has soared during the last decade. The case company managed to establish several industry standards with their patented products, resulting in a position as market leader. Especially the growing interest towards energy efficient solutions fueled the disruption in the lighting industry, where almost all new outdoor solutions, including street- and façade lighting, are LED-based.

Unfortunately, the company has failed to live up to the high growth expectations in recent years. One major factor is the normalization of the lighting market. The annual growth rate of LED-based solutions was more than 30% from 2004 until 2018, when the LED-penetration of the whole lighting market exceeded 65%. After this disruptive phase with phenomenal growth the LED lighting market is now growing only slightly faster than the whole lighting market, which shows an annual growth rate of approximately 3%.

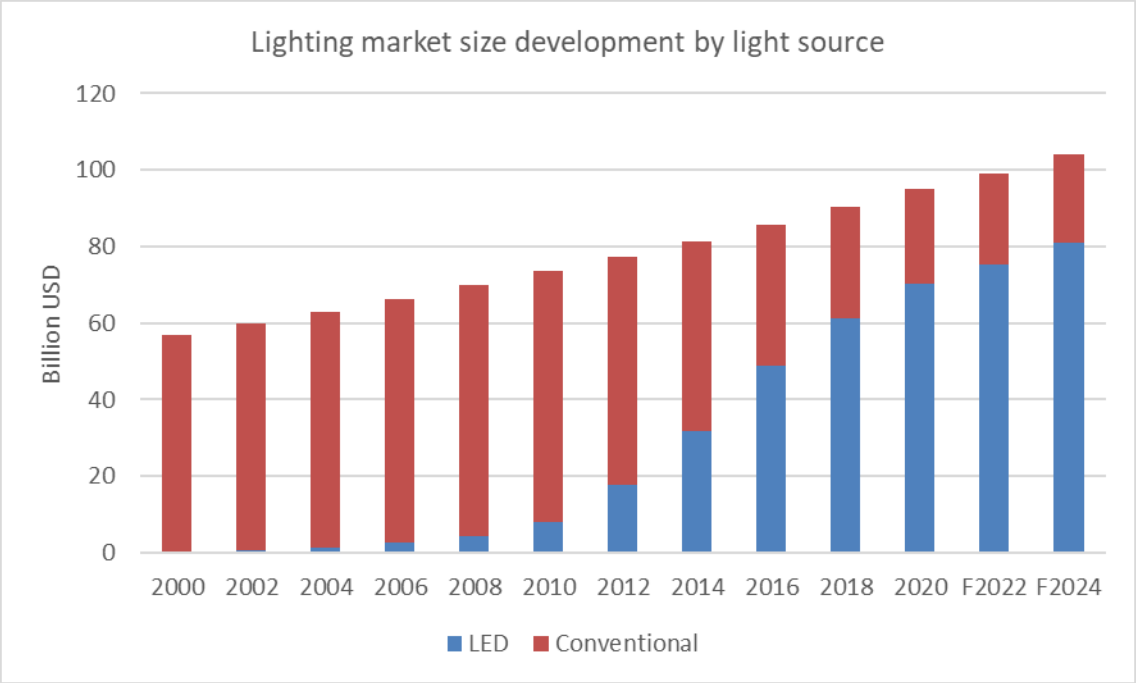

Figure 1 Lighting market size development (CSIL 2019)

As many other companies in the market, the case company grew rapidly and was often barely able to keep up with the growing demand during the disruptive phase. As more and more lighting applications have been transformed to work with LED, coming up with

new inventions has become more demanding. Simultaneously the market growth is flattening, leading to increased focus on cost competitiveness, reliability, and efficiency.

The realization of the changing market situation has led the company to introducing several internal changes. The company is now going through an organizational restructuring, which includes the revamp of the management team to respond to the new market situation. More than half of the newly formed management team members have been either hired from outside the company or promoted from different tasks within the company. Additionally, the company's operations were split into two business units, namely indoor and outdoor business units. Previous understanding of the two product segments is only available for some of the designers and product managers, and a collective understanding of the characteristics of these business units has not yet been established.

During the reorganization process a lack of tools to disseminate timely business information and knowledge has been recognized. The management team finds it hard to create a coherent picture of both the company's internal operational status and simultaneously the external market trends and how they may affect the company. Additionally, the link between strategic decisions and the effect of on operations has not been consistently followed up on, resulting disconnected actions and outcomes. Moreover, the basic understanding of the development and profitability of the separate business units is clearly lacking.

To solve this relevant business problem, the researcher has been asked to create a reporting tool to display the current standing of the business in an easily comprehensible format to build a common understanding to the management team. Once a basic understanding of the information needs has been reached, key performance indicators are to be re-evaluated or created, and implemented to link the strategy execution to daily operations. The researcher was given relatively free hands to carry out the development process of the new tool. As there is currently no business intelligence process put in place, also the search for a suitable framework is included in the project.

1.4 Research structure

The thesis is built around the Information Systems Research Framework (Hevner et al. 2004, 80), which provides a clear picture of the research environment. The thesis starts with introducing the relevant theoretical backgrounds before diving into the empirical implementation.

The first chapter introduces the motivation for the thesis and states the main research questions. Additionally, the case company is introduced for the reader to better understand the business environment and challenges.

The second chapter shows the empirical research design, including methodological choices the data gathering plan.

Chapter three introduces the theoretical background with a consistent review of existing literature on the subject. First, the hierarchies and structure of data and information is examined. Thereafter the development and perspectives on business intelligence are highlighted, covering the managerial, process, and technological perspective on business intelligence.

Chapter four focuses on decision-making and combines business intelligence with the decision-making process. The information needs are closely examined. Lastly, the concept of performance measurement is introduced.

Chapter five describes information need identification during the empirical study. Chapter six thereafter presents the creation process of the artefact based on the insight gained from the interviews on information needs.

The seventh chapter presents the conclusion of the thesis. The theoretical and practical contributions of the thesis are presented, and limitation and further research suggestions are discussed. The thesis structure is visualized in figure 2 below.

2 METHODOLOGY

2.1 Research approach and methodological choices

Information systems research is dominated by two paradigms: behavioral science and design science. The behavioral science paradigm seeks to test and verify theories on human and organizational behavior. Design science seeks to extend human and organizational capabilities by creating new artifacts. (Hevner et al. 2004, 75.) As the goal of this thesis is to create a dashboard to solve the problem of gathering and assimilation of key business data to the management, design science will serve as the chosen methodology in this thesis.

Despite the separation into two paradigms, design science and behavioral science are not dichotomous. On the contrary, they are inseparable. This applies also to information system research, where truth (justified theory) and utility (useful artifacts) are mere two sides of the same coin. The information systems artifact created is often the object if behavioral-science research. (Hevner at al. 2004, 77.)

IT artifacts are broadly defined as constructs, models, methods, and instantiations. Such artifacts represent in a structured form for example software, formal logic, informal natural language descriptions or similar. (Hevner at al. 2004, 77.) Additionally, two processes are identified, namely build, and evaluate (Hevner et al. 2004, 78; March and Smith 1995, 255). Instantiations refer to implemented or prototyped systems, which represents the artifact that is to be developed in accordance with this thesis.

Hevner at al. (2004) developed a conceptual framework that features clear guidelines for understanding, executing, and evaluating design science research in the information systems discipline. They highlight that design consists of both the process and the product and that these cannot be viewed separately. Thereby solving a complex problem requires the continuous shift of perspective between the design process and designed artifact. During the design process a set of activities produce an innovative product, which is then evaluated and further developed based in the received feedback, resulting in a build-and-evaluate loop. (Hevner et al. 2004, 78.)

The Information Systems Research Framework from Hevner et al. (2004, 80) highlights the importance of both relevance and rigor from the design science viewpoint. Relevance relates to the importance of the artifact to the target organization, whereas rigor refers to the academic knowledge base on which the development builds. In figure 3 below the framework has been modified to reflect this thesis.

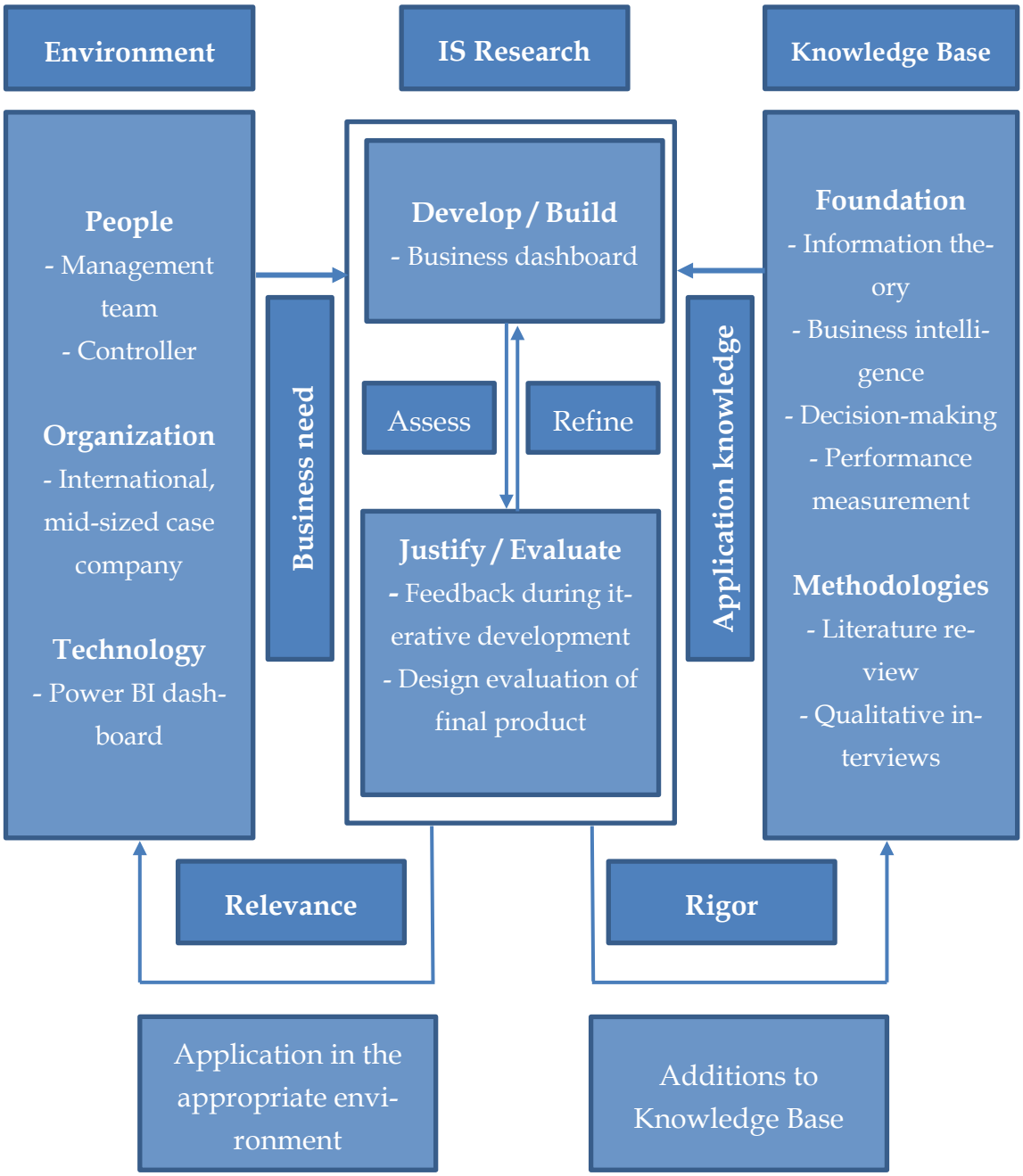

Figure 2 **Modified Information Systems Research Framework (Hevner et al. 2004, 80)**

As the figure 3 above displays, design science emphasizes the unification of practice and theory. The need for an artifact is born from an environment where people, organizations and technology jointly form the requirements and possibilities. In this thesis the management represents people with assistance from the controller to identify needs and potential information sources. The knowledge base enables the researcher to gain application knowledge. The foundation is built around business intelligence, decision-making, and performance measurement. The assess-refine loop will consist of frequent interaction with the management team during the specification and design period and a final

presentation event for the whole team. To ensure the relevance of the artifact, factors like managerial decision-making and business requirements are assessed. The goal is to create a dashboard that fulfills the requirements set by management and becomes an integral part of decision-making. Additionally, the artifact should be easily adaptable to a changing business environment to provide long-term value to the company.

In addition to the information systems research framework Hevner et al. (2004, 83) present a set of seven guidelines to conduct design science research, which aims to ensure the successful, rigor and relevant outcome of the research. The guidelines are presented in the following table, according to which this thesis will be conducted.

Guideline	**Description**
1. Design an artifact	Design-science research must produce a viable artifact in the form of a construct, model, method, or instantiation
2. Problem relevance	The objective of design-science is to develop technology-based solutions to relevant business problems
3. Design evaluation	The utility, quality and efficacy of an artifact must be demonstrated via well-executed evaluation methods
4. Research contribution	Effective design-science research must provide clear and verifiable contributions to design artifacts, design foundation and/or design methodologies
5. Research rigor	Design-science research relies upon the application of rigorous methods in both construction and evaluation of the design artifact
6. Design as a search process	The search for an effective artifact requires utilizing available means to reach desired ends while satisfying laws in the problem environment
7.Communication of research	Design-science research must be presented effectively both to technology and management-oriented audiences

Table 1 Design Science Research Guidelines (Hevner et al. 2004, 83)

As described earlier, the artifact to be created is a business intelligence-based dashboard, which aims to tackle the problem of gathering and disseminating key business information to the management team. The problem is of high importance to the case company, as there are three major forces are affecting the business. The first factor is the long-term shift in the market, where the earlier “blue ocean” market is facing increasing competition and commoditization. Secondly, the current disruption inflicted by the Covid-19 pandemic is causing dramatic uncertainty to the economy, forcing companies to attune their actions and refocus their development strategies. Lastly, the newly formed management team consists of several new executives from external organizations and industries. The team has a wide range of experience, but no common under-standing of the company’s performance and position in the market.

There are several key aspects to the successful execution of the artifact design. The artifact must be perceived useful and ease of use to gain popularity in daily use, as suggested according to technology acceptance model literature (Davis et al. 1989). Secondly, the model must be adaptive to quick changes in the business environment, allowing fast alteration based on changing goals and focus areas. The final ingredient is to identify the business-critical data sources and to present the relevant metrics to form a com-prehensive picture of the business, ultimately aiming to aligning the perspective of the management team members.

