THE STATE OF BUSINESS INTELLIGENCE

In Finnish enterprises

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Tiivistelmä – Abstract

Business Intelligence (BI) has recently been of interest both in information technology and accounting fields of research. This owes at least partly to how organisations today have increasing amounts of data and information at their disposal and they are attempting to reap benefits and competitive advantage from them. This study focuses on large Finnish enterprises and examines how they are applying business intelligence today. Especially the process nature of transforming data in to knowledge is under scrutiny and how BI is utilized in decision making.

The results indicate that organisations are perceiving benefits from utilising their BI processes and while the technological factors are of importance, organisational factors such as top management support and organisational culture have potentially even larger effect on the benefits that the organisation perceives. For individual users, BI improves their speed and quality of decision making and they utilise BI quite frequently in the decision making process. While some are still relying on spreadsheet-applications for their BI needs, other – more specialised and advanced – analysis and visualisation tools are also being widely adopted and used.

Asiasanat
Business Intelligence, BI, Decision making, DM, analytics, big data

Säilytyspaikka Jyväskylän yliopiston kauppakorkeakoulu

CONTENT

1 INTRODUCTION

1.1 The background of the study

In the recent years, there has been an increasing interest towards business intelligence (BI) systems, not only among the practitioners but also in the academia. Enterprise resource planning systems, enterprise wide data warehouses and more sophisticated hardware and software allow for more versatile and powerful BI systems than ever before (Davenport 2010; Negash 2004). The evolutions in information technology (IT) systems transform how data and information is collected and analysed in organisations, including their management and controlling functions (Bhimani & Willcocks. 2014). Consequently more research effort has been directed towards this prospering field of study, both from information technology and business disciplines.

Some enterprises adopting rigorous analytics methods such as business intelligence have realised notable gains from the ability to analyse and act on data (Davenport 2006; Kiron, Shockley, Kruschwitz, Finch & Haydock 2011; Negash 2004; McAfee & Brynjolfsson 2012). However, these gains are not easy to acquire and failing to implement a BI system properly will result in wasted resources (Yeoh & Koronios 2010). Hence a stream of research has been focusing on how to attain most benefits from applying business intelligence to an organisation. Management accountants in particular have been proposed to have a potentially significant impact on the success of the implementation (Simons 2008). Also, top management support and organisational culture have been seen as important success factors (Yeoh & Koronios 2010; Olszak & Ziemba 2012).

But even the most skilfully implemented and designed system does not provide value to the organisation automatically, rather it is created within the processes that an organisation undertakes (Porter 1985). Thus in order to understand how BI can support an organisation, the business processes must be taken in to consideration (Elbashir, Collier & Davern 2008).

Granlund (2011) argues that today there is still a surprisingly limited understanding of the everyday life of financial professionals and how they use IT systems (including BI systems) in their work. For example, research seems to be neglecting the fact that more than half of their working time may be used to tasks relating to the implementation and selection of the software and training other employees to use it (*ibid.*). At the same time it

has been acknowledged that IT systems can affect the organisation's operational and controlling processes by applying a *techno-logic* (Dechow & Mouritsen. 2005). The implementation of an IT system imbeds logic by requiring actions to be taken in accordance with the system.

Shollo & Kautz (2010) found in their literature review that BI studies often omit the examination of how BI is actually utilised in the decision making process – a viewpoint arguably interesting to management accounting community. After all, supporting decision making by providing better information is one of the main tasks often appointed to BI systems (Hannula & Pirttimäki 2003).

Davenport (2010) found that, while in most organisations managers recognised the importance of decision making, they had not any explicit plans in place to develop it. Also, organisations rarely focus on whether or not the information generated by BI systems is actually being used in decision making. While the mainstream of BI research focuses on viewing business intelligence as a rational tool, Shollo (2013) shows how it is not only such but can be utilised in a variety of ways in order to support the decision maker's own goals.

This thesis is partly inspired by the search of management accounting theory as presented by Malmi & Granlund (2009). I strongly agree that current management accounting research seems often times only remotely relevant to practitioners and that this should be improved. Thus in this thesis I seek to enhance the understanding of how business intelligence systems are being implemented and used in today's organisations.

1.2 Research Objectives

This research aims to explore how extensively and why are business intelligence systems implemented and used in Finnish organisations. Research questions including "how" and "why" are often better addressed with a more qualitative research approach (Yin 2014, 9). However, I would like to highlight that this particular study is descriptive and explorative in nature as I intend to discover the broader trends observable in the implementation and use of BI systems. While a survey cannot answer these "how" and "why" questions too definitely, it should be able to provide at least some preliminary results to these questions. Additionally, the results can be used as a guideline as to where to direct a more qualitative and in-depth analysis, *e.g.* a case study, considering the same questions.

The extensiveness of the use of BI systems in organisations is an interesting question also as the latest research focusing on Finnish enterprises was conducted over a decade ago and it found increasing interest towards BI systems (Hannula & Pirttimäki 2003). Considering that there was a substantial increase in investments and research in to business intelligence in the years following (Shollo & Kautz 2010), it is high time to review the current situation.

The overarching research objectives of this study are therefore twofold. Firstly I intend to update the knowledge on the diffusion of BI systems in Finland and secondly explore the questions raised in the academia recently regarding what type of data do organisations collect, how do they utilise it, especially in decision making, and what benefits are the organisations perceiving from it. The underlying motive is to forward the agenda of bringing management accounting research closer to organisations that utilise the knowledge created by research.

2 RESEARCH METHODOLOGY

2.1 Research approach

Academic research has been traditionally divided in to qualitative and quantitative research. The differences between the two are often seen to be ontological and epistemological. Ontologically, quantitative research follows realism, where existence is founded on objectively measurable attributes (*e.g.* I weigh 90 kg) while qualitative research relies more on nominalism, where existence is seen more abstract and dependent on interpretation (*e.g.* I weigh a lot). Epistemologically, quantitative research treats knowledge as *a priori* which means that knowledge can be acquired irrespective of experiencing it (*e.g.* it's -20 degrees outside, thus it's cold). On the other hand, qualitative research leans towards *a posteriori* knowledge where knowledge is inseparable from the experience of acquiring knowledge (*e.g.* I'm freezing, thus it's cold). Ontological and epistemological considerations could be developed further and the above presents only a crude overview of the research tradition in academia. Recently there have been debates to move away from polarizing the two views as opposite to understanding them as complementing each other. Despite the differences that can be made between them, they are in the end just two sides of the same coin, trying to examine the world around us. (Hirsjärvi, Remes & Sajavaara. 2004, 123–157)

The current mainstream of management accounting research builds on the economic-based neoclassical theory and draws upon the quantitative research approach. Neoclassical theory includes a fundamental concept of profit maximisation which is usually described as utility. Therein individual actors are assumed to act in a way that leads to greatest utility from one's own perspective. This includes assumption of rational marginal analysis, *i.e.* decision maker is able to compare different options and choose the one that leads to greatest utility. Main critique towards this assumption is directed at the cognitive limitations of the decision maker and increasing cost incurring from amassing all the information for different options. Despite these shortcomings, the mainstream approach has been quite successful in predicting behaviour at a certain aggregate level. The approach has been thusly seen appropriate for predicting market level behaviour rather than explaining events occurring at an organisational level. (Ryan, Scapens & Theobald 2002, 70–80).

This approach was deemed fitting for the study at hand since the scope of the study is the market level rather than an individual organisation. This study aims to describe current state of BI in Finland, exploring to some extent how it is used, especially in decision making. For the purpose of this study a survey method was chosen as it provides a suitable tool for such descriptive and explorative approach (Alkula, Pöntinen & Ylöstalo 1994, 20–22).

2.2 Survey method

A survey was chosen as the research method for the above mentioned reasons. A careful consideration was undertaken when constructing the survey form, aiming to ensure sufficient validity and reliability for the study. In social sciences, where the phenomena under scrutiny are often quite abstract and susceptible to subjective interpretation, it is impossible to reach absolute validity. This results as it is not feasible to construct a survey that would include enough questions that would lead to results depicting the phenomenon exactly as it is. However, by building on existing research and understanding the differences that academia and practitioners have when it comes to the phenomenon in question, it is possible to ensure that the validity is sufficient. (Alkula *et al.* 1994, 89–94, 125).

Reliability relates to how arbitrary the results of the study are. Better reliability reduces the randomness in the results and thus increases the quality of the study. Increased reliability can be achieved by measuring a variable with more than one question and if the results are consistent, the variable has been reliably measured. (Alkula *et al.* 1994, 94–99).

Business intelligence is a typical example of a concept that can be conceived in various ways (see chapter Defining Business Intelligence). This type of phenomena are challenging to capture since using a single survey question will usually result in poor reliability (in the range of 0.4–0.7) even if the question operationalises the concept adequately (Alkula *et al.* 1994, 129). This is due to the fact that behaviour and some attributes can be quite dynamic in nature and for example the mood of the respondent or the time of day can affect the answers given. Operationalising a concept means making it concrete in way that whoever is answering the question will understand it the same way and thus the question measures the same variable for every respondent, resulting in better validity and reliability. However it is not possible to measure everything with several items as the feasible length of the survey limits this (Alkula *et al.* 1994, 130). Therefore emphasis was given to the most important aspects of the study that best support the research objectives (see chapter Research Objectives).

2.3 Analysis methods

The most basic method used for analysing the survey data is describing the frequency distributions of responses in figures and tables (Alkula *et al.* 1994, 163–165). Especially when handling relatively small samples, the frequency distributions present the data more

suitably. Also, as the survey constituted mainly of nominal and ordinal measures, arithmetic mean and standard deviation are not the best choices for describing such data (Alkula *et al.* 1994, 85). Still, they are provided where deemed fitting. Thus, the analysis of this survey's data relies quite heavily on providing frequency distribution descriptions and interpreting them.

Aside from simply describing and interpreting the survey data, interrelations between different factors can be examined through correlations. Correlation coefficient describes the type (positive or negative) and strength (0–1, zero indicating no correlation and 1 total correlation respectively) of the dependencies between two factors. For examining the correlations, Pearson product-moment correlation coefficient is often used. However, the data in this survey consists mainly of ordinal measures, which violates the assumptions of Pearson's r, interval or ratio measurements. Spearman's rank correlation efficient (rho) has been developed to allow correlation tables to be formed even for factors consisting of ordinal data and thus it is used when analysing the data in the survey. Further, Spearman's correlation coefficient also recognises any monotonic relationships, not limiting to linear ones. (Alkula *et al.* 1994, 233–237).

3 PREVIOUS STUDIES

3.1 Defining Business Intelligence

Business intelligence as a concept was introduced as early as 1958 by an IBM engineer Hans Luhn who described it as "the ability to apprehend the interrelationships of presented facts in such a way as to guide actions towards a desired goal" (Herschel 2010, i). This is surprisingly close to what BI is today, given that this was said half a century ago. Almost every definition of business intelligence assumes that its purpose is to enhance organisational performance through better decision making, which is broadly interpreted the same goal as the one presented by Luhn in 1958.