The design evaluation will be conducted in close co-operation with the management team and controller. The initial specification of the artifact will be drafted based on formal interviews and informal discussions with the relevant management team members. This is the start for the search process, where new solutions and views on how to implement the artifact effectively to the business environment are discovered. During the creation process of the artifact, several iterative assess and refine loops are planned, where the status of the artifact is presented, and feedback is gathered to further develop the final product. The artifact will be rigorously tested with upper management members to ensure its usability, relevance, and quality. Once the testing has been completed, the product will be presented to the whole management team to inform them about the artifacts features and purpose and the gather their initial impressions. Three months after the initial presentation of the dashboard a second round of interviews will be held to conclude the design evaluation based on experience utilizing the artefact.

On top of to the practical contribution the thesis will test if established information systems research theories hold in real business environment settings, particularly related to a mid-sized company. As described within the information system research framework (Hevner et al. 2004, 80), the design process of an artifact will contribute additions to the knowledge base and add to the rigor of it. Especially the theoretical background on information need identification, knowledge dissemination and decision-making will be closely reviewed.

2.2 Data collection plan

The data collection in this thesis will be conducted with several methods. Interviews will be held with management team members during the design process of the artifact. Two formal interviews will be held in the form of semi-structured interviews, where the respondents receive the opportunity to freely express their feelings around the discussion topic on top of structured questions designed by the researcher (Hirsjärvi & Hurme 1991, 205). These interviews will be qualitatively assessed in order to obtain the most information from the interviews in order to specify needs for the artifact.

The target of the first interview is to gather understanding of the business problem and to identify information needs. The second formal interview will be held after the artifact is finished and communicated to the audience. The purpose of the second interview is to measure if the artifact was designed according to feedback from the interviewees and if the business problem was addressed with the final product. Interviews were chosen as data collection method as their primary target is to gain as much information about the research topic as possible (Tuomi & Sarajärvi 2009, 73). As the thesis aims to increase the understanding of the case company's business needs and problems, interviews were chosen as data collection method.

Design evaluation is one of seven guidelines introduced by Hevner et al. (2004, 80). The selection of the appropriate evaluation methods must be matched with the design artifacts features and purpose. Hevner et al. (2004, 86) introduce several design evaluation methods, which they separated into five categories presented below:

- Observational
- Analytical
- Experimental
- Testing
- Descriptive

The artifact in this thesis will be evaluated by several evaluation methods, but with focus on testing within the management team during and after the artefact creation process. Also, observational aspects of evaluation will take place, as business information needs are expected to arise during regular interaction with the executives. Descriptive feedback based on the held interviews will add clear indication to the design evaluation.

The researcher will carry most of the responsibility in the artifact creation process and information need identification, enabling first-hand knowledge on the business environment and involved processes.

3 FROM DATA TO INTELLIGENCE

Chapter three will introduce the theoretical background revolving around data and business intelligence. The examination starts with data and information, covering their suggested hierarchies, sources, and forms. Thereafter business intelligence is introduced, covering the evolution of BI, discussion the differentiating viewpoints and dashboards.

3.1 What is information?

This chapter will create the fundament for the thesis by analyzing information and its forms. Both business intelligence and decision-making rely on information from different sources and in different forms. Information will be examined from the perspective of hierarchies, structure, explicit and tacit knowledge, and the information gaps that may occur during the assimilation and distribution of information.

3.1.1 Data, information, knowledge, and intelligence

At first glance the relation of data, information and knowledge seems interchangeable. According to Davenport and Prusak (1998, 1), the distinction is required to be able to define which of those one possesses, what is needed and what can or cannot be accomplished utilizing them.

The data–information–knowledge–wisdom hierarchy (DIKW) has been regarded as one of the fundamental conceptualization methods in information literature (Rowley 2007, 163). Also known as the "Knowledge Hierarchy" or "Knowledge Pyramid", the concept was initially introduced by Ackoff in his paper published in 1989. The implicit assumption is that information can be built from data, knowledge from information and wisdom from knowledge. The implicit assumption is that higher levels of the model include the categories that fall below it. (Rowley 2007, 164.)

Davenport and Prusak (1998, 1) reduce the categorization to only three dimensions, namely data, information, and knowledge. High-order concepts, like wisdom and insight, are included into knowledge. They acknowledge that many researchers distinguish further entities like wisdom, insight, resolve or action, but the definitions are often difficult to separate and may relate to things that are to be accomplish with information. (Davenport and Prusak 1998, 1-2.) Rowley's research (2007, 174) on information management, information systems and knowledge management literatures support the reduction to only three dimensions. Wisdom has received relatively little attention in the publications related to the knowledge hierarchies. Rowley suggests several possible reasons why

wisdom is not included in the publications, including information and knowledge not being able to be interpreted into wisdom or that the concept has more to do with human intuition and interpretation than systems. She concludes that the limited discussion on wisdom suggests that it is not perceived equally relevant in the field of information systems and knowledge management. (Rowley 2007, 174.) Therefore, wisdom is excluded from further examination in this thesis.

Data is defined as a set of discrete, objective facts about events (Davenport & Prusak 1998, 2). Structured records of transactions reveal volumes, prices, dates and related parties are examples of data. Data management evaluates data based on cost, speed and capacity. The cost of data has decrease dramatically in the past decades and the problem of being able to collect and store enough data has transformed into the challenge of managing and utilizing exponentially growing amount of data. Too much data can make it harder to identify and make sense of the data that matters and most fundamentally, there is no inherent meaning in data. While data is a fundamental raw material of decision-making, it cannot provide suggestions or evaluations. (Davenport and Prusak 1998, 2.)

Thierauf (2001, 10) describes **information** simply as structured data. Information is often seen as a message with a sender and a received, striving to alter the receiver's perception of a matter. "Inform" originally meant "to give shape to" and in the case of information, shape the outlook of the information receiver. Thereby the value of information is judged not by the sender, but by the receiver for its usefulness. (Thierauf 2001, 10–11.) According to Drucker (1989, 202), information has meaning in the form of "relevance and purpose". Data becomes information once it is shaped and organized to form a message to the receiver (Thierauf 2001, 11). Though computers are particularly skilled with adding up data to form information, humans must still add perspective and categorization to be able to leverage information (Davenport & Prusak 1998, 2).

According to traditional epistemology **knowledge** is defined as "justified true judgement" (Nonaka 1994, 15). Knowledge is the fluid combination of experience, information and expert insight that provides a framework to evaluating and leveraging new information and experiences (Davenport and Prusak 1998, 4). According to Dretske (1981, 44), knowledge is enriched with information-produced believe, but the knowledge formation from received information depends on the pre-existing believes of the receiver.

Knowledge is formed in the mind of the "knowers", from which it is transformed into documents, processes, practices or norms. This definition implies that knowledge is neither unambiguous nor simple; it is intuitive and therefore hard to capture. As data can be found within records and information is packaged as messages, knowledge is created within and between humans. (Davenport and Prusak 1998, 4.)

Intelligence is neither included in the knowledge hierarchy nor in Davenport and Prusak's three dimensions described earlier. Thierauf (2001, 11) suggests that "intelligence is not only summarized information but also active knowledge of how to apply the

content of information". In an organizational context, intelligence serves as prelude to action and decision-making. As information is created from data and knowledge from information, intelligence is achieved by enriching information and disseminating and utilizing it within an organization (Pirttimäki 2007, 39). According to Powell (1996, 8), intelligence can be referred to as communicated knowledge that expands the organization's capacity to understand, learn and apply logic.

Nonaka (1994, 14) states that the earlier paradigm of organizations merely processing information is not sufficient to explain such phenomenon as innovation or value creation. Though new knowledge is created by individuals, organizations contribute tremendously to the amplification and articulating of knowledge. (Nonaka 1994, 14.)

Organizational knowledge is created through a dialogue between **tacit** and **explicit** knowledge. Explicit or codified knowledge is easy to disseminate in formal language, but it represents only the tip of the iceberg of all knowledge. Tacit knowledge has more personal quality and is difficult to articulate and express. Tacit knowledge is deeply embodied in action, involvement and structures and is highly context specific. (Nonaka 1994, 16.) According to Pirttimäki (2007, 40), data and information are considered as explicit knowledge, whereas knowledge and intelligence are part of tacit knowledge.

3.1.2 Structure and source of data

A fundamental distinction when classifying data can be made between structured and unstructured data. Park & Song (2011, 12) state that only 20 percent of data is structured. The amount of unstructured data such as webpages, chats, photos, videos, social media content and other unstructured data is growing rapidly and is therefore increasingly important for companies to utilize (Nykänen et al. 2016, 28).

Structured data has been the basis for most of the development in information management, utilized in applications starting from Decision Support System (DSS) back in 1971, followed by more advanced techniques and systems like Online Analytical Processing (OLAP) and Executive Information Systems (EIS). Structured business data is often numerical or distinctly identifiably. (Sharda et al. 2014, 13.)

Structured data is stored for example in data warehouses, smaller operational data marts and spread sheets. Structured data displays transactions, measures and profound information on products, projects, or customers. Structured data can be easily processed by computing, which makes in easily operationalizable. (Baars & Kemper 2008, 132.) Structured data is most often derived from internal sources, like enterprise resource planning (ERP) or warehouse management software (Nykänen et al. 2016, 28).

Unstructured data is of descriptive or qualitative nature with limited possibilities to filter, group or compare. The information is often subjective and reflects the persons

perspective, believes and mood. (Baars & Kemper 2008, 132-133.) Unstructured data may also be referred to as "soft information" (Frishammar 2003, 319). According to LaValle et al. (2011, 21), strategic information is more and more available from external, unstructured digital channels. As unstructured data is ambiguous, it is hard to process with conventional database tools. Compiling and disseminating of reports with unstructured data is time consuming and challenging. Assessing unstructured data demands specialized software and thereby significant investments from the organization. (Frishammar 2003, 318-319; Baars & Kemper 2008, 132-133.)

Bars and Kemper (2008, 133) emphasize that both structured and unstructured data are essential to gaining intelligence, therefore neither one should be neglected. They should be seen as two sides of the same coin, with structured data paving the fundament with comparable numeric measures and unstructured, descriptive data enriching the information.

A closely related distinction is made based the source of data. Choo (2002, 32) divides information sources into internally and externally generated information. He explains that **external information** consists of published materials, like newspapers and articles. Nykänen (2016, 28) explains that external data is simply all data that is sourced from outside the company and made available through for example customer relationship management (CRM) software. Ratia et al. (2019, 404) argue that the utilization of external data has seen increasing importance, especially in relation to innovation and product development. External data is often unstructured and therefore challenging to utilize. At the same time, it is vital for making broad strategic decisions (Uusi-Rauva 1994, 6).

Internally generated data is typically sales, operations, transactions, and resources related information. Internal data is often stored in documents and structured databases (Nykänen 2016, 28). The data relates to the organization itself, its processes, products, employees and performance (Shollo & Kautz 2010, 6). When examining internal data, the focus is easily pointed towards structured data, as it is more easily quantifiable. Choo (2002, 32) points out that employees are often the source for most valuable information, but often forgotten as information source. He underlines that humans can interpret, summarize, and communicate information very effectively. This knowledge is vital for the company to be able to develop and innovate, also referred to as human capital (Ratia et al. 2019, 404).

To conclude, the structure and source of data has significant impact on the possibilities and ease of information assimilation and distribution. Knowledge on data is relevant when considering the possibilities of business intelligence, which is introduced in the next chapter.

3.2 Business intelligence

This chapter examines the different perspectives on business intelligence. First, the history and different interpretations are introduced. Thereafter the process perspective on BI is closely elaborated, as it has significant effect on the empirical part of this thesis. Thereafter dashboards are introduced, followed by a short review of technologies and current BI platforms.

3.2.1 Evolution, definition and rational of business intelligence

The journey of business intelligence started in the late 1960s, when the first database management systems (DBMS) emerged (Shariat & Hightower 2007, 40). Following the rise of information technologies, the term decision support system was defined by Scott-Morton in the early 1970s as "interactive computer-based systems, which help decision makers utilize data and models to solve unstructured problems" (Sharda et al. 2014, 13). The purpose of these systems was to aid managers plan and optimize business specific targets and operative activities. (Wixon & Watson 2010, 13.) Example of such activities were production planning, supply chain optimization or portfolio analysis automation.

From then on, a variety of support systems has emerged. To serve more specific needs, executive information systems, online analytical processing, data marts and further applications have come to light (Shariat & Hightower 2007, 42). To describe these information applications combined in a commercial perspective, the Gartner analyst Howard Dresner coined the term Business Intelligence in the early 1990s (Wixon & Watson 2010, 13). According to Negash (2004, 177), the term business intelligence has replaced terms like decision support systems, executive information systems and managerial information systems.

Business intelligence has attracted increasing attention of academia to research the phenomenon from different perspectives (Wixon & Watson 2010, 13). Several different approaches to define business intelligence have been presented in the past few decades. Sharda et al. (2014, 14) state that business intelligence, like decision support systems, is a content free expression, which may mean different things to different parties. Several researchers title business intelligence an umbrella term (Wixom & Watson 2010, 13; Shariat & Hightower 2007, 42; Trieu 2017, 2) to describe processes, concepts and methods, and technologies that improve decision making with fact-based information systems. Sharda et al. (2014, 13) simplify the definition by characterizing BI as a "unifying phrase or term, combining different tools, applications and methods".

Business Intelligence is often defined as a managerial concept to manage and enrich business information to support operative and strategic decision-making (Gilad & Gilad

1985, 65; Elbashir et al. 2008, 135). Another common view on BI is the combination technologies, processes, and equipment needed to transform data into information, information into knowledge and knowledge into actionable intelligence to increase the insight and competitive position of the organization (Powell 1996, 3). Pirttimäki (2007, 58-59) summarizes that the main idea of BI is identifying information needs and processing the gathered information into valuable managerial knowledge and intelligence. According to Božič & Dimovski (2019, 94) the currently most widely adopted definition is by Chen et al. (2012, 1166) who see BI as "techniques, technologies, systems, practices, methodologies, and applications that analyze critical business data to help an enterprise better understand its business and market and make timely business decisions". This definition encompasses a variety of perspectives and underlines the core purpose of BI to aid decision-making.

Ratia (2019, 397) points out that the importance of BI and related concepts has grown in the field of managerial decision-making. Wixon and Watson (2010, 14) argue that BI has evolved from being a contributor to success to be a prerequisite for it. Several studies show that the implementation of business intelligence is linked to positive impact on organizational performance (see for example Ratia 2019, 397; Elbashir et al. 2008, 149). Côrte-Real et al. (2014, 172) summarize business intelligence as "foundational cornerstone of enterprise decision support".

Shollo & Kautz (2010, 2–11) conducted a literary review aiming to unify the definition of business intelligence. According to them, several authors refer to BI as both process and product. They also acknowledge that the most recent papers in their study incorporated a three-dimensional concept of BI, highlighting the role of technologies in the context of BI. The three dimensions presented are:

1. The refined **information and knowledge** to describe the business environment and the organization's relation to markets, customers and competitors
2. The **process** that produces the above-mentioned insight for management to make better informed decisions
3. The **technologies** that enable gathering, analyzing and dissemination of relevant information

As an example of the three-fold definition, Shariat & Hightower (2007, 42) characterize BI as a collection of processes, technology, and product. They define process as collecting and analyzing of relevant business information, technology as being used within the process and product as the information and knowledge obtained from the process. A similar view is presented by Baars & Kemper (2008, 132), who understand business intelligence as an integrated management support structure, highlighting the importance of technologies that enable BI processes. Negash (2004, 178) presents that "BI systems combine data gathering, data storage, and knowledge management with analytical tools to present complex internal and competitive information to planners and decision makers."

Regardless of the definition of business intelligence, the underlying rational for organizations to invest in BI is the strive to capture, understand, and harness more data to support their decision-making to improve business operations (Sharda et al. 2014, 16; Nykänen et al. 2016, 26). Wixom & Watson (2010, 16) identified three possible targets for companies when implementing business intelligence into their operations. The first and narrowest reason is that organizations have specific needs to put a system in place, for example a department may implement a new system to improve visibility on transactions or marketing actions. The second and broader goal is to implement an organization-wide BI infrastructure as an all-encompassing approach to collecting, analyzing, and disseminating of information in the organization. The third and broadest goal is to utilize BI as enabler for organizational transformation, where the whole business model is restructured, and the new organization relies on the BI system. (Wixom & Watson 2010, 16.) The expressed target of the organization dictates the scope of technologies and processes of the BI implementation (Nykänen et al. 2016, 27).

Gilad and Gilad (1985, 65) and Davenport (2010, 2) highlight the strategic role of BI. Information needs are broad when it comes to strategic decision-making, focusing on external information to better understand the company's position in relation customers and competitors (Thierauf 2001, 66; LaValle et al. 2011, 21). As stated earlier, external information is often unstructured and therefore more challenging to process and disseminate (LaValle et al. 2011, 21).

Elbashir et al. (2008, 149) present that BI is not only limited to strategic decision-making, but the near real-time information provided helps achieve tactical and operational excellence. The operational dimension is also underlined by Negash (2004, 177) with stating that BI systems "combine operational data with analytical tools to present complex and competitive information to planners and decision makers". Pirttimäki (2007, 58) supports the importance of internal data, highlighting the possibility to have a holistic picture of internal operations to achieve success in different business areas. The operational viewpoint plays a central role in this study, as enriching the understanding of management related to sales in different markets and segments, but also to question the current performance of key processes.

The three dimensions of BI identified by Shollo & Kautz (2010, 9) are closely examined in this thesis. The product dimension in relation to data, information and knowledge has been covered in chapters 3, with more details on decision-making following in chapter 4. The process perspective is discussed in the following chapter, along with remarks to the technologies related to business intelligence in chapter 4.4.

3.2.2 Process perspective on business intelligence

To utilize the potential of BI, several business intelligence process models have been presented by academics and consultants. The purpose of a business intelligence process is to convert raw data into actionable intelligence for decision-makers (Gilad & Gilad 1986, 53). The BI process can be approached from an information management process perspective or knowledge creation process, but the focus of a BI process is typically on business-oriented issues and on the conversion of data into actionable knowledge (Pirttimäki 2007, 72).

Gilad & Gilad (1985, 69) present a widely adopted business intelligence process, which focuses on the collection of a vast amount of data that can be communicated through organized reports. They identify collection, evaluation, storage, analysis, and dissemination as key phases for the BI process. Their model shows the progress of the intelligence cycle, as the process moves to the next phase. (Gilad & Gilad 1985, 69.) The model is presented in figure 4 below.

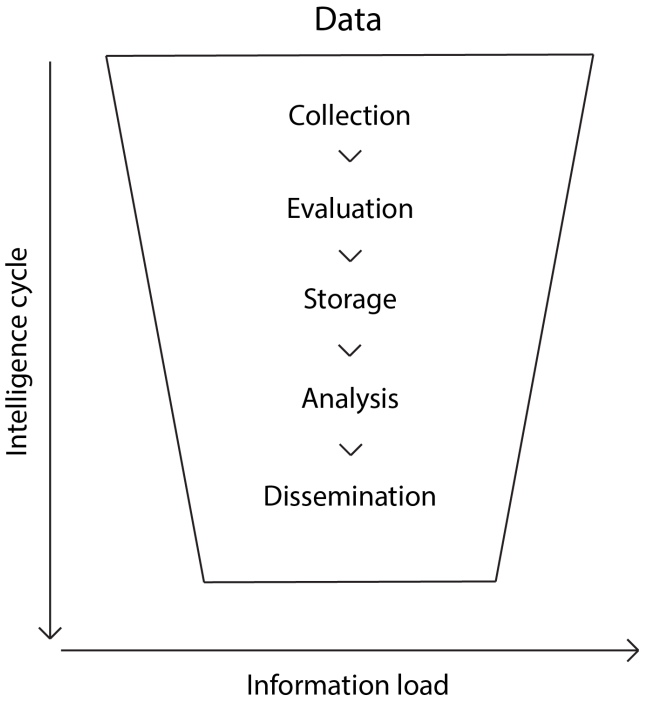

Figure 3 Business intelligence process model (Gilad & Gilad 1985, 69)

Several models are presented in the form of a cycle, which may include a different number of phases and small deviations in the content and sources (Pirttimäki 2007, 72). For example, Vitt et al. (2002, 13-22) argue that BI is more than a management philosophy or technology, but rather an ongoing cycle. They refer to it as a performance management framework where organizations set goals, analyze development, act and start the cycle again. In general, the BI process is understood as a cyclical, continuous and

systematic approach for a company to gather, store, analyze and distribute relevant business information (Gilad and Gilad 1985, 69; Vitt et al. 2002, 13; Pirttimäki 2007, 74).

In their literature review, Shollo & Kautz (2010, 6) identify five key phases related to business intelligence process. Gilad & Gilad's (1985, 69) model focuses on the data processing, whereas Shollo & Kautz emphasize the importance of acting on the provided information. Additionally, the importance of technology as enabler is highlighted. The phases by Shollo & Kautz (2010, 9) are presented below:

- Gathering and storing of data
- Analyzing data and information
- Using information and knowledge
- Acting – decision-making
- Technology support

Shollow & Kautz (2010, 9) argue that true intelligence is only reached once the information gathering process leads to actual decisions and actions, otherwise knowledge is not transformed into intelligence. The decision is made based on information and knowledge obtained from OLAP and other systems under the business intelligence umbrella. (Shollo & Kautz 2010, 9.)

The model used in this study is a combination of the simplified BI processes presented by Pirttimäki (2007, 74) and the phases presented by Shollo & Kautz (2010, 9). The modified framework incorporates the technology support aspect from Shollo & Kautz (2010, 9) into the generic BI model summarized by Pirttimäki (2007, 74) and includes the information need specification phase. The model is illustrated in figure 4.

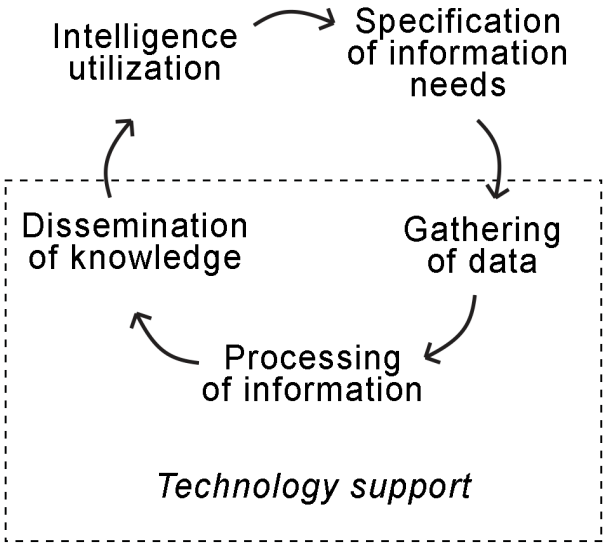

Figure 4 **Business intelligence process model (modified from Shollo & Kautz 2010, 9; Pirttimäki 2007, 74)**

The first phase of the process model illustrates the decision-makers' information need identification. The process is assessed with addressing questions related to key processes, problems, and pending management decisions. Pirttimäki (2007, 75) states that the identification phase is critical for the success of the entire BI process. An important aspect is to identify the actually needed information, to avoid information overload.

The second phase consists of the data collection based on the identified information needs. The data must be gathered from various sources to be able to give a holistic view of the business environment (Shollo & Kautz 2010, 6; Thierauf 2001, 66). As discussed earlier, data sources can be split into internal and external sources, where external sources help understand the business environment and internal information enriches the understanding of processes, people, and performance (Shollo & Kautz 2010, 6). Also, the utilization of structured and unstructured data must be considered, which is detailed in chapter 3.1.2. The second phase also includes the storing of the collected information in such manner that it can be easily processed in the upcoming phases. Data warehouses are a common solution to store the gathered data (Shariat & Hightower 2007, 42). Chen et al. (2012, 1166) points out that BI heavily relies on data collection and extraction technologies to effectively assembly the needed data.

The third phase represents the processing of the gathered information. Processing includes evaluation and analyzing of the information to produce actionable knowledge. Different analysis tools and methods may be used during this phase to be able to process information of different type and source. The aim is to evaluate, interpret and explain ongoing events and signals from a decision-makers' standpoint (Pirttimäki 2007, 75). Quality control is of highest importance in this phase (Gilad & Gilad 1985, 69), as the data reliability and validity affect the decisions that are made as end result of the BI process. Shariat & Hightower (2007, 42) emphasize the Extraction, Transformation and Loading (ETL) operation related to this phase. They mention data cleansing, aggregating, summarizing, and transforming to be part of this process.

The fourth phase is the dissemination of the collected and processed knowledge. This includes the communication to the decision-makers utilizing relevant technology. Techniques like data mining and predictive analytics based on historical and current data enhance the understanding of relations in different data points (Shollo & Kautz 2010, 7). The information is made available through user interfaces, which are for example OLAP based reports, dashboards, ad hoc queries, and alerts to operational and tactical decision-makers (Golfarelli et al. 2004, 3; Sharda et al. 2014, 15). Additionally, newsletters, formal meetings, portals and so forth can be utilized to communicate the obtained information (Pirttimäki 2007, 75).

The fifth and last phase of the BI process closes the loop between the data and decision-makers. The target of the utilization phase is to enable end users and decision-makers to receive the needed information at the right time to make knowledge-based decisions. The

effectiveness of the intelligence utilization phase derives directly from the quality and pace of the preceding phases, where the failure of only one phase may interrupt the whole process. In addition to the possible measurement of the effectiveness, new ideas and information needs may arise based on the decisions made. This then gives new input to the iterative cycle of the BI process.

The empirical part of this study will follow the described framework in order to produce the needed information for managerial decision-making. The phases in the framework highlight the different steps that need to be taken before the identified information need can be transformed into actionable knowledge and decisions. To disseminate the information affectively, a business dashboard will be designed. The following chapter extends the understanding in dashboards and their purpose.

3.2.3 Business dashboards

A commonly referred to definition for dashboards was coined by Few & Edge (2007, 1) as "a visual display of the most important information needed to achieve one or more objectives; consolidated and organized on a single screen so the information can be monitored at a glance." The main purpose of dashboards is to help visualize large amounts of data to identify trends, patterns and anomalies for effective decision-making (Lempinen 2012, VIII). The term dashboard derives from the monitoring application in automobiles and its close cousins, cockpits in aircrafts (Few & Edge 2007, 1). Many dashboard vendors mimic the visuals of conventional automobile gauges to create a familiar structure to the viewer.

Instead of simple static visualization, dashboards should enable interactive visualization to aid unstructured decision-making processes (Lempinen 2012, 25). Drill-down functions, filtering and slicing are examples of functions that increase the interactivity of dashboards. Shariat & Hightower (2007, 42) suggest that dashboards are the most visible component of business intelligence, as it connects the executive management with business intelligence. Eckerson (2010, XIII – XIV) supports the claim and calls dashboards the "new face" if BI. He argues that dashboards transform BI from a set of tools used by business analysts and expert users to actionable information for all decision-makers in the company. Only through dashboards the promise of higher performance and real-time decision support for managers can be held (Eckerson 2010, XIV). Eckerson (2010, XII) argues that performance dashboards, as he calls them, are by themselves a full-fledged business information system that is built on BI.

The use of dashboards has gained popularity within the executive management due to its effective information transfer and user-friendliness that support the decision-making process (Rahman et al. 2017, 3). Decision makers ability to cope with complex problem

scenarios is limited by the human attention span, which may lead to information overload (Yigitbasioglu & Velcu 2012, 48). Visualization of information eases the digestion of complex matters, when the visualized data reflects the relationships and relative dimension of the matter (Lempinen 2012, 117). Visualization is most efficient once a maximum amount of data can be perceived in a minimum amount of time (Yigitbasioglu & Velcu 2012, 46).

According to Eckerson (2010, XII) dashboards are a seamless combination of the following three applications:

1. Monitoring application
2. Analysis application
3. Management application

Monitoring provides critical information with a single glance, which is often tied to the current state of performance. This information is typically presented in graphical elements to ease the interpretation of the decision maker. (Eckerson 2010, XII.) Few and Edge (2007, 1) argue that this is the main application of dashboards and different names should be used to describe further applications.

The analysis application enables users to analyze and explore performance information across different dimensions and levels. The purpose is to be able to get a better understanding of the root causes and patterns shaping the business environment. (Eckerson 2010, XII.) Here the filtering and drill-down functions are highlighted for the user to be able to gain a comprehensive picture of the phenomenon.

The management application is the third application, which fosters the communication between executives, managers, and staff. This dialog enables the management to steer the organization and communicate the current situation effectively to all parties. (Eckerson 2010, XII.)

Velcu-Laitinen & Yigitbasioglu (2012, 39) identified in their survey of sales managers in Finland four distinct purposes for dashboards: monitoring, problem solving, rationalizing and communication. When comparing these to the applications mentioned by Eckerson (2010, XII), the analysis tool features both the problem solving and rationalizing described by Velcu-Laitinen & Yigitbasioglu. The other applications are fundamentally coherent in both definitions.

A distinction between dashboards can be made based on different managerial levels. Rahman et al. (2017, 3) identify differences in dashboard in strategic, tactical and operationals level. Similarly, Eckerson (2010, XIV) sees differentiating purposes of dashboards on the different managerial levels. Operational dashboards track core processes and rely on the monitoring application of dashboards to ensure efficient process flow based on near real-time information (Rahman et al. 2017, 3). Tactical dashboards track information on department and project level, emphasizing analysis over monitoring, though monitoring is present also on the tactical level in the form of KPIs (Eckerson 2010, XIV;

Lempinen 2012, 109). The detail level is higher on the tactical than on the strategic level. The strategic level focuses on monitoring the implementation of strategic goals. Additionally, the communication of strategy and review of performance is conducted on the strategic level. (Rahman et al. 2017, 3.)