In the early 2000's BI had a second coming as more data was available than ever and a need for utilising that data became apparent. This was also noticed by the academia and resulted in increased number of publications on the topic (Shollo & Kautz. 2010). During this time, a greater emphasis was given on technical implementation of systems that allowed the analysis of data and thereof BI was seen as foremost a technical system to exploit the data in the systems (*cf.* Negash. 2004).

Currently there seems to be two main approaches to defining business intelligence. First one is in line with the perception of BI in the early 2000's where it can be seen as a set of technologies. One such definition is provided by Yeoh & Koronios (2010) who define a BI system as

> An integrated set of tools, technologies and programmed products that are used to collect, integrate, analyse and make data available. (Yeoh & Koronios 2010, 23)

It's noteworthy that while this definition doesn't explicitly state enhancing organisational performance to be the goal of BI systems, it is in fact implicitly assumed by the authors that by making data available BI systems assist in making better decisions and increase organisational performance. Secondly BI can be viewed as a process where technology plays smaller, supportive role and more weight is put on the process of transforming data in to information and knowledge in an organisation. Olszak & Ziemba (2012) state that:

> From the business (organizational) perspective, BI systems mean specific philosophy and methodology that refer to working with information and knowledge, open communication and

> knowledge sharing along with the holistic and analytic approach to business processes in organizations. (Olszak & Ziemba 2012, 132)

Again, the explicit statement of improving organisational performance as an objective of the BI system is omitted but the underlying assumption is clear: by utilising information and knowledge and taking analytical approach to business problems will lead to better organisational performance. Perhaps best summarising the current view of business intelligence in the recent literature is the definition provided by Wixom & Watson (2010):

> Business intelligence is a broad category of the technologies, applications, and processes for gathering, storing, accessing and analysing data to help its users make better decisions (Wixom & Watson 2010, 14)

Indeed the term is still finding its final form and lacks a widely accepted definition but this might be because BI itself is evolving quite rapidly. Yet in order to understand the concept of business intellingence better, a more in-depth and detailed depiction is required to better grasp the nature of BI. Shollo (2013, 44) separates four aspects of the BI systems: data, information, knowledge and decisions and compares how the process and technical views of the literature relate to them. This "BI stack" will also serve as the framework for how business intelligence is regarded in this paper. Also when referring to a BI *system*, it is comprehended as a system that encompasses this "stack" and the processes and technologies within.

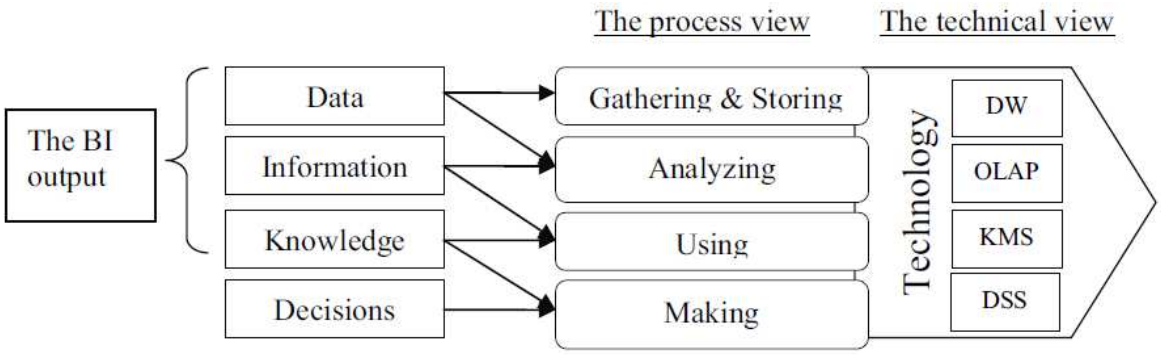


Figure 1 Summary of the BI literature (Shollo 2013, 44)

In the Figure 1 above, data is first gathered and stored in to data warehouses (DW) usually using some kind of extract, transform and load processes (ETL). During ETL raw data is given context and meaning (a figure in euros is attached to a specific sales event), allowing for it to become information which can be exploited. Secondly it is analysed by using tools such as data mining, queries and online analytical processes (OLAP). Analysing information creates knowledge which includes insights regarding relationships within organisation's operations, predicting future customer behaviour and demand and even where the market as a whole is moving. Knowledge management systems (KMS) aid in managing the knowledge effectively and decision support systems (DSS) are used in aiding decision making. Shollo (*ibid.*) further recognises that only the BI output is used in the actual decision making, *i.e.* executives only see the reports and models extracted from the system, not the methods that were utilised in producing them.

Without a doubt, not every (if any) organisation utilise the entire process or every technical aspect described above but it presents an ideal how data processing can result in better decisions and ultimately increased organisational performance. Wixom & Watson (2010) identified three possible targets when implementing BI. Firstly, it can be implemented to tackle small, well defined problems, *e.g.* advertising campaign. Secondly an organisation may aim at utilising organisation-wide BI infrastructure and use an all-encompassing approach to collecting and analysing the data from all over the organisation. Third goal, which is broadest in scope, is to implement BI to assist in organisational transformation where business models are restructured and analysed using business intelligence. It is clear that an advertising campaign does not require or even benefit from too extensive use of business intelligence. On the other hand, when strategies are revisited, partial analysis of the organisation's operations and environment will result in a strategy that only takes into account a part of the relevant factors affecting its operations. The target of the organisation thus dictates the technologies, processes and scope of the BI implementation.

As such, it is interesting to investigate what parts of the BI process and what technologies organisations utilise today and for what purposes have they implemented business intelligence.

3.2 Data, Information, Knowledge and Big data

Data is indisputably in the very core of business intelligence, yet current BI literature is not united regarding the terms data, information and knowledge. Rather the terms can be used sometimes even interchangeably (*cf.* the quoted definitions on BI in 3.1 Defining Business Intelligence). Briefly described, data is objective facts without meanings, information adds meaning through *e.g.* contextualisation or categorisation and finally knowledge is created when humans gain insight that is not readily available as information (Davenport & Prusak. 1998).

As the field is not united in the terminology, a more thorough epistemological scrutiny of the differences between these terms is considered beyond the scope of this thesis and in this paper the terms will be used in the context defined above and in the previous chapter. Further discussion on the sources and type of data is however in place as it can be detrimental in defining how organisations use BI. Bhimani & Willcocks (2014) present various examples on how these might – and already have – affected financial professionals. Summarising, the variety and amount of data available in today's organisations is rapidly increasing and the organisations need to be able to identify the most important pieces of information and know how to use them. Table 1 illustrates the different types and sources of data that organisations could use as input for their business intelligence systems.

Type / Source	Structured	Semi-structured
Internal	ERP database	Meeting memos
External	CRM	Market analyst reports

Table 1 Types and sources of data (adopted Negash 2004)

The sources of data can be divided to external and internal categories. Internal data relates to data inside the organisation *e.g.* ERP databases. As for external data, it's sourced from outside the organisation, *e.g.* customer relationship management (CRM) systems. While an organisation can implement BI systems based entirely on internal data, it is easy to see how the external data can substantially increase the impacts of the system. Additional information provided by CRM for example is often seen very valuable for organisations. Amazon is a prime example of how they segment customers and provide suggestions to them in order to increase sales. Omitting some important aspects of a business' operating environment from the BI system will probably cause the outputs of the system to be inaccurate because of the lacking key information. (Negash 2004).

The type of data is here used to distinct structured and semi-structured or unstructured data. Structured data is essentially everything that is easy to store in relational databases' rows and columns. For example ERP-systems produce mainly structured data. Unstructured data on the other hand is everything that is not elegantly storable in a relational database. For example an e-mail does not fit in to a single row in a database table. In this regard, an e-mail is essentially unstructured piece of data. However, often even unstructured data can be converted to a format with some structure in an economically sustainable way, allowing easier manipulation of the data (Bhimani & Willcocks. 2014). Consequently, the term semi-structured data is sometimes considered more appropriate (Baars & Kemper 2008). Onwards, this paper also uses the term semi-structured data.

It should be noted that the typology presented here does not cover all the data or information that organisations have at their disposal. Rather it should be seen as a distinction between different types and sources of data that can be implemented in to organisations' information systems. Data or information that is converted in to a format that is easier to handle by computers, *i.e.* zeros and ones, inherently loses some of the more tacit (internal, uncodified, embodied) knowledge that is often in a crucial role when making decisions (Bhimani & Willcocks. 2014). For example, a car dealer can "read" a customer and be able to tell what kind of offer, if any, would be likely to lead to a closed sale, where as a computer would unlikely be able to take in to consideration factors such as the mood, body language or tone of the speech of the potential customer.

While the utilisation of structured data is today quite well managed in the regard that it is accurate and timely, the same cannot be said about semi-structured data. Even though semi-structured data is recognised as an important asset for the company, its

employment faces technical difficulties as it is not as straightforward procedure to apply analytics on semi-structured data as it is for structured data (Baars & Kemper 2008).

Despite the inability to incorporate semi-structured data in to organisations information systems, it is in fact becoming increasingly important for many organisations. According to Bhimani and Willcocks:

> Drawing business intelligence from […] searching behaviour, website visitations and browsing sequence has, for some companies, become a necessity in understanding emerging trends, developing new products or devising selling strategies and in creating competitive entry barriers for new entrants who can replicate the basic business model with ease but not the knowledge base already developed by leading market incumbents. (Bhimani & Willcocks. 2014, 476)

Further, LaValle, Lesser, Shockley, Hopkins & Kruschwitz (2011) found in their survey that "strategic information has started arriving through unstructured digital channels: social media, smart phone applications and an ever-increasing stream of emerging internet-based gadgets". Thus the sources and types of data organisations utilise in their business intelligence systems is an important factor to consider when evaluating how organisations have adopted BI solutions.

Big data is another very important concept that relates to business intelligence. The term is defined as encompassing all enterprise related data – be it internal, external, structured or semi-structured – and being able to provide insight in to organisations operations (CGMA 2013). As its name suggests, big data is also seen as being larger than regular data, preventing easy handling in conventional databases. Inclusion of semi-structured data is naturally another factor that requires solutions other than relational data tables. While the term relates to data only, as a concept it is often seen as including the analysis of the data as well which is reflected in the insight part of the definition. It is therefore not only seen as data but means to arrive at better decisions through analysis (McAfee & Brynjolfsson. 2012). The term "big data" often seems to be used in somewhat the same purpose as business intelligence, though more emphasis is perhaps given to the volume, velocity and variety of the data rather than on the analysis and decision-making parts of the process.

Especially in the eyes of practitioners big data can be synonymous to business intelligence and this should be taken in to consideration when collecting research data. Gartner, one of the world's biggest IT research and consulting companies, defines big data as follows:

> Big data is high-volume, high-velocity and high-variety information assets that demand cost-effective, innovative forms of information processing for enhanced insight and decision making. (Gartner 2014)

Clearly this is not very far from what business intelligence is comprehended as consisting of in this study. Even though big data is specified as the asset that requires processing, such as analysing, in order to provide insight, it includes the assumption that these methods are used. After all, to what end would one collect data if not to use it? Thus, while the distinction between big data and business intelligence can be made, in this paper big data as a concept is included in business intelligence, placed in the early phases of BI process as depicted in the previous chapter.