Eckerson (2010, XIV) suggests that multiple versions of each dashboard type should be implemented into companies, but the data should be integrated, and the same set of rules should be applied to maintain data validity between the dashboards. Rahman et al. (2017, 3) highlight the importance of considering different information needs on different managerial levels during the development phase of the dashboard. Lempinen (2012, 109) supports the claim and suggest the utilization of different performance measurement models to identify and implement measures on all levels in the organization.

3.2.4 Business intelligence technologies

As proposed in the modified business intelligence process model, technology support plays a crucial role to implement a successful BI process. Shariat & Hightower (2007, 43) propose in their standardized BI architecture model that the dashboard is the top layer of the BI pyramid, representing graphical visualization of the data. To feed information to the top layer, information from the enterprise data warehouse (EDW) is utilized. Data marts and other applications for direct queries may be utilized to access the EDW, but these are often aimed at middle-management and data analysts, as performing these queries requires special technical skills. (Sharda et al. 2014, 83 – 87.) During the preceding data extraction, transformation, and loading (ETL) phase information is obtained from several sources and imported into the EDW. These sources are referred to as operational systems and are for example enterprise resource planning (ERP) or HR-software that include central data related to the business. Together these levels form the basic components of a BI architecture. (Shariat & Hightower 2007, 43 – 44.)

Modern BI applications are able load and transform data independently, instead of simply visualizing the imported information. They also provide direct access to several sources, so an EDW may not be necessary to create multi-source reports and dashboards with BI applications. Modern assets, such as OLAP, search engines, text mining or social media analysis are available in the latest BI applications (Božič & Dimovski 2018, 99).

In order to be able to compare the available business intelligence solutions, Gartner (2021) provides an annual review of the most popular BI platforms available. In their magic quadrant presented in figure 5 below, they separate providers based on their ability to execute and the completeness of their vision. Thereby the applications are separated into four quadrants: niche players, challengers, visionaries, and leaders.

Figure 5 Gartner's Magic Quadrant for Analytics and Business Intelligence Platforms (Gartner, 2021)

Niche players focus on specific business areas or applications, as for example IBM on existing Cognos customers to expand the range of analytical tools available. Challengers show a high ability to execute, but their vision is not as wide and clear as from other players in the market. For example, MicroStrategy was one of the first suppliers in the field of BI and the functionality is good, but the vision is more limited. The third quadrant, visionaries, represents a great set of major players, including Oracle and SAP. Their products are advanced and provide modern features and a good level of usability. The final quadrant separates themselves by higher ability to execute while having advanced vision and usability. Tableau, Qlik and Microsoft are the only three vendors to make it to the leader quadrant in 2021. (Gartner 2021.)

Compared to previous years, Microsoft with their Power BI solution has managed to increase their lead compared to competitors. Power BI was launched in 2013 and started as a follower, but the popularity of other Microsoft products, their organic integration capabilities and the familiarity of use has boosted Microsoft's jump to the first place. Additionally, Microsoft has invested heavily in the development since 2018 and the extended offering of features, including add-ons by third parties is putting Power BI clearly ahead of the competition. (Gartner 2021.)

Following the three proposed targets of BI implementation (Wixom & Watson 2010, 16) presented in chapter 3.2.1, the objective in this thesis can be seen on the second level, which represents an organization-wide implementation of the BI process to provide a holistic view of the business. This target requires great technological support to succeed, therefore only options in the leader quadrant by Gartner (2021) were considered. As the existing product portfolio in the case company consists of mainly software provided by Microsoft, the choice of Power BI was rather easy, given the highest rank in the quadrant and easy integration with existing systems.

This concludes the overview on business intelligence. The next chapter will address decision-making, particularly from a managerial perspective. The information need identification will be discussed in detail, as it sets the base for a successful BI process. Finally, performance measurement within companies is discussed to highlight different metrics that can be used with dashboards to increase the company's productivity.

4 DECISION-MAKING AND PERFORMANCE MEASUREMENT

This chapter covers three areas: managerial decision making, information need identification, and performance management. The chapter builds the connection between business intelligence and the underlying business needs. Additionally, performance measurement is introduced, which provides tools for better communication of current activities and business status to decision-makers.

4.1 Decision-making

Decision-making is one of the most fundamental aspects of managerial work. The earlier described business intelligence paradigm aims to support decision-making, but to do so, the decision-making, especially from a managerial perspective, must be understood first. Data-driven decision-making is described in chapter 4.1.2, highlighting the interconnection between well-informed decision-making and business intelligence.

4.1.1 Managerial decision-making

The fundamental idea of a decision is a choice between alternatives available to an individual (Sauter 2014, 23). The consideration of facts and judgement paves the way for taking course of action. Decision making has been viewed as one of the most important activities in organizations, as it shapes the course of the company's future (Eisenhardt & Zbaracki 1992, 17). No matter if the decision-maker is an executive or a manager serving the customer, the ability to improve decision-making is crucial, as it has a major impact on business performance (Davenport 2010, 11). According to a generally accepted definition within managerial decision-making, Harrison (1996, 46) defines a decision as "a moment, in an ongoing process of evaluating alternatives for meeting an objective, at which expectations about a particular course of action impel a decision maker to select that course of action most likely to result in attaining the objective".

One of the cornerstone paradigms to decision-making is the assumption of rational action. The decision-maker has clear objectives once entering the decision-making process. These objectives determine the value of possible outcomes. (Eisenhardt & Zbaracki 1992, 17.) On of the best-known managerial decision-making models by Simon (1960, 2) features three phases: intelligence, design, and choice. A similar framework was introduced by Mintzberg et al. (1976, 252) in their study on strategic decision-making, where the phases are called identification, development, and selection.

Continuing with the wording by Simon (1960, 2), during the first step “intelligence” the problem or opportunity is identified. This topic is closely examined in the chapter 4.2.1 about information needs. During the second step, design, the business problem should be analyzed and evaluated. Here the problem is framed and detailed in order to find the desired outcome. Alternatives and possible effects are modelled and presented to create a strong foundation for the decision phase. In the last phase, choice, the alternatives are compared and based on sensitivity and the presented information, a choice of action is taken. (Mitzberg et al. 1976, 252; Simon 1960, 2.)

An important aspect of the decision phase model by Simon is the concept of decision structuredness, which has been made famous with the management information systems framework by Anthony Gory and Michael Scott Morton in their 1971 seminal article (Arnott at al. 2017, 59). A totally structured decision is a situation where all the phases of the decision-making process can be specified. On the other end of the continuum is an unstructured decision, where no phase can be clearly articulated. There is a wide middle ground between those extremes, which can be described as semi-structured decision. Semi-structured decisions represent traits of both structured and unstructured decisions to a varying degree. In general, the more structured the decision, the more can be assisted with decision support systems or BI, whereas completely unstructured decisions must be carried out by managers, as decision support systems are unable to assists. (Gorry & Morton 1971; Arnott et al. 2017, 59.)

Critique on the assumption of rationality has been presented by academia. Cognitive limits have been discovered to the rationality of decision-makers, resulting in satisficing instead of optimizing. Also, the sequential model of problem solving is shown to jump back and forth instead of a linear sequence. (Eisenhardt & Zbaracki 1992, 22.) As a counterweight to sequential models, anarchical processes emphasize the irrationality of decision-making. These processes regard decision-making as a social construct which happens in a complex and unpredictable environment. The garbage can model by Cohen et al. from 1972 is a metaphor for decision-making situations where problems and solutions come together randomly, and the process is characterized as chaotic. (Langley et al. 1995, 262.)

Politics have shown to have a significant impact on the decision-making process. Sauter (2014, 24) argues that managers may pay more attention to presenter of the idea than the underlying facts. Individuals may exercise political activities in order to proceed personal or institutional goals in a decision-making situation. Politics are often used to display clarify power relationships in an organization. This must not be seen as a negative, as exercising power may bring consensus or drive forward important projects. (Mintzberg et al. (1976, 262.)

Strategy is closely related to decision-making, as strategy is regarded as the organization’s course of action. Formulizing of a strategy is a decision by itself, but the strategy

has an effect on the tactical and operational decisions in order to find competitive advantage. As strategic decisions can affect the organization's capabilities and focus, their importance is fundamental with long-term effect on performance and profitability. (Eisenhardt & Zbaracki 1992, 17.)

Decision-making can be seen as the most significant activity by managers in all types of organizations and levels therein (Harrison 1996, 46). He claims that in a managerial decision-making process the first step is setting objectives, which then starts the search for alternatives. The decision-making part follows, as the different evaluated options are presented, and the act of choice based on the alternatives must follow. Thereafter implementation and follow-up on the decision are carried out, differentiating the process of managerial decision-making from a generic decision. (Harrison 1996, 48-49.) From a managerial perspective, gathering the relevant business data to support the decision-making process is significant.

Managerial decision-making has been a popular focus area in relation to BI. Elbashir et al. (2008, 135) define business intelligence systems as enablers for management to provide and analyze relevant data for the decision-making process across a range of business activities. Business intelligence is becoming a necessity to form a holistic view of the business environment (Pirttimäki 2007, 59). Chen et al. (2012, 1166) clarify that BI helps the organization better understand its market and thereby supports to the timely decision-making. For a company to utilize data in their decision-making, a change in culture and process is often required. The next chapter will introduce the concept of data-driven decision-making, which guides the decision-making to rely on underlying information instead of intuition.

4.1.2 Data-driven decision-making

Companies are striving to increase efficiency and performance. A key component to achieving this goal is optimizing the decision-making in the organization. To be able to achieve this target, utilizing data during the decision-making process plays a crucial role. Utilizing a better set of information than another improves the decision-making process of a rational decision-maker (Brynjolfsson et al. 2011, 6; Blackwell 1953). Following this rational, improving the supporting information in the decision-making situation leads to better outcome.

Data-driven decision-making (DDD) refers to the practice of building decisions on data rather than intuition (Provost & Fawcett 2013, 53). The increasing availability of big data and analytics technologies has paved the way for data-driven decision-making (Brynjolfsson & McElheran 2019, 2; Chen et al. 2012, 1166). According to Okwechime

et al. (2021, 41) DDD has benefitted tremendously from the ease in which data can be collected, stored and processed with modern technologies.

DDD is not an all-or-nothing practice, but instead companies engage in it to greater or lesser degree (Provost & Fawcett 2013, 53). In other words, DDD includes incorporating various sources and characteristics of data to decision-making, but the choice is still influenced by intuition (Okwechime et al. 2021, 44). For example, a marketing specialist may base their decision on either experience (intuition), A-B testing (data analysis) or a mix of these aspects.

Brynjolfsson et al. (2011, 1) show in their study on 179 listed companies that organizations that engage in DDD display 5 – 6% higher output and productivity than their peers. A similar effect translated into other metrics of these companies, including market value and return on equity. Once business information becomes more current and accessible, decision-making should be more numbers driven, leading to improved profitably. (Brynjolfsson et al. 2011, 1.)

LaValle et al. (2010, 4) found that organizations using BI and analytics to differentiate themselves within their business environment are twice as likely to be top performers in their industry than bottom performers. Another finding in their study was that top performing companies are more willing to use analytics to steer their strategic decision-making process to outperform competitors. Several studies show a shift in decision-making within organization, where earlier reliance on intuition has been replaced, at least to some degree, with the application of data analytics (Okwechime et al. 2021, 40). Trieu's literary review (2017, 11-12) shows that BI has been shown to improve organization's performance by correctly targeting customers, transforming business processes, enriching organizational intelligence, and creating new or improved products.

Yet it appears that the diffusion of DDD has been uneven within industries. Brynjolfsson and McElheran (2016, 134) show that acceptance and adoption of data-driven decision-making has been most prominent in companies with high levels of information technology and educated workers. Also, the enterprise size plays a key role in relation to the adoption of DDD (Brynjolfsson and McElheran 2016, 134). In their follow-up study on DDD Brynjolfsson & McElheran (2019, 1) discovered that the focus of leading companies had shifted towards the use of predictive analytics. As more and more companies engage in business intelligence solutions, also advances within the field must be taken by top performers to stay ahead of their competition.

Another view on data-driven decision-making is that it refers to increasing organizational performance by bringing together relevant information and key decision-makers (Okwechime et al. 2021, 41). Thereby utilizing DDD requires both effective systems, well-organized data, and capable personnel to get the best outcome. Though pinpointing the most relevant data for decision-making is often troublesome, the more important it is

for the end result. The next chapter will highlight the key aspects of information needs and the gaps that arise in managerial decision-making situations.

4.2 Information needs

Information needs are the key customer of business intelligence. By serving the real information needs a company can address the most relevant aspects of the business from a decision-making point of view. Several gaps arise when examining the needed, provided and wanted information. The identification process is examined, and the findings are utilized in the empirical part of this study.

4.2.1 Information needs and gaps

The need for information arises typically in relation to a pending decision, challenge, or uncertainty. Information management aims to provide and share relevant data to decision makers, but identification of the most relevant information in the given context is increasingly challenging. According to Choo (2002, 26), decision-making situation are very complex due to the large number of factors affecting the decision, but also contextual factors such as organizational culture, internal control, functional hierarchies and so forth may affect the process. The free flow of information in the organization is prerequisite for successful decision-making (Davenport et al. 1992, 53). Information management cannot function or be useful unless the purpose of the information is explicitly stated (Choo 2002, 28). The information needs of an individual or an organization may vary significantly and are always dependent on the current environment and situation (Pirttimäki 2007, 41).

Identifying information needs is one of the most demanding tasks of information management (Pirttimäki 2007, 42). Identifying the correct information need has proven difficult, as the problems are often multi-dimensional. One suggested reason by Pirttilä (2000, 65-66) is that some needs are unconscious and therefore impossible to determine. Additionally, the business environment is becoming more and more dynamic, making standardized information extraction, processing, and sharing more challenging (Pirttimäki 2007, 42). Timing plays a crucial role, as the information need often does not arise before the situation of actual decision making (Pirttilä 2000, 65-66).

Unfortunately, not all information wants are actual information needs. Research suggests that there is a clear distinction between information wants and needs, typically referred to as an information gap (Aguilar 1967; Pirttimäki 2007, 43). Aguilar (1967) categorizes the information gaps into three classes. First decision makers receive information

that they want but that is not needed. Secondly, they receive information that is needed but not wanted or perceived useful. The last gap lies between decision-makers' needs and information that is not received. (Aguilar 1967; Pirttimäki 2007, 43.)

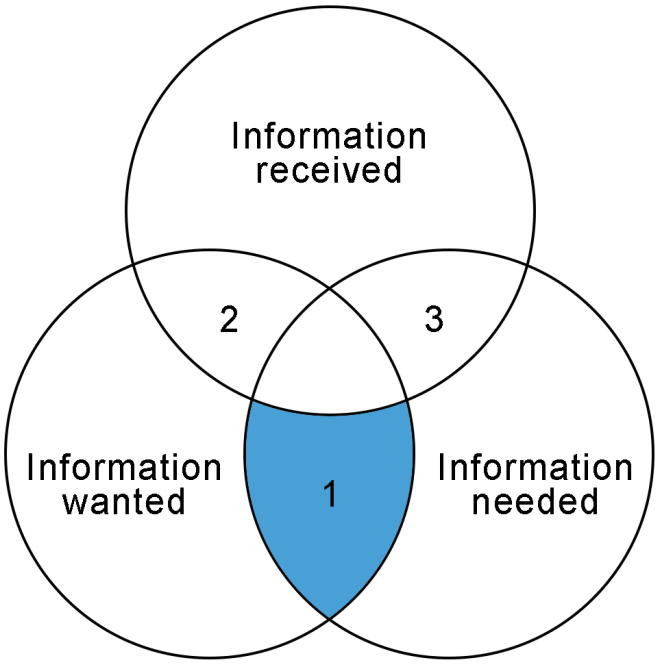

Figure 6 Information Gap (Pirttimäki 2007, 43)

As illustrated in the Venn diagram in figure 6, the most value-adding information is available in the area number 1, where information wants and needs overlap, but the information is not provided to decision-makers (Pirttimäki 2007, 43). Also, Pirttilä (2000) suggest that the focus of data collection should be pointed in this area, but the collection may not always be possible. Motivation from management and other stakeholders to resource the collection from this area is most naturally available, as the desire for the information is already present.

Pirttimäki (2007, 109) highlights, that the gathering of extensive amounts of data that the company is not able to transform into information or knowledge is a waste of time and money, as it cannot support the decision-making process within the organization. This realization points to the gap between information wanted and received (area number 2 in the diagram). Choo (2002, 26) states that it is valuable to know what information is not required. Often information that has been once asked for or that have been traditionally collected is not questioned, resulting lost resources tied to non-profitable reporting and data overflow for the receiving parties.

The gap number 3 between received and needed information is described as the "analysis-gap" (Vitt et al. 2002, 29). This gap may derive from the great amount of available data leading to information overload, that is distributed without clear purpose or need.

Aguilar (1967, 60) suggests, that careful attention should be paid to the selection of distributed information. On top of to the addressed gaps, a significant amount of needed information is neither wanted nor received. Often decision-makers are not aware of the significance or existence of this kind of helpful data (Pirttimäki 2007, 43).

Pirttimäki (2007, 44) states that it is impossible to state business needs in general, as each company is unique and has different resources and capabilities. Information needs are often divided into internal and external needs. Internal needs are company-specific and relate to product features, sales figures and processes, whereas external needs consist of market situation, competitor strategies and offering, customers and partners. (Uusi-Rauva 1994, 5-6; Pirttimäki 2007, 44.)

According to Marakas (2003, 90-91) decisions can be split by into strategic, tactical and operational. Though the grouping is in theory rather strict, the practical separation of the decision types may be very difficult (Pirttimäki 2007, 44). Bocij (2008, 21) simplifies the distinction to strategic and operational and shows that the decision type has significant impact on multiple dimensions of the information need, as presented in table 2 below.

	Time period	**Frequency**	**Source**	**Certainty**	**Scope**	**Detail**
Strategic	Wide	Infrequent	Mainly external	Less certain	Wide	Summarized
Operational	Narrow	Frequent	Internal	More certain	Narrow	Detailed

Table 2 Information needs on different managerial levels (based on Bocij 2008, 21)

The amount of needed external information increases when decisions are of strategic nature. The information need in terms of time and scope are widest on the strategic level, explaining the need for extensive external data for the decision-making (Bocij 2008, 21). Laitinen (1998, 148) emphasizes the time dimension of decision making and highlights that the longer the decision effect period is, the broader the information need becomes. Uusi-Rauva (1994, 6) and Pirttimäki (2007, 45) highlights the need to understand the corporate environment on strategic decision-making level, increasing the need for external and wide-scale information. The information detail must be summarized, otherwise the amount of information cannot be assimilated.

When examining operative managerial decision-making, the focus shifts to the current business and ensuring efficiency and reliability of operations (Pirttimäki 2007, 46). The level of required detail increases on lower managerial levels, whereas time and scope narrow down (Bocij 2008, 21). These operative actions often relate to chores and actions

of individuals or small teams, whereas tactical decision making is often performed by middle management (Laitinen 1998, 146).

To conclude, the most value-adding information can is not yet received by decision-makers but is both needed and wanted by decision-makers. When the managerial level and decision type are taken into consideration, the information need becomes clearer. These insights guide the collection, processing, and dissemination of information. The next chapter will examine the identification process of information needs.

4.2.2 Identifying information needs

Different types of information gaps were discussed in detail in the previous chapter. A key element to enhancing decision-making is to identify these information needs and thereby closing the information gap between needed and received information. Unfortunately, the identification of information needs proposes many challenges due to the unsymmetric form of decision-making (Turban et al. 2001, 441).

According to Pirttimäki (2007, 41) identifying information needs is the first step of an information management process and is thereby "most important template for the success of the later phases of the process". Overcoming information gaps may take place in several sequences and orders, but a logical starting point is to assess needed information in the organization's current environment (Choo 2002, 26). By increasing the awareness of the current situation, the wanted information starts to overlap more and more with the actually needed information. By expressing and demanding the need, relevant data is gathered and can be assimilated to the correct audience, whereby the information received by decision makers align with the business needs.

The selection of the utilized identification method should be considered with special care, considering the prevailing business environment. Several studies suggest that the identification of information needs should focus on business processes (Reynolds 1995, 342; Fischer 2004, 10). To understand what kind of decisions are made, the most essential units and activities must be mapped to within the business process (Fischer 2004, 12). Gaining understanding of the underlying process helps identify real information needs and drivers for the process success. Reynolds (1995, 343) adds that critical success factors must be examined continually, and therefore these factors must be captured.

Fischer (2004, 10–15) sees identifying key decision makers within the business process as the natural continuum. The reasoning is that the information needs can then be targeted at the most influential individuals within the process. Choo (2002, 28) supports this perspective, suggesting that "particular information needs will have to be elicited from individuals".

In order to extract the information, several methods are suggested. On top of informal communication within the organization, interviews and questionnaires are presented. The value of cross-functional teams and sources is emphasized, ranging to the extent of organized networks of individuals for information collection (Choo 2002, 31). Additionally, brainstorming sessions are suggested to facilitate key persons jointly to reflect on the underlying factors (Vitt et al. 2002, 57).

Pirttimäki (2007, 48) states that that a well-grounded, practical framework is needed to be able to identify information needs in real business situations. She points out that the hierarchical classification of data, information, knowledge, and information is not a sufficient framework to identify business needs. Instead, she introduces a framework with three dimensions to consider when identifying information needs.

The cube of information is separated into three dimensions, which are specified as the source, subject and type of information. The form and subject of information are separated into internal and external, which has been closely discussed in chapter 3.1.2. The type of information is divided into qualitative and quantitative. (Pirttimäki 2007, 48.) Quantitative information is typically defined as data that is structured in an easily processable manner, for instance in numerical statistical information. On the other hand, qualitative information consists of unstructured information, such as ideas or strategies. (Frishammar 2003, 319.) An illustration of the cube is presented below.

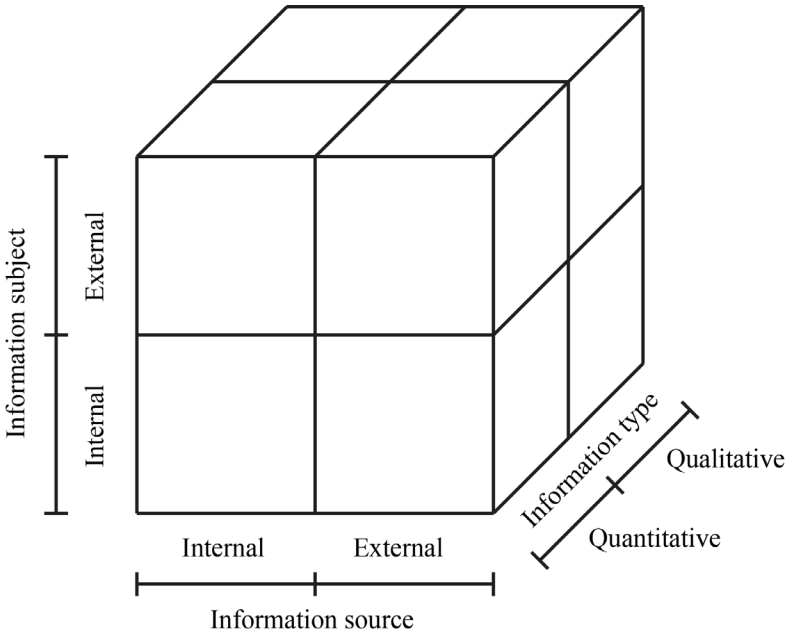

Figure 7 Cube of business information framework according to Pirttimäki (2007, 48)

The cube of business information (Pirttimäki 2007, 48) will be used to assess the identified information needs and selected information sources during the design evaluation of

the framework. To know what to measure and how to display the data, the next chapter will focus on the field of performance measurement.

4.3 Performance measurement

Performance measurement has been a highly debated research field for several decades. Already the first edition of the Administrative Science Quarterly, published in 1956, featured an article related to performance measurement consequences. Two recurring themes appear in academic research: the desire to quantify performance, and simultaneously examining the consequences of conducted performance measuring. Drucker was one of the first to express the need to balance measurement systems to gain a more comprehensive picture of the company to determine also future potential instead of just looking backwards (Drucker 1954; Neely 2005, 1265).

Performance measurement systems aim to monitor business activities to determine if strategic goals and objectives of the company are met. Thereby measurement provides organizations with the possibility to access how well they are progressing in relation to set targets. Additionally, identify future initiatives based on current strengths and weaknesses is made possible. (Yigitbasioglu 2012, 48.) The organization's measurement system strongly affects the behavior of managers and employees. The actions performed by these individuals ultimately contribute to the organization's performance, which can be summarized with the statement "What you measure is what you get." (Kaplan & Norton 1992, 71.)

The immense improvement of decision support systems put more speed into the transformation within the measurement movement. In his manifesto from 1991, Robert Eccle articulated the foundation for the 1990s boom in performance measurement when stating that "Within the next five years, every company will have to redesign how it measures its business performance." The statement includes a radical shift in in managerial perspective: from treating financial indicators as the foundation of measurement to treating them as one among a broad set of measures (Eccle 1991, 131). This trend led to the formulization of several performance management and measurement frameworks. The purpose of these models is to identify where measurement is needed, design the metrics and key performance indicators (KPIs), and to follow up on the performance of the metric against a set target value (Lempinen 2012, 120).

The performance measurement matrix by Keegan, Eiler and Jones is one of the first notable performance measurement framework, which includes key performance indicators within the company. The matrix is divided into four areas, where the variables are internal and external, and non-cost and cost items. They point out that the previous year's performance is a common yardstick, and though it is useful, benchmarking external

companies' performance brings significant insight into internal operations. Another key finding is the measurement of non-cost items, as they argue that also improving non-cost measures ultimately results in cost improvement, though the impact may be indirect. (Keegan et al. 1989, 45 – 48.)

Perhaps the best known and most cited performance measurement framework is the balanced scorecard by Kaplan and Norton from 1992 (Neely et al. 2005, 1267). The scorecard consists of four perspective on the company's performance. The financial perspective is still relevant, as it shows the outcome from earlier actions. In addition, Kaplan and Norton highlight that the three other perspectives are needed in order to give a full view of the current business performance. The second perspective focuses on the customer, answering the question "how do customers see us?" The measures applied by customers often fall into four categories: time, quality, performance, and cost. By measuring the company against these expectations and following up on the customer satisfaction grants additional insight into the future potential of the company. The third perspective relates to internal operations and the identification of key success factors. These key factors must stem from customer need, thereby the second and third perspective are tight together. The fourth perspective is the innovation and learning capability of the company. In order to grow and stay relevant in the quickly changing business environment, the company must be able to innovate and develop in order to create actual value to the customer. The synthesis of these four perspectives enables management to gain insight for the company to outperform competitors. (Kaplan & Norton 1992, 71 – 79.)

Neely et al. (2001, 6 – 12) Introduced the performance prism framework to undo some of the shortcomings in the balanced scorecard. Their prism has five interrelated facets, of which the first is stakeholder satisfaction and the last stakeholder contribution. Stakeholders are not only share owners and customers, but also employees, suppliers and intermediaries are included. The idea is that the company both tries to deliver value to the stakeholders and has simultaneously expectation on the contribution of these stakeholders to the company. The second facet is strategies, which starts at the question of "who are the stakeholders and what do they want?" instead of taking strategy as a given. The third facet is process, which aims to put business processes in place to allow the strategy to be executed. The fourth facet are capabilities, which are required for the processes to run efficiently. Capabilities are the combination of people, practice, technology, and infrastructure, which build the foundation for corporate actions. (Neely et al. 2001, 6 – 7.)

Norton and Kaplan (1993, 2) highlight that the framework cannot be implemented as such into any industry or organization, but instead it must be tailored to fit the specific business environment. Keegan et al. (1989, 46) emphasize that performance measurement must always be linked between business unit actions and strategic plans. A common weakness in companies before the implementation of such a measurement framework is not the lack of measures, but the high number of unlinked KPIs. Companies tend to

implement numerous performance measures, of which many are obsolete or inconsistent (Keegan et al. 1989, 46).

Nowadays KPIs and other performance measures are presented via BI solutions, especially dashboards. Yigitbasioglu and Valcu (2012, 52) argue that the primary purpose of dashboards is to present and compere KPIs. Modern BI applications have enabled drill-down functions and further analysis options on KPIs, increasing the value of the presented information from simple statements to root-cause analysis options. Modern dashboards still rely on the foundational ideas of measuring business from different angels, where the capability of BI to utilize information from several sources near real-time provides significant advantages.

This concludes the theoretical review of the thesis. The next chapter will detail the empirical information need identification, which is the first phase of the business intelligence process.

5 IDENTIFYING INFORMATION NEEDS

This chapter describes the identification process of the management team members' information needs. This is the first phase of the business intelligence process model, presented in chapter 3.2.2. First, the methodology for the identification process is presented. thereafter the data collection plan is described. The results of the conducted interviews are presented in chapter 5.3.

5.1 Methodology

As presented in chapter two, the chosen methods in this thesis are design science research and qualitative research. Design science research creates the main framework for conducting the research. Qualitative research is utilized to obtain relevant information during the artifact creation process and design validation. Design science research is detailed in chapter 2.1, but the qualitative approach and methodology are assessed in this chapter.