3.3 Rationales for Adopting Business Intelligence

While the underlying reason to implement business intelligence in an organisation is almost always assumed to be to enhance organisational performance, there is usually a more specific reasoning behind the implementation and its timing. This is analogous to almost any IT investment and previous studies should give some insight to what these rationales can be.

Malmi (1999) explored the rationales affecting the diffusion of activity-based costing principles in Finnish firms. He divided the rationales in to three categories: Efficient-choice, Forced selection and Fashion & fad. Efficient choice represents motives such as replacing an outdated system for a more efficient one or implementing it to answer a new business requirement. Forced selection means that a business unit was ordered to implement the new system by parent company. Fashion & fad includes implementation from consultant's advice or just out of curiosity towards a new tool.

He found that efficient choice was the strongest explanation in the early stages of diffusion and the organisations adopting the new system and gaining benefits from it are the driver for the diffusion at this point. But at the later stages of the diffusion (*i.e.* the innovation is not so new and rare anymore) both efficient choice and fashion perspective became significant rationales for adoption. The diffusion was also partly driven by consultant agencies *etc.* in addition to organisations that utilised the innovation. Forced implementation did not arise as an important explanation but this is most likely due to the fact that most surveyed companies had independent power of decision. (Malmi 1999).

It is less surprising that in the early days of an innovation there is little effect from fashion or fad factors as there were no one to take influence from but the fact that consultants have had such a strong influence on the diffusion is surely worth noting. It could actually be argued that taking an advice from consultant might be an efficient choice if the company lacked the expertise and knowledge to make a decision that they could justify as more grounded than the recommendation by consultant. "Trying something new" can also be interpreted as staying up-to-date with the competitors and indeed many of the respondents giving fashion-oriented rationales for adoption also had efficient rationales as well. Only slightly over 10 % based their motives only on fashion/fad while over 80 % relied on efficient choice or the mix of the two (Malmi 1999).

It should be noted that humans tend to rationalise even the most irrational decisions and it is thus expected that efficient choices are often chosen in a survey that asks for the motives for a decision. It is therefore challenging to acquire information on the exact weights that different motives had at the time of decision making but surveys are sometimes able to provide indications of alternative motives as well. Even if the results do not turn out to be statistically very significant, they can serve as a preliminary result that is useful when designing a more thorough case study or open interview.

Hannula & Pirttimäki (2003) focused specifically on the adoption of business intelligence in Finland as they examined 50 large companies operating in different sectors. They found that over 80 % of the companies had identified a need for information to support decision-making and planning, 65 % wanted to obtain more information on the operating environment and 51 % saw that it was a necessity in order to stay competitive. The most significant benefits that the companies expected to gain were better information

quality (95 %), better observation of threats and opportunities (83 %), growth of knowledge-base (76 %) and better information sharing (73 %). Interestingly only 14 % and 30% expected cost- and time-savings, respectively. Business intelligence was thus seen as a strategic investment that required resources to produce long-term benefits.

3.4 Maturity Models

After implementing a BI system, it is beneficial for the organisation to at least roughly estimate how the system could be further developed and enhanced. Maturity models build on the idea that the systems grow and develop over time and systematically. They can thus be used as a tool to assess the stage of the BI system in the organisation and act as a rough guideline as to in what direction it could be improved. (Rajterič 2010).

Eckerson (2004) originally developed a maturity model for data warehousing which had six stages of development. Through these stages the data warehousing improved and delivered more business value as the DW matured. The model has since seen further development and now lives under the name TDWI Maturity Model, after the organisation for which the model was originally developed. The model is not anymore only for gauging the maturity of a data warehouse but includes the business intelligence aspect as well (TDWI 2012). The model consists of five stages: Non-existent, Preliminary, Repeatable, Managed and Optimized.

In the Non-existent stage there are two sub-stages: Operational reporting and Spreadmarts. Operational reporting refers to an environment where all the reporting is derived from operational systems *e.g.* a payroll system. The reports are of standard form and cannot be easily altered. Spreadmarts are born from the need to customise the reports and users bring data to desktop databases or Excel where they can better manipulate the data. The problem is that the information from spreadmarts is not accessible to other users who might have interest in it and manipulating the information is resource intensive in as it takes a lot of time from the business user. Information created in this way is also inherently a view presented by the user who created it and can thus lead to many versions of ROI for a project for example when the project leader and a business controller both calculate the ROI in their own Excel sheets. (TDWI 2012).

The Preliminary stage is characterised by department wide BI initiative where first data marts (to where the data is brought from operational systems) are created and ad hoc querying or OLAP tools are also implemented. This enables the users to more easily generate customised reports and analyse historical data in a robust manner. It also promotes a single version of the truth as everyone in the department use the same data and the same models for analysis and the analyses made by other users are readily available online, preventing overlapping work. The number of users of the system is typically still few in this stage, *i.e.* only the BI project members and most technically oriented have adopted the new tools. (TDWI 2012).

The Repeatable stage is similar to Preliminary stage in technical architecture but the use of the system is more widespread and especially the business users have ready-made analysis models that they can easily tailor for their specific needs. This is opposed to the previous stage where only the most technically oriented were able to create the analyses by themselves and the use of these models was limited rather than pervasive. Customized

dashboards and other interactive reports including KPIs tailored for specific target groups are often developed. (TDWI 2012).

The Managed stage refers to organisation-wide, strategic BI system where the architecture is unified across the board and all the required data can be found within the system, rather than having to import it manually from another data source. This means that the system is also flexible and able to respond to changing business needs. Analytics also stretches from reactive to predictive as the system is used to create sophisticated analysis models that not only react to what has happened but also predict what's going to happen. (TDWI 2012).

The last stage is called Optimized and it extends the BI to include customers and suppliers as the organisation offers them similar customizable reports as those inside the organisation. This makes BI a value-adding service and can lead to BI becoming a driving competitive force for the organisation. The system is further developed by using service-oriented architecture (SOA) and cloud based solutions. (TDWI 2012).

TDWI maturity model assesses the BI/DW system for 8 aspects or categories that are:

- *Scope*: How widely is it used in the organisation?
- *Sponsorship*: How strong is the sponsorship and commitment to it?
- *Funding*: Is the funding sufficient for the program?
- *Value*: Is it effective in meeting business needs?
- *Architecture*: How advanced is the system and is it unified across the organisation?
- *Data*: Does the data in the system meet business requirements?
- *Development*: How effective is the development of the system?
- *Delivery*: Are the reports/analyses available from the system useful for the business users and how extensively are they used?

Below is a summary of the TDWI maturity model (TDWI 2012):

Category/Stage	Nonexistent	Preliminary	Repeatable	Managed	Optimized
Scope	Individual	Department	Division	Enterprise	Inter-enterprise
Sponsorship	Non-existent or uncommitted	↔	Somewhat committed & accountable	↔	Very committed & accountable
Funding	None	Departmental budget	Divisional budget	Corporate IT budget	Self-funding
Value	Cost Center	Tactical	Mission critical	Strategic	Competitive differentiator
Architecture	Spreadmarts	Non-integrated data marts	Non-integrated data warehouses	Central DW with or without data marts	BI or data service via service-oriented architecture
Data	Not trustworthy, not timely, not comprehensive	↔	Somewhat trustworthy, timely, and comprehensive	↔	Fully trustworthy, timely, and comprehensive
Development	Non-standardized processes	↔	Somewhat standardized processes	↔	Fully standardized processes
Delivery	View static reports	Analyze trends and issues	Monitor processes	Predict outcomes	Automate processes

Table 2 TDWI Maturity model (TDWI 2012, 12)

While the full exploration of the organisation's BI system's maturity is not feasible to be explored in this study, including the aspects presented in the framework will give at least

some insight in to how mature an organisation's BI system is. The maturity of the system is expected to reflect many other aspects of this study, *e.g.* an implementation that successfully takes in to consideration the critical success factors is expected to result in more mature BI system than an implementation failing to do so.

3.5 Value Chain and Critical Success Factors

Granlund (2011) pointed out that more than half of the financial professionals' working time is consumed on selecting and implementing software and training other employees to use it. From accounting perspective it is thus very justifiable to identify the factors that one should focus on when selecting and implementing new software. Critical success factor research addresses this very problem by identifying the vital aspects of implementing and using BI systems in order to ensure that returns are realised for the investment.

Before examining the specific factors that contribute to the success of a BI initiative, we must establish an understanding of how successful BI affects the organisation, *i.e.* why it is being implemented. We touched upon the subject in the previous chapter 3.3 Rationales for Adopting Business Intelligence by reviewing some of the more explicit reasons for adoption of BI but from a wider, organisational perspective we can summarise that BI is undertaken in order to improve organisational effectiveness and increase the value created (either through increased revenue or decreased costs).

As with any complicated system arching over an entire organisation, measuring its success or value created is not an unequivocal matter for BI either. After all, successful implementation in technical sense is not necessarily successful from the organisation's management's perspective (*cf.* Yeoh & Koronios. 2010). To determine whether or not a BI system is improving organisational performance, one must be able to locate where it is having an impact. Correlation does not imply causality and improved quarterly earnings after implementing BI software does not imply that the software caused that improvement.

The value chain as established by Porter (1985) explicates how value is created in the activities undertaken by the organisation. The activities are divided in to primary and support activities. Primary activities consist of Inbound logistics, Operations, Outbound logistics, Marketing & Sales and Service. They are the processes that physically create and deliver the product or service to a customer. Support activities on the other hand are, less surprisingly, supporting the primary activities and each other and include: Procurement, Technology development, Human resource management and Firm infrastructure. Support activities can be appointed to specific primary activities but they also span across the entire value chain with the exception of firm infrastructure that cannot be disaggregated because activities like finance or general management usually support the entire value chain, rather than individual activities. Although the activities are represented as independent entities, in reality they are very much interdependent. There exists strong linkages between the activities that affect the value and costs that incur. As a sum, the value chain creates value from which one can detract the costs incurred in creating this value and the remainder is called a margin. The value chain is summarised in Figure 2. (Porter. 1985, 36–50).