Qualitative research can be conducted with different methods, depending on the research object and purpose. The purpose of qualitative research is to provide a holistic picture of the research object based on analysis of multiple empirical sources (Eriksson & Kovalainen 2008, 5). A common theme for qualitative research is the aim to understand the research object within the business environment and assess its purpose and factors shaping it.

The chosen method for the qualitative assessment is case study. Overall, the purpose of qualitative case study is not to make generalizations of the subject matter, but instead describe and analyze the phenomenon in the given context (Yin 2003, 89). In information science research the application of qualitative studies focuses on management activities, whereas a quantitative approach is used primarily for technological problems (Myers 1997, 241). As the purpose is to identify the information needs of the management, qualitative study provides the perfect approach to obtain deep understanding of the needs and pain points of the executives. Qualitative research is utilized particularly to answer the research questions "*What are managerial information needs?*" in relation to the case company.

Identifying the real information needs is a vital step towards achieving value-adding business intelligence, as described in chapter 4.2. To find out the needs within the case company, interviews were selected as the primary information gathering method. An interview can be seen as a guided conversation rather than structured query, which can focus directly on the study topic and provide causal inferences (Yin 2003, 86–89). The interviews were held with all management team members to get feedback from all relevant perspectives on the company. During interviews, the researcher is able to control the

proceeding of the discussion and moderate the direction of the conversation. As the objective is to obtain specific information on the information needs, interviews are a suitable method to conduct the qualitative research.

In particular semi-structured interviews with questions were used. The open-ended nature ensures that facts of the presented matter can be assessed, giving respondents the opportunity to express deeper feelings around the matter. In addition, it enables the researcher to ask for the respondents' own interpretation on the occurrence and additional follow-up questions. (Yin 2003, 90.) Thereby the respondents can more freely comment on the artifact, opposed to structured questions without closer discussion on the underlying reasons.

5.2 Data collection

The interview respondents were chosen based on their role in the case company. After consideration, all seven management team members were interviewed to grasp all perspectives of executive tasks in the company. The interviews were held individually, ensuring that all respondents could express their own feelings, needs and opinions. The respondents' history within the company ranged from less than one year to over 10 years of experience. All respondents are accountable for at least part of the company's processes and functions, thereby the relevance of all opinions could be considered high. Table 3 below shows the position of the interviewed persons.

Date	**Position**	**Interview duration**
20.10.2020	CFO	54 minutes
7.12.2020	HR Director	37 minutes
10.12.2020	CEO	25 minutes
14.12.2020	Indoor Business Director	36 minutes
17.12.2020	CCO	27 minutes
18.12.2020	Operations Director	20 minutes
21.12.2020	Outdoor Business Director	53 minutes

Table 3 Interview group 1

The interviews were held in face-to-face if possible, but due to the pandemic some of the interviews had to be held via Teams meeting calls, still allowing to see the respondent through the video chat. All interviews were recorded and transcribed into text for the researcher to be able to analyze the results. The interviews followed the same pattern, where the interviewer first presented the background and reasoning for the interview and

thereafter two-fold questions were asked: firstly, general comments on the need and usability of a dashboard to better understand the expectations of the respondents towards the artefact and secondly more specific questions on the respondent's role and managed operations in order to identify the related information needs. The semi-structured questionnaire was built based on earlier findings within the literature review and adjusted based on each respondent to match the responsibilities of the executive.

5.3 Interview results

This chapter discusses the results of the initial interviews with the management team members before the implementation of the BI dashboard. The purpose is to better understand the earlier experience and expectations towards the BI project. A key take-away was to gather the information needs from different perspectives within the management, so that a balanced outcome of the dashboard could be ensured.

5.3.1 Earlier experience and general expectations

The interview revealed that there is plenty of earlier experience related to the use of different DSS and BI applications. Several versions of Qlick had been used before and two of the respondents had earlier experience with Power BI in particular. Still, the respondents were most familiar with Excel-reporting and described that a common way had been to extract data from a DSS or ERP system into excel for further analysis. The existing knowledge turned out to be helpful for the interviews to proceed effectively, as the interviewees could more easily relate to the topic based on their earlier experiences.

Both the CEO and CCO, who had joined the company within the last two years, had experience of earlier BI implementation projects. They described an interesting change both in the mentality and the process which followed the BI system implementation. The companies had earlier applied manual corrections to reports, mostly done in excel after extraction from ERP or other system. The change to utilizing data directly from several data bases had revealed significant shortcomings on the data validity. The master data and relations were not properly maintained, which made the reliability of the presented figures questionable to say the least. The CCO described that in his previous company it took longer to fix the underlying data to receive reliable reports than the initial need identification and the creation of the dashboards combined. This forced the mentality change, when earlier corrections had been made manually to the output data, now the information had to be fixed at the source. He proposed to put significant attention to the data reliability when creating the artifact, which was noted by the researcher.

The discussion around the expectations and targets for the BI implementation revealed rather eager anticipation from the respondents. Especially the managers who had joined the company within the past two years were very excited about the project. They longed for a clear, unified view on the business to really understand the connections and patterns within the company and market. A similar need was presented by respondents with the longest history within the company, but they expected to gain additional insight into the business and the recently created business units. They described that the operations had earlier been rather strictly divided between functions and that therefore the understanding of processes within other functions was lacking. Thereby the desire for a comprehensive, centralized tool was highlighted. The creation of a "common view" was the most consistent aspect through-out the interviews.

CEO: "Target, actual, deviation, action."

A frequently mentioned theme was gap closing. This meant the identification of operating areas which displayed shortcomings in relation to expectation and the following actions to improve performance to the desired level. This was highlighted by the upper executives, CEO and CFO. In their view the BI system could add the needed monitoring capabilities into operations to follow-up if strategic targets could be met. The strive towards information-based decision-making was described in most interviews in different relations.

The usability of the system was also closely discussed. Several respondents raised the issue of static and responsive dashboards. They had earlier experience of fixed dashboards, where the view could not be altered. They felt in general positive about utilizing such dashboards in case the presented data was informative enough to display a clear narrative without deeper analysis of the underlying issues. This could help to create a common understanding of the current situation as everybody saw the same trendline. In addition to these static dashboards, reports with drill-down functions, slicers and filters were desired. This could then help to understand the underlying variables affecting the trend, for example identify the product categories driving change in gross profit compared to earlier periods.

Outdoor Business Director: "In terms of reporting – the current way of working is ad hoc."

The desire to combine data from several sources was raised by most of the respondents. This presented in their view a significant improvement opportunity compared to the current data utilization, where manual extractions from different systems and extensive processing work was required to gain valuable insight into the existing relation of occurrences. Especially the business unit directors felt that it was extremely troublesome for them to gather data from several systems to produce monthly reports related to sales, market development and engineering status. They felt that the reporting was conducted in an ad hoc manner and they hoped for a more systematic way to provide their needed

data in the future, maybe even by presenting directly from the BI dashboard instead of creating separate presentations. In this connection the automatic data collection was also mentioned to free up time compered to current procedures. The data update frequency was not seen as a major problem, with most information desired to update on a daily basis. Some aspects were described as even less time intense, with updates expected on a weekly or monthly basis.

Reflecting on the general assumptions of the managers, the planned dashboard promises aid to all the mentioned topics. The desire for a shared, coherent view of the business environment for better decision-making can be traced directly to the definition of BI, presented in chapter 3.2.1. The monitoring capabilities to make active decisions to close the performance gap relates to the information need specified in chapter 4.2.1. Also, the usability expectations are aligned with rather general traits of dashboards, presented in chapter 3.2.3. Thereby the interviews affirm the presented literature review on the broader topic of decision-support for managerial tasks.

5.3.2 Leadership and key performance indicators

The second phase of the interview focused on KPIs and leadership based on performance indicators. All interviewees expressed familiarity with leading based on performance indicators, with a up to 30 years experience for a few executives. The Operations Director expressed that his leadership has been based on KPIs through-out his career, during which he has worked related to supply chain management in different companies.

> *Outdoor Business Director: "I see them (KPIs) so that they show the direction. – Not so that we just refer to them occasionally, but that they guide us towards our strategic targets."*

A repeating theme during the interviews was the need for clearly specified operative KPIs, which could be linked to the wider strategic alignment of the company. At the time of the interviews, a holistic set of key performance indicators was not specified, and the monitoring of some processes was either lacking or completely missing. Here the ad hoc mentality of reporting was highlighted by the Outdoor Business Director, who was asking for continuous follow-up on the progress of clearly defined KPIs. The CEO, CFO, CCO and Outdoor Business Director all emphasized that KPIs are a vital tool to link strategy into operative actions. In their view strategy sets the direction of the company, and KPIs are utilized to guide and track the implementation into operative processes.

Once asked about their opinion on the needed number of KPIs, a rather uniform response was "not too many". Several of the respondents had encountered data overflow in their past positions, with a mention of more than 100 KPIs presented in an earlier company of the CEO. The CFO proposed that the key performance indicators should fit on

one or two pages in the dashboards, which should be followed-up on by the management team. More detailed indicators and measures related to specific functions could and should be implemented, but these could be shown on separate reports or pages.

> *Operations Director: "Of course everybody is married with their own KPIs – the question is, what should be presented to the whole team?"*

An interesting discussion was around the KPIs that would be key to the success of the company. Several indicators were already in place during the interviews, but their relevance was questioned during the process. The Operations Director and Indoor Business Director expressed that they had a good view of their own KPIs, but the knowledge of other processes and their performance was not coherent. In relation to this matter, the question of which KPIs should be followed by the whole management came up. The target to create a common understanding was elaborated, which requires cross-functional knowledge of the company's activities and processes.

The definition and effect of KPIs raised some concerns among the respondents. It was unclear at the time of the interviews how some of the currently used KPIs were defined and how much manual alterations were performed to get the numbers. Also, the risk of misleading indicators was raised by the Indoor Business Director. The risk of key performance indicators taking the company towards an undesired direction, for example nurturing only existing customers without focusing on new customer enquiry to boost personal KPIs, may lead to sub-optimization and result in an unfavorable outcome for the whole organization. Another concern was raised by the Operations director related to the potential disconnection from the data once the automation would create the dashboards without manual work to it. He noted that the daily or weekly habit of gathering the data helped him understand also some more minor aspects of the data, as he had to work to get the numbers.

> *CEO: "The first thing in the morning was to open my laptop and check the dash-board."*

The most highlighted theme was the usability of KPIs in relation to daily managerial work and decisions. The CFO emphasized that the visualization of the data is not the most relevant aspect, but from a managerial perspective the ability to act based on the received information. To effectively support decision-making, the timing of the presented data is key, as was acknowledged by the CEO, CFO and Outdoor Business Director.

Challenges related to knowledge-based decision-making were raised from the business unit Directs and the CCO. They explained that their current challenge derived from the multi-function operations that they were managing. It was not just sales and promotion, but the product development and the underlying strategy that needed to be combined from their perspective. As several systems were used internally and the need for external information on customers was also current, they felt that a BI solution could leverage their understanding significantly.

A slightly surprising aspect during the interviews was the keen desire to share most of the key performance indicators not only with the management team, but to the whole organization. The CCO expressed good results of such a procedure in his earlier role in another company, where the cost awareness and commitment to the company's profitability had in his experience improved.

Based on the responses during the interviews, the management focused on the daily leadership and the potential benefit from KPIs. The strive to make better informed decisions was coherent with the academic findings presented in 4.1.1 and the strong believe in utilizing data to improve decision-making shows that the management shows traits of DDD, closely described in chapter 4.1.2. The perspective of the interviewees was clearly focused on internal activities to support the recently updated strategy. Based on these findings, the company's business intelligence target is closest related to the second stage introduced by Wixom & Watson (2010, 16), where the company seeks to gain a complete perception to the business with the help of the BI solution, as presented in chapter 3.2.1. The comments by the management team were very much in line with earlier findings on KPIs listed in chapter 4.3.

5.3.3 Specific information needs

In order to grasp the key aspects of different activities within the case company, more detailed questions related to the business unit or function were presented to the respondents. By doing so, the key aspects of those functions are examined, and the information need related to those identified.

Starting with the sales function, the need to filter the sales in multiple dimensions was discovered. The sales had been presented by product, family, and territory to that point. A new requirement was to be able to allocate sales by business unit in order create understanding on the commercial aspect of the recently formed business units. Earlier sales had been led as a whole, without separating indoor and outdoor segments. This was very important to the new business unit directors, who were struggling to grasp the dimension of sales within their business units. Additionally, the profitability per customer, family, segment, and further dimension was requested by the CCO and Indoor Business Director. An important project recognized by both business unit directors was to prioritize customers, therefore the profitability of them was needed on top of the revenue information. The classification of customers was also requested, though it had not yet been created.

> *Outdoor Business Director: "When going through the daily order report I wonder if this is now indoor or outdoor business?"*

In addition to analyzing historical sales the need to understand the order intake rates and reviewing the open order backlog were identified by the Indoor Business Director.

At the time of the interview only sales information was available in detail for management, but visibility into future deliveries was lacking. To improve forecasting capabilities, the integration of information from the CRM system was requested by both business unit Directors. Sales opportunities and meeting minutes are documented in the system by sales representatives, but this data had been barely utilized by the management.

The CFO, CEO and CCO highlighted the need to implement accounting information in the form of profit and loss analysis and visibility on the balance sheet. The revenues can be traced closely based on the sales data, but the cost base of the company was not shared in detail. They emphasized the need for cost-consciousness within the whole management team to provide excellent profitability. The cost side was felt to be only the concern of top executives at the time of the interview and therefore spreading knowledge on the fixed expenses was regarded as important.

Continuing with the business units' needs, the follow-up on engineering activities was raised by the CFO, CCO and both business unit directors. A system to track project schedules had been adopted by the engineering team one year before the interview, but the data was not presented to people without access to the system. The described need was to follow up on the ability to maintain the planned schedule of the projects. Measuring the absolute duration of projects was not deemed as important, as the project scopes varied significantly and therefore the durations were not comparable.

When discussing the HR related indicators, the importance of the employee's views and attitudes was emphasized by the HR Director. An annual employee survey presented the best source for information in this regard. A problem was identified in relation to refresh rate of the information, as the survey was only conducted once a year. The proposal to implement a "pulse survey", which would gather key attitudes and feelings from the staff on a monthly or quarterly basis, was introduced to grant timely insight into the staff's mood. Additionally, the tracking of trainings and capabilities within the work force was discussed. The outcome was that the number of training was not a reliable metric based on which to assess the capability of employees, therefore this aspect was not seen suitable to be implemented.

> *Operations Director: "I considered what would be a good summary for externals in order to understand the complexity of all operations, as there are several functions in-volved."*

The final perspective on the business through for support operations, which includes sourcing, logistics, warehousing, and quality functions. Here a set of KPIs had been identified earlier and put in place, which was updated and presented on a monthly basis. The current KPIs included order to delivery times (OTD), order processing time, complaint rates and inventory value development. These were discussed and found to be relevant also going forward, but additional information to enrich the data was desired. Just recently a process to split the inventory items into A, B, C and D category based on their demand

had been implemented. This data was only available in excels and wasn't actively utilized at the moment by other employees except the Operations Director. The possibility to track inventory levels based on the classification was requested. This could enable stock level optimization, including determining of goods to be scrapped and setting of buffer levels for top performing products.

The interviews revealed detailed and valuable information on the information needs of the management team members. Reflecting on the four dimensions in Kaplan and Norton's balanced scorecard (1992, 71 – 79), all dimensions were covered during the interviews through different interviewees and their insight on specific actions. As described in chapter 4.3, generic performance indicators cannot be directly implemented into all companies, but instead the business environment, processes and activities must be considered in the target company. The held interviews gave great input for specific metrics for the case company to utilize in the artefact. Based on the collected information the artefact building process could start, which is presented in the following chapter.

6 DASHBOARD CREATION

The formal interviews with the management team presented a solid baseline to start the building phase of the artefact. According to the business intelligence process model established in chapter 3.2.2, the first step "information need specification" was performed during the interviews, as presented in the previous chapter. The following chapters will present the information gathering, processing and dissemination phases before reaching the final stage, where the information is utilized by the decision-makers.

6.1 Gathering of data

The second phase of the BI process model is the gathering of the relevant information. As the information needs were specified in the first phase, the second phase aims to identify the relevant sources. Once these sources are identified, access to the information must be obtained and the extraction method are to be specified. The last part of the gathering phase is storing of the collected data in such fashion that the data can be further processed and consumed in later stages of the process model.

Based on the input in the interviews and informal discussions with key employees, most of the requested data can be acquired from systems that are internally managed within the company. The primary information source is the EPR system, from which the highly requested revenue and order intake information can be extracted. Additionally, most of the desired dimensions in which to slice and filter the data are available in the ERP system, related to both the customers and products. Customer information includes geographic location, used currency, classification as distributor or end-customer. The product data shows the product family, release year, and separation between custom and standard products. The product master data is stored in a separate system, but the most relevant information is automatically migrated to the ERP, thereby the master data related to products can be simply extracted from the ERP system. In addition to revenues and orders, several KPIs related to logistics, warehousing and the supply chain can be tracked based on information from the ERP. The most relevant data from the ERP is automatically loaded into the company's data warehouse, which eases the utilization in further phases of the process.

The second sales related data source is the CRM system, which features details on customer meetings, customer classification and sales opportunities for planned projects. The data is enriched by the sales team with meeting reports and new opportunities related to the customers. The CRM system is cloud-based, and the information is not automatically synced to the EDW.

One challenge in the case company is that the customer field is very fragmented, with close to 10 000 customers, of which the majority is served through distribution channels. As the company does not sell directly to the end customer but the sale goes through distribution channels, the end-customer cannot be tracked based on revenue details. To grasp the actual lighting manufacturer customer base, the company receives resale reports from the distributors, which are collected and consolidated in the company's data warehouse. Here the direct sales to lighting manufacturers from the company are combined with the resale data from distributors, providing a more accurate picture of the customer base. This information is utilized in the CRM, whereby the input from sales representatives can be linked to sales figures per end-customer.

Moving to information related to engineering, project scheduling is documented in a separate project management system. Once a project starts, the target schedule for the project is input in the system. As the project proceeds, the actual project development can be compared to the initial plan. On top of the schedules, the responsible project managers and the count of ongoing projects can be tracked from the system.

Information related to employees are not tracked in any dedicated system, but as discussed during the interview with the HR Director, the annual employee surveys provide valuable insight into the mood and attitude of the employees. As the surveys were held in the same format throughout the years, the responses can be compared year over year and the change tracked. The planned "pulse surveys" are not yet implemented and therefore this information cannot be utilized in the dashboard.

The final piece of requested information relates to accounting. The accounting figures were only available to the CFO, CEO, and controller in Excel format at the time of the interview. To be able to utilize the data in the dashboard, key elements were identified, based on which the figures are summarized and transformed into a different format to be imported into the EDW.

Looking at all identified data sources, data is utilized from the company's ERP, CRM, project management software, customer surveys, distributor resale reports and accounting reports. When analyzing the gathered information with the help of the cube of business information by Pirttimäki (2007, 48) presented in figure 8, the information is mainly of quantitative nature. The exception are project descriptions and meeting reports from the CRM by sales representatives. Analyzing the information subject, a significant amount of the gathered information relates to internal objects. The external perspective is dominated by the customer view through sales information and input from the sales team. The information source is somewhat balanced between internal and external, where the information from distributors and meeting reports represents the customer perspective on top of the internally generated data.

To summarize the data gathering phase, the information sources could be rather easily identified based on the input from the interviews and informal discussions with the

stakeholders. The company's existing data warehouse presented a perfect solution for storing the identified information. To localize and understand the important details to be gathered, informal discussions were held continuously with the key employees responsible for the operations. As the information needs were rather specifically enclosed during the interviews, the discovery of the needed sources was a rather simple step in the BI process model.

6.2 Processing of information

The third phase in the process model consists of the processing of the gathered information. During this phase, the data is processed to turn the raw data into information that can be utilized and visualized by the target audience. The ETL operation is used to extract, transform, and load the information from the original source to the point where information can be utilized in the dashboard. Additionally, the information is evaluated and cleansed to ensure data reliability and compatibility.

In order to utilize the gathered data more efficiently, the information from the company's ERP, project management software, employee surveys, distributor reports, and accounting reports is stored in the company's data warehouse. The process for the distributor resale reports to be stored in the EDW had already been established and utilized for years, but the ETL process for the other identified sources had to be formalized and implemented. Direct integrations of these systems to the EDW were not created, but instead semi-automated processes, requiring user input to start the process, were put in place to extract and load the data into the EDW. Based on the earlier identified key information needs, the raw data from the sources was extracted with minor transformations in order to be loaded into the EDW. For example, a process to export monthly accounting information was established so that the monthly, uniform data sheet was imported to the EDW through an export Excel sheet. The process was coded with VBA to directly insert data from Excel into a specific data table in the EDW, including information related to the reporting period. The process requires little manual input and can be performed within minutes, which enables timely and effective processing of the information within the company.

The transformation of the data was performed mainly after importing to the EDW with the help of different update and view queries performed with Microsoft's data warehouse management studio software. The program grants access to the SQL database, including the possibility to create new tables, views, and automated update functions to transform and sort the imported data. The imported data from different sources was on purpose minimally summarized or aggregated to perform the transformations within in the EDW. By importing detailed information from the source systems and reports, the researcher

ensured flexibility in future processing, joining and presentation of the data. Thereby changing needs within the business environment can be answered effectively in the future, as detailed information is readily available in the EDW. Also, data cleansing in the meaning of transforming data into compatible format and excluding of irrelevant data was performed in the EDW to ensure high reliability of the output data.

To further enrich the data from external sources based on the requests from the management team members, additional information related to customers and products was imported into the data warehouse. For example, the ABCD classification of the products was directly loaded into the EDW, as it was not available in the ERP system. A similar approach had to be taken to separate sales based on business units. The product families had been allocated to either indoor or outdoor, but the information was not stored or maintained in any system. This information was loaded to the EDW to support the classification of sales, inventory, and orders.

Once the data was sufficiently formatted and made available in the EDW, the loading stage of the information into Power BI started. Connecting Power BI to an SQL data warehouse is one of the most common steps to obtain data into the system and proposed no challenges. Additionally, the connection to the cloud-based CRM system was created. The connection process to the CRM turned out to be straight forward, as the CRM was also supplied by Microsoft and an existing connector was available out of the box.

The advantage of data loaded through the EDW was the comprehensive possibility to transform data before loading into Power BI. Power BI also features relatively advanced transformation capabilities, but creating specific views and extracts based on several conditions was easier to perform directly in the EDW and thereafter load the transformed data into Power BI.

To take full advantage of the data loaded into Power BI, the data model was organized into a star schema. By utilizing a star schema, the relationships between data tables can be effectively created, enabling multi-dimensional modelling of the data and features such as drill-down are made effectively possible. Thereby the need to state the same dimensional data in multiple tables is made redundant, as the data can be inherited to the fact table through the created relationship. This process decreases the total amount of data loaded into Power BI and positively affects the overall performance of the data processing. As an example, the date hierarchies, product dimensions and customer details were imported in separate dimension tables and connected through relationships within Power BI to the sales fact tables.

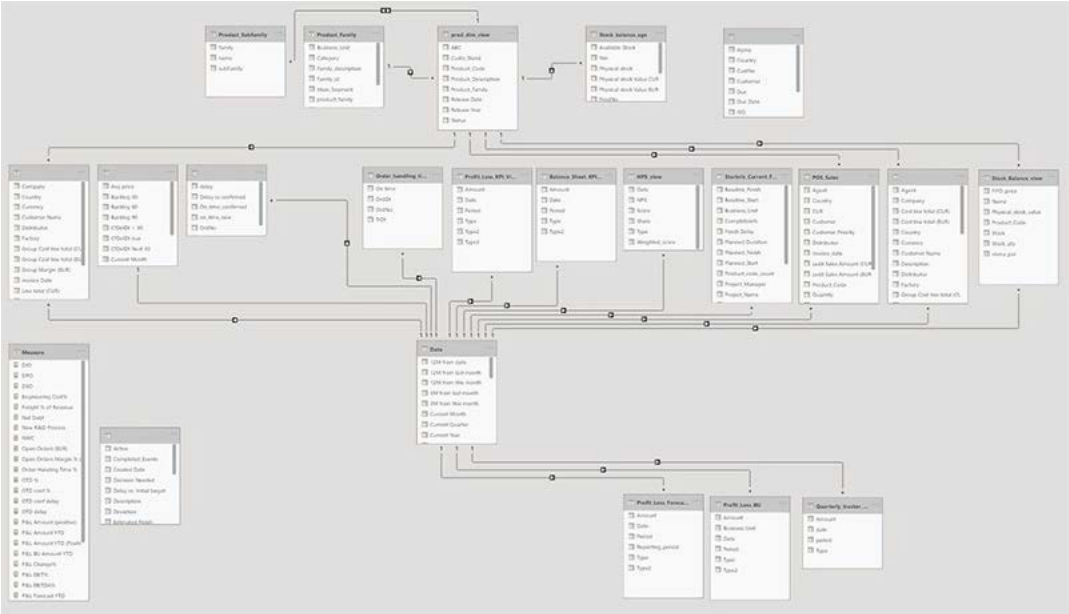

Figure 8 Database model

As suggested by Shariat & Hightower (2007, 42), the ETL process proved to be significant during the information processing phase of the BI process model as described in chapter 3.2.2. Implementing the new sources to the data warehouse required the implementation of new processes to the company. Daily, weekly, and monthly routines were put in place in order to extract the needed information. The responsibility for the transformation and loading process was dedicated to the controller, who is also responsible for maintaining the EDW. After the data was imported and the data model in Power BI was established, the designing of the dashboard could be started.

6.3 Dissemination of knowledge

The fourth phase of the BI process model covers the dissemination of the collected information in such manner that the target audience can easily obtain the relevant information and monitor changes in the business environment. As the information needs were specified in the first phase and the data was gathered and processed in the following phases, the key aspect of the dissemination phase is to combine, visualize and highlight the key metrics. Here the identified KPIs and variables play a key role, but also the availability and user-friendliness of the report are important aspects to ensure efficient use of the artefact.

As discussed with the management in the interviews, the number of displayed KPIs in the dashboard should balance between expressing all needed information and not overwhelming the audience with data overflow. Based on these inputs, a single-page dashboard for the most important KPIs was drafted. Here the proposed balancing of variables

by Kaplan and Norton Kaplan & Norton (1992, 71 – 79) was considered. The target of this dashboard is to give a one-glance view on the current operations, including a forecast for the upcoming quarter. Financial metrics take up roughly 40% of the dashboard covering both cost and profitability development. Monitoring of internal operations, with focus on engineering schedule, on-time-delivery and stock age take up another 40% of the dashboard, with the remaining 20% focusing on employee satisfaction. On top of customer related sales information several of the internal metrics have direct impact on the customers, especially custom project development and OTD on customer deliveries, whereby the customer perspective is also covered as proposed in the balanced scorecard.

In order to gain deeper understanding and display more specific KPIs related to specific functions, the decision was made to include several additional pages to the dashboards. Changing between pages in Power BI is very easy and reminds flipping from one sheet to another in Excel. Dedicated pages for engineering, HR, operations, sales, orders, order backlog, profit and loss statement, balance sheet, and forecast were created. This enabled the visualization of several graphs and the inclusion of numerous filters to be applied to function specific dashboard pages. These pages featured rich drill-down functions and slicers, whereas the dashboard for the most important KPIs had to be rather static.

Visualizing the needed KPIs from the imported data required the utilization of Power BI's DAX (Data Analysis Expression) formula expression language. The language resembles a mixture of Excel functions and SQL queries. The researcher had no previous experience of the programming language; therefore, the coding of the desired measures consumed most of the dashboard design time. The significant benefit of the coded KPIs from the imported data is that new information is automatically included in the metrics and no further alteration or manual input is required to update the KPIs. The validity of the underlying data and the correctness of the calculation were verified several times together with the key stakeholders.

As stated in the interviews and supported in the literature review on KPIs, the expression of plain numbers or percentages does not inform the reader on the performance trend. Instead, the ability to compare to earlier periods or set targets should be included. Both aspects were considered when designing the visuals and tables in the dashboard. Extensive work was done on the calendar function to provide comparability by day, month, quarter and year. The different refresh schedule of some information provided additional challenges, as for example the accounting figures for the past month were in general ready five working days after the closing of the month. To visualize the latest month that showed data, a separate logic for displaying comparable figures had to be coded in addition to simply assuming the current date.

Target levels were implemented in two ways, either through support tables that featured the target values, or through inbuild functionalities in the visuals. The inbuild

functionalities lack the possibility to adjust automatically and are only available for certain graph types, therefore dedicated tables for targets are also required. The inbuild targets are very useful in KPIs such as the on-time-delivery where a single target exists throughout the year and the target level does not have to change per selected period. Targets for sales and profitability are more challenging, as business seasonality affects the numbers, and the benchmark is changes constantly and varies per object. Here the dedicated data tables with targets were a good solution to display the gap between actuals and the target level. Here relative measures, as change percentage between periods could also be implemented with the help of more advanced DAX expressions.