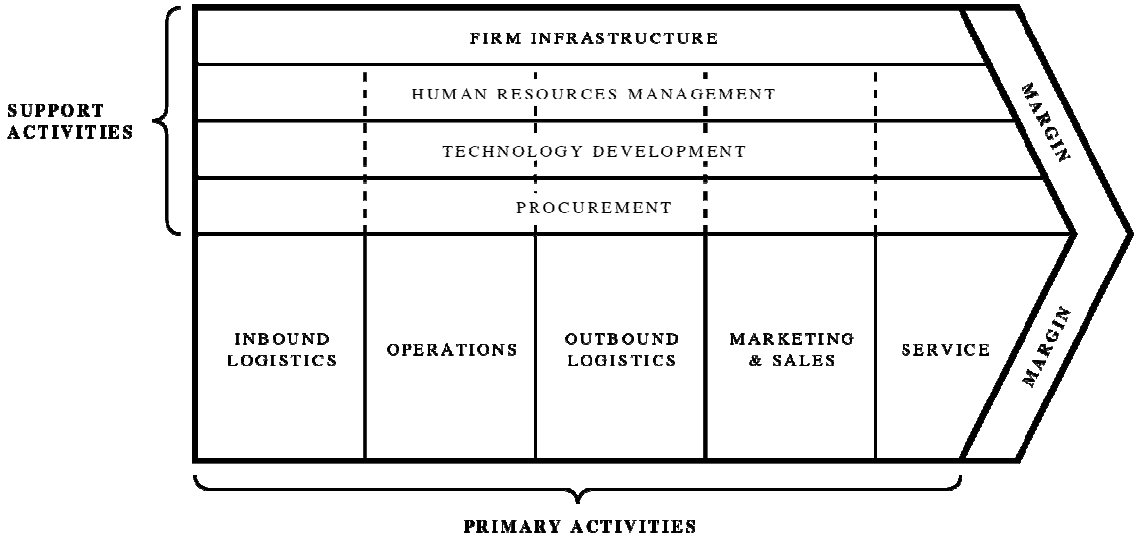


Figure 2 The Value Chain (Porter. 1985, 37)

It is open to debate whether or not the value chain as presented by Porter is comprehensive and accurate depiction of an organisation's activities but the underlying idea that is important for this study is that technology creates value for the customer by supporting different processes (other activies) and the value chain as a whole. This is detrimental when considering the successfulness of BI as the following studies have shown.

Elbashir *et al.* (2008) set out to investigate what kind of effects BI systems have on organisation by studying how different business processes, *e.g.* marketing, affect the organisational performance. By pointing at the factors that increase organisation's process and overall performance, they highlight the areas that a BI system should enhance in order to have a positive impact on the organisational performance. They divided the measures affecting business process performance, and consequently organisational performance, in to three different factors all of which proved to be significant indicators of business process performance. The three factors are customer intelligence, supplier relations and internal efficiency. Customer intelligence refers to knowing the customer's habits and being able to predict their behaviour, thus enabling proactive decision making. Supplier relations affect process performance by enhancing coordination and possibly integration with suppliers, resulting in better effectiveness and lower transaction costs with suppliers. Internal efficiency relates to the processes within the organisation, *e.g.* decision making and manufacturing.

They found all the three factors positively correlating with business process performance which in turn correlated positively with organisational performance. Their main finding is that if one wishes to achieve better organisational performance through an implementation of a BI system, one has to analyse the organisational processes and carefully design the system to support them.

Yeoh & Koronios (2010) on the other hand study the specific factors that contribute to the success of a business intelligence system. In the first stage of their study they

conducted a Delphi study where 15 BI system experts were interviewed. Based on the results they created a framework with several organisational, process related and technological factors that contributed to the success of the system. Following figure illustrates their findings:

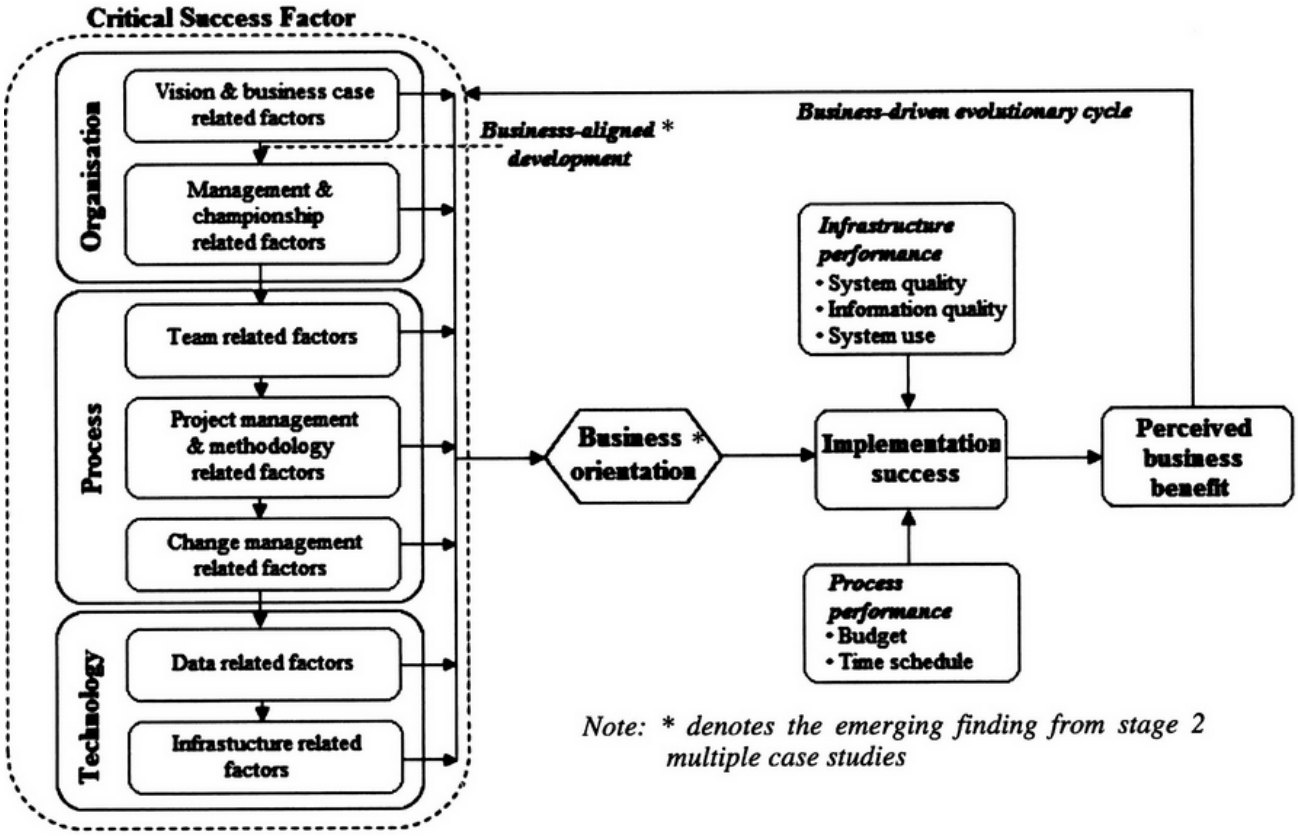


Figure 3 CSF's framework for implementation of BI systems (Yeoh & Koronios 2010)

in large enterprises operating in different sectors. Resultantly they were able to provide illustrative explanations and insight to the critical success factors but their most significant finding was the business orientation meta-factor. This means that in order to achieve success in implementing a BI system, one must thoroughly assess how the system will and how it should affect the organisation and the processes within. Technological aspects are important as well but they should only be focused on after the business impacts are investigated. In their case studies they found that organisations that first and foremost focused on the technical issues, tended neglect the business perspective and this led to worse implementation results and even to a complete failure to implement the system.

Isik, Jones & Sidorova (2011) study the relationship between BI capabilities and user satisfaction, which serves as a surrogate for the success of the system. In their survey, their respondents were business managers from enterprises varying in size and sector. By doing this, they essentially measured success from the manager's perspective.

BI capabilities	BI success		
	Pearson correlation	Sig. (2-tailed)	*N*
User access	0.687*	0.000	116
Flexibility	0.564*	0.000	116
Quantitative data quality	0.519*	0.000	116
Interaction with other systems	0.508*	0.000	116
Risk management support	0.507*	0.000	116
Internal data reliability	0.368*	0.000	116
Internal data source quality	0.366*	0.000	116
Qualitative data quality	0.293*	0.001	116
External data source quality	0.194**	0.037	116
External data reliability	0.172	0.065	116

Table 3 Correlations between BI success and satisfaction with BI capabilities (Isik *et al.* 2011)

Of the five most important capabilities affecting BI success (those with over 0,5 Pearson correlation) only one had to do with the data itself, quantitative data quality. This reasserts the finding from previous studies that technical aspect is only a small portion affecting the overall success of the BI system. Also, two capabilities that highly correlate with BI success are not backed up by high user satisfaction. Less than 50 % of the respondents were satisfied with system's flexibility and interaction with other systems. This underlines the issue that traditionally there is a strong focus on certain capabilities when implementing an IT system and these capabilities are also well taken care of in the case of BI implementation. However, the capabilities that strongly contribute to the success are not necessary very well supported.

Lönnqvist & Pirttimäki (2006) also recognise the need for focusing on more than just pure monetary benefits and technical aspects and propose measuring the success by dividing the assessment in to two approaches. First approach focuses on the process of using the business intelligence and the second on the effects it's producing. They argue that while the former alone would provide insufficient and the latter inaccurate information, combined the two should result in a more meaningful and precise measure. The effects (*e.g.* increased market share) are difficult to pinpoint to originate from the BI system, even if it was the case. Also some effects (*e.g.* gained insight) are nigh impossible to gauge. It would be very hard to evaluate how much monetary benefit does a business gain from using BI in its strategic decisions and inevitably this process of valuation would be uneconomical compared to the benefits gained from the information. As such, Lönnqvist & Pirttimäki (2006) propose that an additional approach is taken that focuses on how the BI system is used. Here the value comes from how the user of the BI system (*e.g.* mid-tier-manager) perceives the benefits gained from the usage. The system might produce the most accurate, real-time data in flashy dashboard format but if the manager is not able to reap any additional benefits from this compared to the legacy system that was in use previously, it is arguable whether BI has any value at all. This second approach is also reflected in some of the result presented above in the sense that business process compatibility was highlighted as an important success factor.

When these two approaches are combined one might arrive at something similar to a balanced scorecard (or performance prism) for businesses, only applied to BI systems (*c.f.* Lönnqvist & Pirttimäki 2006). The underlying idea is to measure different aspects of the system, not only the financial benefits it is producing. For evaluating how the BI process is performing, one should take into account every aspect of it: gathering and storing data, analysing information and using the knowledge acquired when it comes down to decision making. In this study I aim to take this balanced approach when surveying the respondents and include different aspects of the BI system in the questionnaire.

A survey is unlikely to be able to give a sufficiently deep understanding of the usage of BI and the types of effects it is having on an organisation in order to establish its value or impact. However, some simple correlations can be drawn, shedding some light to the matter and reaffirming previous research results or hinting at new directions.

The studies presented thus far provide evidence that there are certain factors that have been found important in the implementation of a BI system from the organisational process perspective. While it is widely accepted that the technical aspect of a business intelligence system is critical for its success, attention is being called to address other aspects as well. LaValle *et al.* (2011) underscored managerial and cultural challenges in implementing analytics in organisations as managers tend not to have the time or expertise to focus on analytical inspection of a problem due to parallel and simultaneous obligations that their role imposes. Still support from the top management and careful review of how the BI system will contribute to business processes are seen as very important factors. Technical aspects of the systems, *i.e.* data quality, are also of high importance for the success of the system but they should ensue, rather than precede the organisational factors.

3.6 Business Intelligence in Decision Making

Decision making in organisations is often viewed from the perspective of rational choice theory where different options are evaluated based on the available information and the best option is chosen as a result of this evaluation (Shollo 2013, 48). Business intelligence systems seem to suit well to support this kind of decision making as they provide more accurate, relevant and up to date information to the decision makers. Indeed, this approach in decision making has been adopted by the majority of business intelligence research and studies have thus focused quite heavily on how to ensure and improve the accuracy and timeliness of the information that BI systems provide – critical success factor research is a prime example of this (see chapter 3.5).

Davenport (2010) brings forth the importance of explicitly recognising how information is coupled with decision making. A lot like the majority of BI research, organisations often consider decision making as a rational process and assume that if information is available it is being used. Orton & Weick (1990) discussed extensively the characteristics of different types of loosely-coupled systems in organisations, not limiting to decision making. They assert that coupling has more dimensions than simply being connected or disconnected. Davenport's framework contributes to that discussion by examining several different aspects affecting coupling in decision making context. Further, Davenport (2010) brings forth that organisations rarely document the processes for

decision making nor do they have explicit plans to develop it. Davenport refers to this as the "invisibility" of decision making, *i.e.* something that is recognised to exist but is not very clear at what it actually consists of and hence, is challenging to act on. Davenport aims to clarify the connection between information and decision making by presenting a framework (Figure 4) in which there are three types of links.

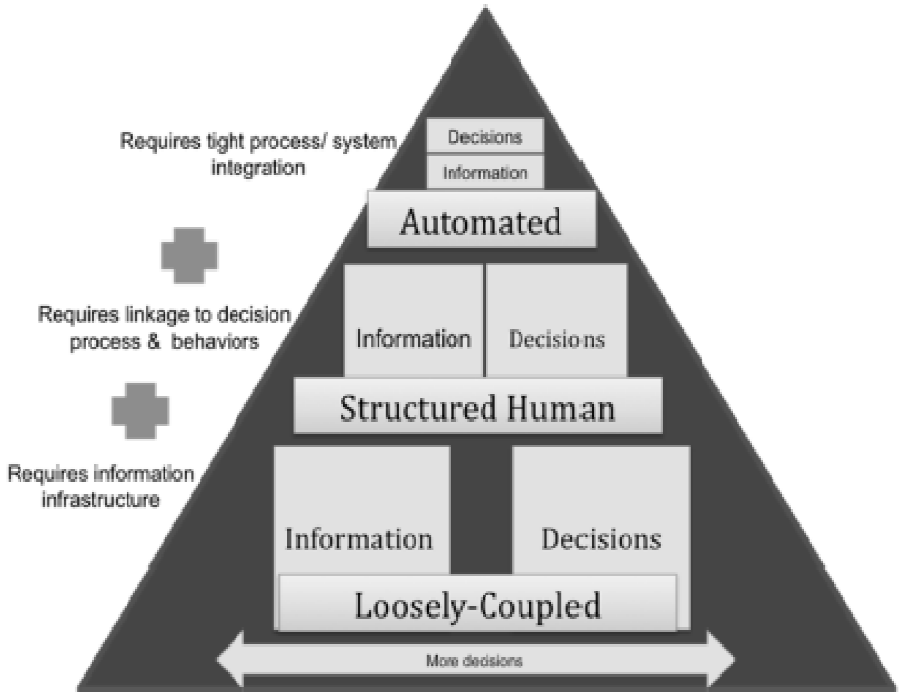


Figure 4 Approaches to linking information and decisions (Davenport 2010).

Loosely-coupled approach is probably the most common in today's organisations of the three. It typically includes information from various sources, combined to serve a specific area of business, *e.g.* sales, rather than any particular problem. This approach is flexible in the way that it allows specialised analysts to provide information to large set of problems and it is also how most organisations utilise their business intelligence. However, this information is not necessarily actually applied in the decision making process. Because the information is provided to serve a number of problems, rather than a specific one, it cannot be easily monitored that what information is being used for which decisions. Hence it is not possible to know whether the information is being used at all. A successful loose-coupled decision making approach requires much more than simply making the information available, *e.g.* collaboration between IT and business departments and clear objectives for the information that is provided. (Davenport. 2010).

In structured human decision environments the decision making is still entirely in the hands of human actors but information is being offered in a more targeted and tailor-made fashion. Rather than trying to serve multiple decision makers in a variety of problems, information is being produced for a specific purpose in mind. This ties information more closely to decision making but at the same time increases the efforts required to produce the information. Again however, merely providing the tools is not enough to ensure the actual use of the information in decision making but organisational changes are often required to receive the most benefits from the system. Davenport (2010, 6) suggests that this kind of decision making should be utilised for problems that are

"particularly critical to organizational success", *i.e.* decisions that are recognised as strategically important. If one were a mobile phone manufacturer, utilising tailored analyses to find out whether customer want phones with touch screens not, might be *vital* for organisational success. (Davenport. 2010).

Automated decisions provide the tightest coupling between information and decision making as in this case decisions are made entirely based on the information. This approach can be utilised when decisions are made in an automated fashion, based on certain rules. Most examples seem to come from financial applications where data is very accurate and decisions are made within strict limits. The costs of implementing this sort of decision making environment are significant as the system must be bulletproof or the organisation risks significant losses occurring from bad decisions. Imagine for example a credit approval system where loans were given to persons already deeply in debt and unlikely to repay. High investment requires high return in order to justify itself. Therefore the system should be implemented for decisions that are made often and where there are benefits to realise from increased efficiency in decision making. (Davenport. 2010).

Davenport admits that his framework represents a fairly early phase of research in linking decision making and information. More approaches are likely to surface and the ones presented will be improved. Davenport sees two problems in linking information and decision making in practise. Firstly, there are various systems in place to aid decision making but they do not integrate with other systems and decision making processes nearly as well as would be desirable. Secondly, in many organisations, decision-making is implicitly considered as an "individual managerial prerogative" (Davenport 2010, 10). This suggests that it is not to be reviewed and improved by someone else than the decision maker itself and this complicates the process of improving decision making and linking it with information.

While the mainstream of BI research treats business intelligence systems as rational tools of analysis and focuses on how to optimise the process of utilising them, Shollo (2013) takes a slightly differing view by illustrating how BI output can be employed in a variety of ways in decision making. She specifies that it is the output that decision makers use in the decision making process rather than the analytical process that precedes it. Further, she describes BI output as a "device" in order to communicate its ability to submit itself to various purposes of its use. Some of the common BI outputs include: bar, pie and line charts; heat maps offering geospatial information, scatter plots, box plots, word clouds, correlation matrices, decision trees and many other that vary between applications.

In her study she identified several other devices that decision makers utilised, *e.g.* networks of colleagues, sponsors and expertise. Different devices can and most likely will be used in different parts of the decision making process by the decision maker, rather than only relying on a single one. BI output is thus most often only a part of the decision making process and usually not the determining factor. Rather, it was seen as a conversation starter, point-zero, from which the decision-making process and discussions begun and around which it revolved. Shollo suggests that this was due to the fact that many decisions included incomparability and uncertainty between different options. Thus BI output – that provided unambiguous answers – is not an entirely rational object but rather an outcome susceptible to subjective interpretation and manipulation. This is valid reasoning as multifaceted problems often do not, and further cannot, have a single best

answer. Consequently, more often than not, the output does not act as a purely rational device.

Shollo (2013, 219–221) identified four additional tactics for the use of the BI output, besides its solely informative and rational one. *Supplementation* became an alternative use when the output alone wasn't enough to persuade other decision makers and additional devices had to be used to achieve consensus. BI output was also sometimes *substituted* when it was seen as containing false information or when it was generated for political purposes. Here other devices did not seek to supplement BI output but to delegitimise and disprove it. Sometimes the output was ambiguous and left room for *interpreting* the results conveniently from the decision maker's point of view. Those involved in the process of producing the BI output also had the option to *reframe* it by adjusting underlying assumptions and predictions in a way that provided an output that forwarded their own agenda.

The findings that Shollo (ibid.) provides above, are very interesting as they open the discussion of business intelligence systems to a more subjective and interpretative approach. In order to gain relevance to practitioners, research should look more deeply to how management accounting, of which analytics is becoming a big part of, should be done (Malmi & Granlund 2009). Hence it would be beneficial to understand better all the different purposes of use and when and where they are applied. Shollo (2013, 236) proposes for example that it would be fruitful to examine in which situation is each of the aforementioned tactics optimal and how do the different uses relate to each other.

Wixom & Watson (2010) raise another question regarding the BI output and its form of delivery. There is a wide array of different ways of presenting information *e.g.* dashboards, scorecards, charts, tables and even animations but what way is the best in a given situation? This problem is highlighted as BI is becoming more pervasive and it is being employed by a diverse group of users. Consider for example a CEO trying to grasp the enterprise's strategic position compared to rivalling companies and a product line manager deciding on how to develop their offering or a data scientist mining terabytes of data to discover unforeseeable relations. The informational needs of different groups are inherently varied and a dashboard is probably not the most suitable presentation for everyone and every type of information.

4 FINDINGS OF THE STUDY

4.1 Survey form

This chapter gives an overview of the construct of the survey and its contents. The survey was carried out as an internet survey where the respondents received an invitation to take part in the survey via e-mail wherein a link to the survey was provided. The initial invitation was sent on 12th of February and followed by a reminder on the 16th. Final reminder was sent on February the 23rd and finally the survey data was compiled on the 26th.

The recipients of the survey invitation were executives and high-level managers in large enterprises whose turnover were over two million euros and employed over 200 people. Respondents were from different functions of the enterprise, including *e.g.* top management, finance and IT. Enterprises spanned over several different industries ranging from manufacturing to financial and insurance services. As a quantitative study, a comprehensive sample would have been preferred (>100 observations) in order to be able to conduct statistical analyses of the data. However, as is often the case with internet surveys, the response rate remained low (~2 %) and resulted in only 41 observations (n=41). Important aspect to consider is that while the statistics may indicate significances, they need to be considered as initial results at best. Still, with 19 content related questions, of which some were multiple- and other single-choice-questions, this resulted in approximately 3000 data points which does provide some tools for reaching the research objectives.

The survey form (Appendix A Survey form) consisted of four sections: Background information, Organisational BI orientation, Personal BI orientation and Personal BI utilisation in decision making context. The topics were not strictly organised under these heading on the survey form but rather grouped and ordered in a way that created a coherent and continuous flow of question.

The first section, Background information, required the respondents to provide their roles and titles in their respective organisations and the turnover and number of employees employed in the organisations. The respondents also provided estimates on the level of uncertainty in their competitive environments and the type of strategy they employed in the organisation. These questions provide information on the organisations

and the respondents in a way that they support in setting the context for the responses; how big organisations are the respondents and in what type of environment do they operate?