Figure 9 Dashboard sample

The final component to visualize KPIs is the rich variety of available graphs in Power BI. Not only simple bar and line charts, but composition trees, maps, waterfall charts and gauges are utilized to show the data in an easily comprehensibly fashion. The drill-down function related to the Treemap function has been utilized in several pages, as it enables the user to dig deeper into the underlying data based on the specified dimensions with one simple click and informative visualization. By adding slicers to the pages, the presented data can be altered with effect on all visuals on the page. For example, the sales dashboard can be filtered by business unit and product type, and the sales, dimension and profitability graphs align accordingly.

The dashboard was frequently reviewed and commented on by management team members during the building process. The contents of separate pages were reviewed in short meetings or simple Teams calls by sharing the screen and asking for feedback based on the current format. The iterative process and fast paced development run very smoothly, as the researcher was able to maintain good communication to the stakeholders. The attitude “fail fast” was adopted and several proposed pages were deleted within days

of the first introduction, but these brought frequently new ideas to implement on other dashboard pages, adding to the final output of the artefact.

To conclude the dissemination phase of the BI process, the selected Power BI software presented a suitable platform to create the desired dashboard artefact. The possibility to include several data sources, create a multi-dimensional data model and the wide variety of available visuals enabled the deeply customized dashboard to be designed. By familiarizing with the DAX expression language, the automatic calculation of KPIs and comparable figures was made possible. The final step of the process was to introduce the artefact to the target audience and put the artefact on trial.

6.4 Design validation

To close the business intelligence process circle, the artefact must be utilized by the decision-makers. The following chapters detail the initial presentation of the dashboard to the management team and follow-up interviews after two moths of practical use in the real business environment.

6.4.1 Presentation to the management

The artefact was presented to the management team on the 27th of January 2021. All pages in the dashboard were presented to the audience during the one-hour long session. Additionally, the functions and logic of Power BI were introduced during the meeting. For the managers to gain immediate advantage of the system, functionalities like drill-down and slicers were illustrated based on questions during the presentation.

The initial feedback was throughout positive. Several attendees commented that some functions were exactly what they were waiting for to dig deeper into the business information. The CCO commented that the report provided new information that should help the sales team prepare better informed forecasts, as they could access the business development through new perspectives. New Power BI users had more questions on the usability and access to the report, which were answered on the spot.

Improvement requests related to the available dimensions in the provided graphs, as some specific dimensions were still desired. Additionally, the availability of the open orders by different dimensions was requested, as this had not been part of the introduced dashboard. Another request came from the CEO, who asked if for a quarterly sales tracker, that would include the actualized net sales and additionally the confirmed orders for the running and following quarter. This was discussed and promised to be added during the further development of the tool.

Related to the visualization of KPIs, the CCO commented that target levels should be implemented into all charts if possible. This comment was supported by the whole management team. The researcher noted that most graphs already had target levels, but that some targets were not set and thus needed to be defined by the responsible executive.

As in the first round of interviews, the wish to share information from the dashboard to the whole organization was repeated. This was noted and agreed to be implemented step by step to all functions.

By introducing the artefact to the management team, the design science research guideline to communicate the product to the relevant audience was fulfilled. Based on the number of questions related to both content and usability of the dashboard, it was good to present the artefact in person instead of providing simply formal instructions. Simultaneously, the problem relevance of the artefact and the design validation could be assessed during the meeting. Based on initial reactions, the design of the dashboard was very much in accordance with the executives' expectation. Also, the problem relevance was immediately recognized, as the presentation stopped on several items on the dashboard to dig deeper into the data, as the management was reflecting current issues with the information provided, which caused business related discussions on the spot.

6.4.2 Feedback after implementation

Though the presentation of the artefact to the management team displayed already a good reception of the dashboard in terms of the problem relevance and design, the actual adoption of the artefact was of interest to the researcher to acknowledge the design validity. A second interview was held with most management team members to find out more details on the artefact adoption. Details on the interviews are presented in the table below.

Date	Position	Interview duration
7.4.2021	CEO	6 minutes
7.4.2021	CCO	14 minutes
7.4.2021	Indoor Business Director	8 minutes
7.4.2021	CFO	7 minutes
8.4.2021	Outdoor Business Director	9 minutes
9.4.2021	Operations Director	6 minutes

Table 4 Interview group 2

During the second interview round all participants were asked the same set of questions, whereas the first interview featured specific questions on the represented functions of the interviewee. The same methodology was applied as in the first interviews, described in chapters 5.1 and 5.2. The interviews were again formed around semi-structured

questions, where the respondents could express deeper comments on the business dashboard. The following questions were asked:

1. Has the dashboard expanded your knowledge on the company's business environment?
2. How have you perceived usability of the dashboard?
3. Has the dashboard been further developed based on feedback?
4. What further features would you like in the dashboard?
5. Has the dashboard helped in tracking and setting targets?

Going through the questions, the first question on expanding the understanding of the business environment received unanimous confirmation. Especially the CCO and CEO, who had joined the company during the past two years, declared that the dashboard had expanded their understanding of the business significantly.

> *CCO: "When coming into the company, you realize the fragmentation of the market. Before you get to surf around the data as it is presented in BI, you can't get a hold of the business."*

The possibility to drill into the data layers and ask follow-up questions on the findings was found to be very useful. The Operations Director gave credit to the real time KPIs, as he had previously received the metrics only monthly. Also, the segmentations and numerous dimensions on the sales dashboard received credit from the business unit Directors.

When asking about the usability of the dashboard, some improvement areas were identified. The CFO commented that one must be very careful with the slicers to avoid false interpretations of the data. The integration into Microsoft Teams received critique, as the buttons and slicers were scaled to bigger screens and the usability suffered. Some felt that the filters did not work at first, but then realized that they simply could not apply them as the layers overlapped due to the scaling problem. On top of these, only the color theme used in the report received bad feedback. In general, all respondents had familiarized quickly with the dashboard and had no major problems with the use. The researcher suggested to use the report in the web browser instead of the Teams integration in order to avoid scaling problems of the report.

As design science research highlights the importance of iterative development, the respondents were asked about the further development of the dashboard after the initial presentation to the management team. Specific requests from the CEO, Operations Director and the CCO had been implemented in relation to open orders, quarterly sales tracker, and targets to the KPIs. The Outdoor Business Director mentioned that one request related to open orders per business unit was still pending, which was confirmed. Generally, the respondents felt that the development had continued, and the changes were made almost immediately after expression of the development suggestion.

The fourth question about further needs to be added to the dashboard received several suggestions. The CFO stated that the data was mainly internally generated, and that more external data should be implemented in the future. The CCO longed for stronger connection between strategic objectives and operational targets. Additionally, the calibration of targets for engineering schedules was discussed, as the Indoor Business Director felt that a day's delay was not worth flagging, but that there should be a buffer. The suggestions were discussed shortly during the interview and set to be discussed in detail in separate meetings.

The last question related to the monitoring and target setting of KPI. The question was greeted with a two-fold response. All interviewees commented that the monitoring had improved, according to the Operation Director and Outdoor Business Director significantly. The benefits of BI on actual the target setting received mixed responses, as the initial thought was that the targets must be defined by the management and not the system. After little consideration, the CCO and CEO remarked that the dashboard helped understand current shortcomings and thereby led to the formulation of new targets, whereby the dashboard influenced decision-making as well in their opinion.

On top of responses to the formal questions, the adoption of the sales dashboard by the sales team was thanked for. Opening of the dashboard to other employees than the management team had been requested and implemented for the engineering and sales teams by the time of the second interview. Additionally, the gained understanding of other functions' operations and KPIs was mentioned to help the collaboration between functions.

To conclude, the artefact appears to be well-adopted into the daily operations of the case company. The dashboard had proven to be very helpful to bring additional information to gut feelings, as for example the order-to-delivery capability had been questioned and it was discovered that there was a significant drop in performance compared to previous years. The fact-based verification of the issue made it easier for the management to react, leading to the inspection of allocated resources to support the order-to-delivery process. Minor challenges were discovered in relation to the usability, especially when operating though the Teams application or low-resolution screens. The content of the dashboards has been iteratively developed and the continuous stream of new feature requests suggests that the dashboard is actively used.

7 DISCUSSION AND CONCLUSION

7.1 Key findings

This chapter summarizes the findings based on the performed literary review and empirical data gathered in relation to the artefact creation process. The conclusion aims to answer the research questions presented in chapter 1.2. The main research question of the thesis is:

How can business intelligence be utilized to gather, process, and disseminate needed information for managerial decision-making?

As the main research question is rather broad in scope, three supporting research questions were formulized to guide both the literary review. The first supporting research question is *"What is the relation of business intelligence and managerial decision-making?"*. The question was addressed throughout chapter 3, which covers data and business intelligence. To provide the needed fundament, the information hierarchy was defined in chapter 3.1.1. The data structure and possible sources were introduced in chapter 3.1.2, as these affect the design of the BI artefact and must be considered during the entire BI process.

In order to understand the concept of business intelligence, chapter 3.2 started with the history and definition of BI. The term business intelligence has no uniform meaning, but it can be assessed from different perspectives. The managerial perspective of BI was highlighted by pointing out that BI can be seen as a managerial concept to manage and enrich business information to support operative and strategic decision-making (Gilad and Gilad 1985, 65; Elbashir et al. 2008, 135). Thereby the link between business intelligence and managerial decision making is inseparable, as BI stems from the need to make data-driven decisions. The related data-driven decision-making concept was introduced in chapter 4.1.2, which supported the rise of companies relying on extensive data and thereby gaining advantage over competitors.

To create a comprehensive picture of BI, the process perspective and technology perspective were also reviewed in chapter 3.2. The business intelligence process, closely presented in chapter 3.2.2, provided the fundament for the business intelligence process, which guided the artefact creation process. The utilized framework was modified from the presented frameworks by Shollo & Kautz (2010, 9) and Pirttimäki (2007, 74). The modified version combined the general process phases with the importance of technology support to achieving the desired outcome. The dashboard features, described as the most visible component of BI (Shariat & Hightower 2007, 42), was closely examined in chapter 3.2.3.

The second supporting question *"What are managerial information needs?"* was covered in chapters 4.1.3 and 4.1.4 of the literature review. To provide real value from the business intelligence solution, the information needs of the company had to be identified. Chapter 4.1.3 introduced the concept of the information gap according to Pirttimäki (2007, 43), which visualized the relation of received, needed, and wanted information. The information need identification is one of the most demanding parts of the BI process, but simultaneously crucial to provide value adding information to the decision-makers. To be able to identify the needed information, several methods were introduced in chapter 4.1.4. Based on the literary review, interviews with the management team were selected as the information gathering method in the empirical part of this thesis.

The third supporting research question *"What is business performance measurement?"* was addressed to provide valuable information to the management. The concept of performance measurement to improve the company's efficiency saw a peak in the 1990s when DSS enabled more effective measurement and monitoring of activities. Several frameworks were introduced, which all emphasized the importance of examining a wider range of information than simply financial indicators. Principles from the balanced scorecard were considered when creating the artefact, starting from the information need identification phase where a broad set of respondents with different managerial responsibilities was selected. As suggested, the framework was not directly implemented, but instead customized to fit the case company.

The objective of the thesis was to create a centralized information system to support the decision-making of the management team. The main research question *"How can business intelligence be utilized to gather, process, and disseminate needed information for managerial decision-making?"* was formalized to help seek for a suitable solution to solve the business problem in the case company. Based on the literature review and the empirical creation of the artefact several perspectives, approaches and interconnections between data, business intelligence, and decision-making were discovered.

To be able to create the final dashboard, several steps needed to be taken first. The modified business intelligence process was adopted to ensure that all relevant phases of the dashboard creation were covered. As highlighted in the literary review on information needs, the identification was time consuming but extremely important in relation to the end product. The following data gathering, processing and dissemination phases were highly dependent on the knowledge gained during the first phase. From a technology perspective, the selection of Power BI as platform turned out to be successful, as few system related limitations were met during the design process of the artefact.

To close the loop of the BI process, the utilization of the artefact had to be validated. Based on the feedback received during the artefact introduction session and in the follow-up interviews, the dashboard is perceived as value-adding in relation to decision-making and monitoring of the business environment. Continuous design validation was part of

the iterative creation process, as the development was frequently discussed and reviewed with members of the target audience. Thereby the main research question could be supported through both the literary review and the empirical adoption of the artefact in the case company.

7.2 Practical and theoretical contribution

As noted by Nykänen et al. (2016, 25), earlier research on business intelligence and its adoption has focused on large enterprises, especially in Finland. The thesis expands the understanding of BI implementations within medium-sized companies, where resources are more limited, and the business scale is somewhat narrower than in large companies. Based on the empirical part of the thesis, latest software enables relatively seamless implementation of BI solutions to SMEs, which should enable more and more companies to adopt business intelligence solutions in their organizations.

The dashboard creation process brought empirical evidence on the theory of business intelligence implementation. The importance of the information need identification was confirmed during the BI process, as the latter phases of the process are dependent of manager's information needs to create value to the decision-making. The suggested method of information gathering via targeted interviews with respondents from several areas of the company proved to be very informative. The adapted business intelligence process model, which was strongly grounded in existing theoretical literature, fulfilled its purpose, and provided a base for continues improvement of the created artefact. The successful utilization of design science research gives further support to the validity of the research method. The seven research guidelines were perceived well formulized and helpful during the research project, ensuring a successful completion of the artefact creation.

According to design science research, the practical contribution of the artefact is of greatest importance. The need for the artefact stems from the business environment, where people and organizations jointly form the requirements for the product. Based on the feedback from the management team, the artefact has been able to meet the expectation of providing relevant information on the company's status. Thereby the business problem of information gaps has been tackled to some extent. Several decision-making situations have been supported through information received via the dashboard, demonstrating the utility of the artefact.

7.3 Limitations and future research

As the study examined the dashboard creation process in one case company, the results cannot be generalized to all organizations. The case company's size, attitude towards new technologies and capabilities affect the end result of the study significantly. Still, the research reveals the successful adoption in a medium-sized, Nordic company operating on the industry sector, where the findings can be seen as relevant.

During the implementation process mainly internal sources of information were identified by the management team and researcher. This is partly due to the relatively small size of the company, which does not permit large-scale external information gathering. Additionally, the market in which the company operates is a niche segment within the lighting market, which makes specific data gathering difficult, as clear market data is not available. To present more relevant information from a strategic point of view, more external information should be gathered and utilized.

Though the artefact was assessed with the follow-up interviews three months after the introduction, a longer timespan would be needed to measure the impact on the company's performance and profitability. Here a quantitative approach could bring reliable insight into the effect of BI on medium-sized companies, as most of the earlier studies focus on large enterprises with significant resources. Also, the potential changes in the company's culture when moving towards data-driven decision-making cannot be mapped in this thesis, which would provide an interesting future research aspect.

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