The second section which examines the organisational BI orientation consists of several sub-sections. First questions related to the drivers and inhibitors behind BI usage. Respondents were allowed to select all the applicable answers and also give additional ones in open fields. The proposed options were constructed based on previous research by Malmi (1999) and Hannula & Pirttimäki (2003). These questions are able to provide some insights into the rationales for using or not using BI. Second sub-section charted the types of data and different tools that organisations are using to conduct their business intelligence activities. Data types were identified according to the structured-semistructured/internal-external framework exhibited in chapter 3.2 (Negash 2004). The tools that organisations use will illuminate in part how advanced are their BI activities as some tools require more knowledge and better infrastructure than the most basic ones. Again the respondents were allowed to simply choose all the applicable choices. Thirdly, there were several questions regarding the scope of BI in organisations. Questions here forth were answered on a Likert scale from one to five with one indicating that the respondent disagreed with a statement and 5 representing agreement with the presented statement. Under scrutiny were aspects such as funding, organisation of the BI function, pervasiveness and the operational and strategic uses of BI. These questions explain more about "how" organisations use their business intelligence and for what purposes. Fourth sub-section describes how the top management of the organisation views BI and whether or not they emphasize fact-based decision making culture. This is an important factor to consider as previous studies have often pointed at the importance of top management support as an imperative for the success of BI initiatives (chapter 3.5). Fact-based decision-making culture must here be interpreted as a measure of how important the top management (the respondents) consider that the decisions in their organisation are made based on factual evidence. Final questions related to the benefits of BI where the respondents stated whether or not BI reduced costs, increased revenues, improved coordination with suppliers or customer and if it supports the business processes. These questions tackle quite straightforwardly the success of their BI systems. Multiple, strong benefits indicate that they have been quite successful in using BI whereas the opposite results signal problems with business intelligence activities.

The third section of the survey focused on personal BI orientation. Here the questions were divided between two sub-sections. The first examined the tools that the respondents used themselves in their daily activities. The options were somewhat similar to the ones presented in the previous section regarding the organisational orientation but here the focus was on what the top management uses, rather than what are being used in the organisation. They answered on a Likert scale from one to five whether they used never (1) or very often (5) reports, analyses, monitoring, forecasting and automation. Similarly to its organisational counterpart, these questions provide clarification on "how" BI is being utilised. Second section was regarding the usability and usefulness of the business intelligence. These questions built heavily on previous research and focused on the factors that the users had identified important. Data quality, user-friendliness, comprehensiveness of information, integration with different software and usability of the tools were under scrutiny as they were previously found to be having a significant impact

on the success of BI from the users' perspective (Baars & Kemper 2008; Elbashir *et al.* 2010; Isik *et al.* 2011; Olszak & Ziemba 2012; Yeoh & Koronios 2010). These questions were again aimed at answering the question regarding the successfulness or benefits of the BI activities for the respondents.

In the last section of the survey the utilisation of BI in decision making context was under scrutiny. There were three sub-sections: Tools and techniques used, purposes of use and the benefits of BI in this specific context. Tools and techniques covered again quite similar items to the tools-sections in the previous sections of the survey but they were slightly altered to better answer the questions raised by Davenport (2010) regarding the linkages between information and decision making. Uses of BI on the other hand tackled the questions of multiple uses of BI that were raised by Shollo (2013) and also whether or not BI was used in strategic and operations-specific context. Lastly the respondents answered whether or not BI improved the speed or quality of the decision making.

4.2 Background Information

In this chapter I will review the first section of the survey, background information on the survey respondents. These are mostly plain descriptive statistics that are aimed at providing information on the respondents and setting the context in which the results are to be interpreted. Some of these are also used in analyses in the following sections of the survey.

Table 4 Industries the organisations operate in

	Frequency	Percent
Manufacturing	15	36,6
Transportation and storage	4	9,8
Other service	4	9,8
Information and communications	3	7,9
Construction	3	7,9
Consulting and Research	3	7,9
Retail Trade and Wholesale	2	4,9
Financial and Insurance	2	4,9
Administrative and support service	2	4,9
Accommodation and food services	1	2,4
Mining and quarrying	1	2,4
Electricity, gas and steam	1	2,4
Total (n=41)	41	100,0

As previously mentioned and observable from Table 4 above, the respondents are from a wide variety of industries. The high number of respondents from manufacturing can be possibly attributed to the fact that manufacturing industry covers roughly a third of the turnover created by all Finnish enterprises (Statistics Finland. 2013).

Table 5 Responsibility areas of the respondents

	Frequency	Percent
Top management	17	41,5
IT	10	24,4
Finance	5	12,2
Marketing	4	9,8
Business Development	4	9,8
Sales	1	2,4
Total (n=41)	41	100,0

A significant number of the respondents (~88 %) were from other than finance functions of the organisation which will noticeably decrease the number of insight that are possible to draw specifically from the accounting point-of-view. Nonetheless, the sample should provide answers regarding the view of business intelligence at large.

Table 6 Turnover and number of employees of the organisations

	Mean	Median	Skewness	Std. Error of Skewness
Turnover (thousand euros)	690 000	200 000	2,685	,369
Employees	2300	530	3,473	,369

A noteworthy point to consider in Table 6 is that the turnover and number of employees are significantly skewed to the right which denotes the fact that there are a limited number of organizations that are very large while the majority are smaller. Thus the medians of 200 million euros in turnover and 530 people employed represent the sample somewhat better than the means. This also results in having to resort to non-parametric tests in correlation and variance analyses or at least applying logarithmic conversions to these variables.

Table 7 Overall emphasis of the organisational strategy

	Frequency	Percent
Cost effectiveness	9	22,0
Differentiation	6	14,6
Both	26	63,4
Total (n=41)	41	100,0

While most of the organisations do not specifically emphasise cost effectiveness differentiation entirely over the other, a third of the organisations do. This division interprets the two options as the opposite ends of a continuum and most of the organisations appear to situate somewhere in the middle.

Table 8 Level of uncertainty in organisation's competitive environment

	Frequency	Percent	Cumulative Percent
Very low	1	2,4	2,4
Low	8	19,5	22,0
Medium	22	53,7	75,6
High	10	24,4	100,0
Very high	0	0	100,0
Total	41	100,0	

The level of uncertainty in organisations' competitive environments is regarded as quite mediocre as half of the respondents answered "medium" and the rest were divided in half between "High" and "Low". Only one estimated the uncertainty as "Very low" and none as "Very High". Though on the scale the answers were somewhat concentrated, even "Low" and "High" can be interpreted here as significantly differing from the medium.

To summarise, the respondents are from executive and senior positions in relatively large organisations and come from different responsibility areas. The sectors of the organisations are also varied and while the small number of responses (n=41) severely limits the strength of the results that can be derived from the sample, the answers should give somewhat heterogeneous picture of the state of business intelligence in Finland.

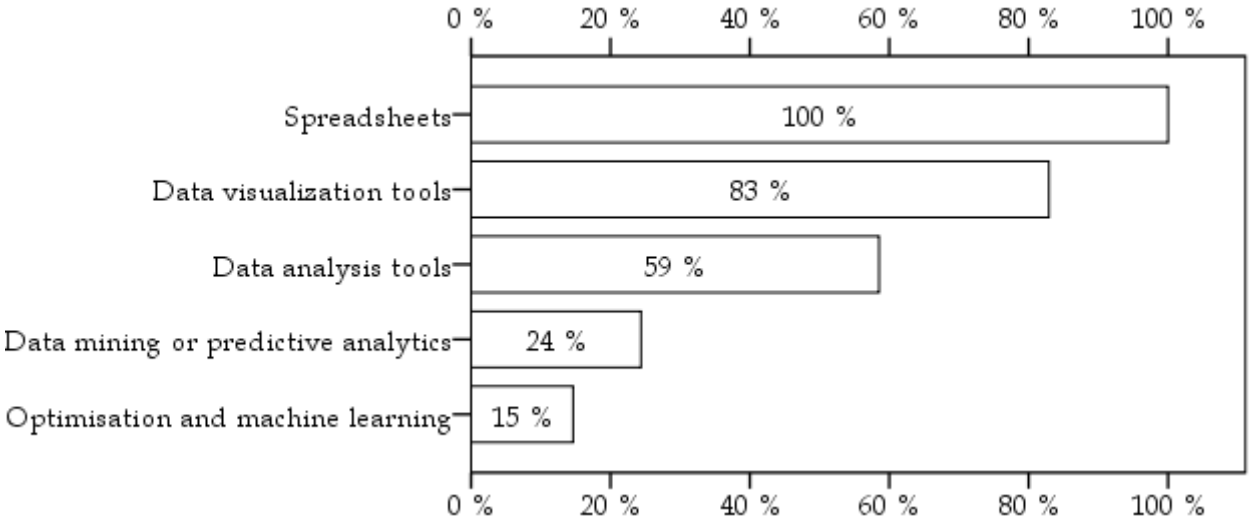
4.3 Organisational orientation

The second section of the survey focused on exploring the organisational orientation towards business intelligence. This part of the survey focused on several sub-sections: drivers and inhibitors for using BI, tools and types of data utilised, the scope of BI, top management's view of BI and the benefits for the organisation.

Utilisations of different tools in organisations are summarised in Figure 5. As expected, every organisation of the study uses at least the very basic form of BI, a spreadsheet application. Specialised data visualisation tools were in use in 83 % of the organisations and 59 % of the organisations used dedicated data analysis tools. The more advanced techniques such as data mining or predictive modelling were less frequently used as they were utilised in 24 % of the organizations. Only 15 % of the respondents indicated that some form of machine learning or automated algorithms were in place.

In this survey, there were no significant differences in perceived organisational benefits (defined later in this chapter) among the different tools or technologies used, which can result from the small number of respondents in the sample, but it could also underline the fact that the tools and technologies themselves do not create value. It is only through the value chain of the organisation that benefits are realised and BI tools and technologies are only in the supporting role in that process.

Figure 5 Tools and technologies used for BI activities



The types of data that were utilised in organisations (Figure 6) also followed expectations as the utilisation of structured data in business intelligence was very high (95 % for internal and 83 % for external data sources). Also semi-structured data was somewhat often used in BI activities as 51 % of the respondents indicated that internal semi-structured data was in use and 63 % said the same about external semi-structured data. It should be noted however that in this particular question, it was not specified whether or not the data was stored in IT systems. For example, an executive can use printed market reports for activities that do fall under the definition of business intelligence, such as reviewing market outlooks, even if that report is not integrated in to the organizations BI systems. Thus the results do not represent the ability of BI systems to use different data types but rather what types are considered useful and therefore used in BI activities.

Figure 6 Types and sources of data utilised

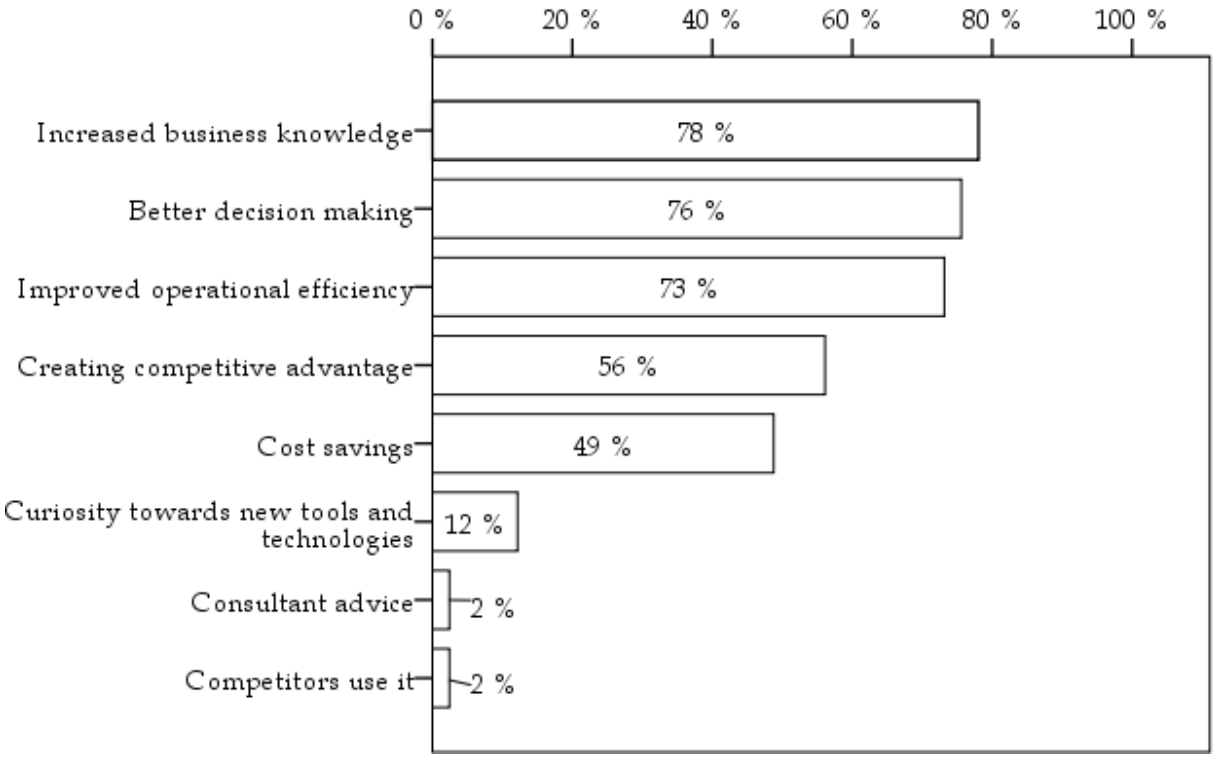
Type Source	Structured	Semi-structured
Internal	95 %	51 %
External	83 %	63 %

Of the different data types, semi-structured external data utilisation was the only one found to have a statistically significant (p=0,022) correlation coefficient with perceived organisational benefits (Pearson's rho=0,357). This is not very strong correlation nor does the small sample size give very much support to do any conclusions about this correlation

but at the very least it does not contradict the importance of these data sources, as advocated previously in the literature (Bhimani & Willcocks 2014; LaValle *et al.* 2011).

Rationales for using business intelligence were mostly what are previously described as "efficient-choice" motives by Malmi (1999) in chapter 4.1 and they are summarised in Figure 7. Increased business knowledge (78 %), improved operational efficiency (73 %) and better decision making (76 %) all were motives for approximately three fourths of the respondents. On the other hand only slightly under half (49%) used BI because it provided cost savings. Cost savings are here treated as a very large category as the saving can drive from decreasing IT costs as well as from reduced inventory levels. Still, it seems that operational efficiency (that can include reduced costs) is more important than the reduced costs alone as a motive. Competitive advantage was also seen as somewhat frequent motive as 56 % of the respondents indicated it as a driver for using business intelligence. The preceding are all regarded as rather rational motives. Only one respondent indicated that consultant advice and competitors using business intelligence is driving their use of BI. This was however somewhat expected, as argued in chapter 3.3, because humans tend to rationalise their motives. Five respondents (12 %) did indicate though that curiosity towards new technologies was at least part of the driving force behind BI use.

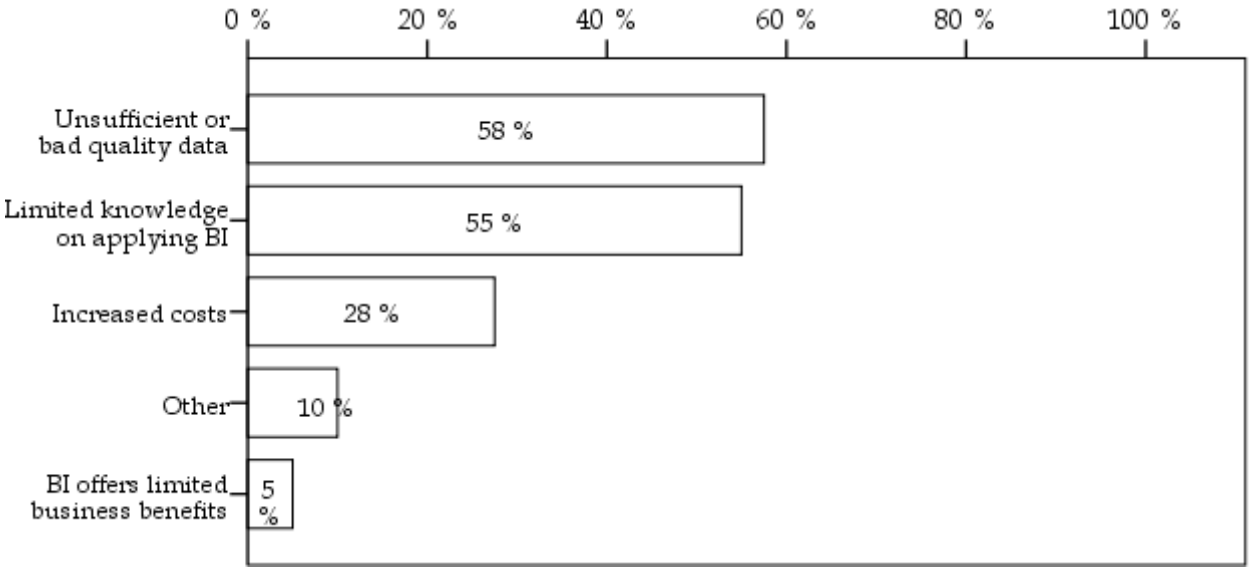
Figure 7 Drivers for using BI



In addition to the drivers behind BI the respondents provided information on the factors that impair its usage and the results are presented in Figure 8. Slightly over half of the respondents denoted that data related issues (58 %) or limited knowledge on using BI (55 %) were preventing them from gaining the most from the BI. Increased costs were of concern for 28 % of the respondents and only two (5 %) suggested that BI was not offering business benefits for them. Few respondents gave open answers to "Other"-category as well, but they can be interpreted to include in the limited knowledge and increased costs-

categories. The biggest obstacles therefore seem to be relating to data and knowledge of applying BI as 83 % of the respondents named at least one or the other as a factor impairing the utilisation of BI. Few question the business benefits that business intelligence can offer and some are concerned about the increases in expenditures as well but there seems to be more to overcome in realising the upside potential of BI.

Figure 8 Factors impairing the use of BI



The benefits of the BI system can be difficult to measure as pointed out in chapter 3.5 and by Lönnqvist & Pirttimäki (2006). The respondents were asked for estimates on whether or not BI a) reduces costs b) increases revenues c) improves coordination with suppliers d) improves coordination with customers or e) supports business processes. The responses are summarised below in Table 9.

Table 9 Perceived benefits of the BI system for the organisation

	Disagree	Somewhat disagree	Neither agree or disagree	Somewhat agree	Agree	Mean
BI reduces costs	0 %	12 %	24 %	49 %	15 %	3,66
BI increses revenues	0 %	12 %	34 %	39 %	15 %	3,56
BI improves coordination with suppliers	7 %	15 %	34 %	37 %	7 %	3,22
BI improves coordination with customers	2 %	2 %	20 %	56 %	20 %	3,88
BI supports business processes	0 %	15 %	29 %	46 %	10 %	3,51

All of the benefits scored over three on the scale from one to five, indicating that BI is perceived somewhat beneficial on average. The strongest benefit appeared to be coordination with customer (mean=3,88) which suggests that BI offers information and

insights about customers that would not be available in the absence of the BI system. Cost reductions were second-most named benefit of the BI system with a mean of 3,66. This result is somewhat more difficult to interpret as BI can potentially reduce costs by a number of different ways, including everything from reduced software licencing costs to improved operating efficiency. The previous is backed by significant positive correlations (at 0,05 level) between cost reductions and coordination with suppliers as well as cost reductions and supporting business processes (for full correlation table see Appendix B Correlations between organisational benefits). On the other hand increase of revenues was positively and significantly (at 0,01 level) correlated with improved coordination with customers. This is somewhat logical and expected when considering that a better understanding of the customer probably enables the organisation to generate higher revenues with them but the results' statistical significance should be questioned as the sample size is small. Overall, a sum factor (Cronbach's alpha=0,636) including all the benefits indicates that BI systems are beneficial with a mean of 3,57 on the scale from 1 to 5. This sum factor is used below in the evaluations of scope's and top management support's correlations with the overall benefits of the BI system.

The scope of BI was examined from three perspectives: dispersion, pervasiveness and strategic orientation. This is slightly differing from the Eckerson's model (TDWI 2012) where these factors are seen as strongly linked in way that high pervasiveness indicates centralization from dispersion's point-of-view and a highly strategic orientation. In this survey the factors were examined as independent factors and results even indicate that there was no significant correlation between the factors (see Appendix E). Table 10 below summarises the results regarding the scope of BI in organisations.

Table 10 The scope of business intelligence

	Disagree	Somewhat disagree	Neither agree or disagree	Somewhat agree	Agree	Mean
Business Intelligence activities are mainly organized as a separate, centralized function.	20 %	20 %	5 %	44 %	12 %	3,10
BI is used in every division of your organization.	7 %	20 %	12 %	44 %	17 %	3,44
BI is designed to support specific strategic goals.	0 %	10 %	24 %	46 %	20 %	3,76

The scope, or how are the BI activities organised, was quite diverse among the respondent organizations. Most divided perspective was regarding the question of whether BI is organized as a centralised function or not. 39 % indicated that their BI activities were spread across more than one department or function while 56 % agreed at least to some extent that the activities are centralised. This question reflects more "how" the activities are executed rather than whether they are executed at all. While it can be argued that more centralised BI activities may be broader in scope in a sense that centralisation can bring a – perhaps more strategic – view on the whole organisation, it could equally well be that actually decentralised BI activities are more deeply embedded in to business processes all over the organisation. Also, no such correlation between centralisation and strategic

orientation was to be confirmed (see Appendix E Correlations between different perspectives of scope). Further, a sum factor describing the organisational benefits derived from the BI system did not correlate with this centralisation factor (Spearman's correlation coefficient=0,129, p=0,422).Thus the results should not be interpreted as one being better than the other but rather as two different approaches. The pervasiveness examines more how extensively and widely BI is being used all over the organisation. 61 % agreed to at least some extent that every division of their respective organisations used BI as 27 % disagreed with the statement. While dispersion describes how BI is organised, pervasiveness is a better measure for the extensiveness of use in the organisation. It is somewhat difficult to interpret just what it means that a respondent disagrees with the statement that BI is used in *every* division. Some may have very immature BI system that is not yet ready for full deployment while others may have very sophisticated BI activities but they are just narrowly applied. Nonetheless, the fact that the majority of the respondents agreed with the statement indicates that BI activities are at least somewhat pervasive in those companies. Unlike the centralisation factor, pervasiveness appeared to have a positive correlation with organisational benefits (Spearman's rho=0,434, p=0,005), indicating that it describes better the maturity of the BI system. The last factor to consider in light of the scope of BI was the strategic orientation. The responses indicated that two thirds of the organisations supported strategic objectives with BI. This factor contributes to the scope as a more strategic orientation in BI can be interpreted as a wider, organisational approach to using BI, rather than only using it for function- or division-specific purposes. The results thus suggest that there is at least some strategic orientation behind BI activities and it is not solely implemented for operational and ad hoc purposes.

	Disagree	Somewhat disagree	Neither agree or disagree	Somewhat agree	Agree	Mean
BI is considered a high priority by top-level management.	2 %	5 %	10 %	56 %	27 %	4,00
BI is regarded as a strategic asset in your organization.	2 %	10 %	29 %	41 %	17 %	3,61
Fact-based decision making and operational improvements are encouraged by executives and managers.	0 %	7 %	10 %	56 %	27 %	4,02
In your organization, fact-based decision making culture is promoted.	2 %	5 %	15 %	61 %	17 %	3,85

Top management support and organisational culture have been found to affect BI activities (Elbashir *et al.* 2008; Isik *et al.* 2011; Olszak & Ziemba 2012; Yeoh & Koronios 2010, *c.f.* also chapter 3.5). The survey form's question 14 examined these questions (Appendix A Survey form) and in this study, for 83 % of the organisations BI was considered as a high priority by top management and a strategic asset for 59 % of the organisations. These two factors were also markedly correlated (correlation coefficient 0,673, p=0,001) and they can be interpreted as presenting overall organisational importance of BI. A sum factor including the preceding two items (Cronbach's alpha=0,795) has a statistically significant positive correlation coefficient (Spearman's

rho=0,580, p=0,001) with perceived organisational benefits, indicating that, as suggested by literature before, organisational importance is closely related to the benefits that the BI system offers.

Organisational culture is something that is undeniably very hard to measure and in this survey the focus was solely on how fact-based decision-making and culture is promoted by the leaders of the organisation. The mean for this factor (measured by two items in the survey, Cronbach's alpha=0,759) was 3,94 as 85 % of the organisations scored over 3 on the scale from one to five. This seems to signal that fact-based decision making culture is promoted in the organisations included in this survey. Like the organisational importance factor above, this cultural factor is significantly and positively correlating with the perceived benefits of the BI system (Spearman's rho=0,594, p=0,001).

There were not any statistically significant linkages between any of the organisational factors and the size, environmental uncertainty or strategy of an enterprise. This was however quite expected given the small number of respondents.

4.4 Personal orientation

The third section of the survey focused on how individuals used business intelligence in their daily activities. First, the different tools and their respective frequency of use were examined (Appendix A Survey form, question 16) and the responses are summarised in Table 11 Personal utilisation of BI below.

Table 11 Personal utilisation of BI

	Never	Rarely	Sometimes	Often	Very often	Mean
View static reports	2 %	0 %	7 %	59 %	32 %	4,17
Create static reports	2 %	22 %	32 %	27 %	17 %	3,34
Create analyses using visualization or statistical tools.	7 %	12 %	24 %	41 %	15 %	3,44
View analyses created by others.	5 %	7 %	29 %	41 %	17 %	3,59
Monitor on-going business processes	5 %	12 %	34 %	41 %	7 %	3,34
Apply predictive analytics or forecasting	15 %	10 %	34 %	37 %	5 %	3,07
Automate decisions or processes	39 %	24 %	32 %	2 %	2 %	2,05

Almost everyone (90 %) viewed static reports often or very often in their work. They were however less frequently actually generated by the users as only 44 % did this on the same frequency. 56 % of the respondents often performed some form of analysis themselves and 59 % often viewed analyses created by others. Interestingly, even if the percentages are alike there is some variation between respondents as some rarely performed analyses

themselves and still often used ready-made analyses while some relied mostly on self-made analyses (see Appendix D Contingency table of using analyses for a contingency table). Mostly however, those who used analyses made by others, created them by themselves as well, which is indicated by the responses situating fairly near the diagonal of the contingency table but most likely the small number of respondents and couple of outliers resulted in statistical correlation being non-significant (p=0,082). Nearly half (49 %) of the respondents also used BI for more continuous process monitoring purposes often or very often. Even predictive analytics or forecasting was used by 41 % at least often and that figure rises to 76 % when those who use it sometimes are included. This suggests again that there is more to BI than purely historic reporting. Automation was not very common use of BI for the respondents as 63 % never or rarely used it. 32 % indicated that they sometimes used automation in their daily work but unfortunately the survey cannot provide more insights regarding for what exact purposes it is used on these occasions.

Second sub-section (Appendix A Survey form, question 17) focused on examining the usability of the BI system from the user's perspective. There are of course many different aspects and levels to examine and not all of them can be covered in a single survey form. The key areas on which this survey focused, were derived from previous studies, especially building on the BI capabilities presented by Isik *et al.* (2011) and other critical factors presented in chapter 3.5 as well as the Eckerson's maturity model (TDWI 2012). The answers are summarized in Table 12 below.

Table 12 Usability of the BI system

	Disagree	Somewhat disagree	Neither agree or disagree	Somewhat agree	Agree	Mean
The data is of good quality (accurate and comprehensive):	0 %	17 %	27 %	49 %	7 %	3,46
The applications are user-friendly.	2 %	29 %	39 %	24 %	5 %	3,00
The applications fulfil your information and analysis needs.	0 %	17 %	32 %	44 %	7 %	3,41
It is easy to gather all the data required for reporting or analysis.	2 %	49 %	24 %	22 %	2 %	2,73
It's easy to share the analyses and insights with other users.	0 %	15 %	27 %	46 %	12 %	3,56
Different software integrate well with each other when needed.	12 %	34 %	39 %	15 %	0 %	2,56
Applications can use many different data sources when needed.	15 %	20 %	17 %	34 %	15 %	3,15

Data quality in itself can be a multifaceted factor and could (and should) be given more emphasis if the technical evaluation of the BI system was in the focus of the study but here it is simply measured as accurate and comprehensive data. Slightly over half of the respondents (56 %) agreed to some extent that the data fulfils these requirements. This does raise questions regarding how the rest see data as failing in these respects. Is it not accurate or just not comprehensive enough? Perhaps it's not timely and thus irrelevant?

"Garbage in, garbage out" goes the saying about using bad data for analyses that are not therefore accurate and in worst cases misleading. Data are the building blocks of any BI system and therefore it could be argued that its quality should be quite high.

Integration was the worst performing area in this sub-section which was measured by three items: gathering the data, integration between applications and using different data sources. A combined sum factor (mean=2,81, Cronbach's alpha=0,743) indicates that it's often not very easy to get the data from where it is stored to an application where it could be analysed. Analytics professionals often use dedicated ETL-tools for this and it is likely safe to assume that top management probably does not possess these tool or skills to use them and applications in themselves are not able to do ETL-procedures sufficiently. As such, organisations' BI systems appear to fail to provide sufficient integration with different applications and data sources.

User-friendliness was another factor that the respondents were not very satisfied with. Only 29 % agreed to even some extent with the statement that BI applications are user-friendly while 32 % disagreed. There were also significant correlations with all the other factors regarding the usability of BI systems, suggesting that user friendliness is closely related to the overall usability of BI (see Appendix C Correlations between usability factors). Users were more satisfied with BI's ability to fulfil their information and analysis needs as 51 % agreed to some extent and only 17 % somewhat disagreed with this. It is interesting that while the users see data- and user-friendliness related problems with BI, they still appear to be somewhat satisfied with the information they receive from it.

A sum factor including all of the items describing usability of the BI system (mean=3,13, Cronbach's alpha=0,850) suggests that there is still room for improvement in the usability of the BI systems but at the same time, as noted above, they are somewhat satisfied with the quality of the data in the systems and their ability to provide the information and analyses that the users need.

The usability and utilisation are closely related to the personal perceived value of BI as shown by the positive correlations in Appendix F Correlations between usability, utilisation and value. The findings thus support previous literature arguing for more emphasis on the actual utilisation and usability of business intelligence.

In this small survey sample, there was not to be found any significant differences between respondents from finance function and others regarding the utilisation and usability of the business intelligence system.

4.5 Utilisation in decision making context

The BI utilisation in decision making context was explored with sub-sections covering the tools and technique, the purposes and the benefits of using BI in this specific context (Appendix A Survey form, questions 18, 19 & 20). Decision making was intentionally loosely defined as drilling down to different aspects and types of decisions to make would have been impractical to carry out in a survey setting. Thus the answers reflect a wide variety of decision making situations ranging from those more operational in nature to more strategic ones. The responses regarding the different types of BI utilised in decision making are summarised in Table 13.

Table 13 Forms of BI used in decision making

	Never	Rarely	Sometimes	Often	Very often	Mean
Use readily available generic purpose reports.	2 %	2 %	10 %	56 %	29 %	4,07
Use reports that are created with a special purpose in mind.	2 %	0 %	39 %	41 %	17 %	3,71
Create analyses yourself to answer emerging problems.	7 %	17 %	32 %	34 %	10 %	3,22
Use automation or algorithms	37 %	20 %	34 %	7 %	2 %	2,20

The most used form of BI in decision making is viewing generic reports of the organisations operations as 85 % of the respondents this type of BI often or very often and only two indicated that they never or only rarely used BI in decision making. This type of reporting consists usually of items such as last month's sales or annual profit development. Also quite frequently used are customized reports or analyses designed to support decision making as 59 % indicated that they use this type of reporting often or very often and further 39 % used them at least sometimes. Slightly smaller number of the respondents indicated that they were themselves creating analyses to answer emerging needs, 44 % often or very often and 32 % at least sometimes. Least often used was automation by algorithm or rules as 56 % never or rarely used this type of BI and only 10 % indicated that they were using it often or very often. The results suggest that for the most part, BI outputs support decision making by a wide variety of generic reports and analyses. Half of the respondents also utilise the more customised and tailored analyses that are sometimes produced by the decision-maker him- or herself. This suggests a slightly tighter coupling between BI and decision making for that half of the respondents but the tightest form of coupling, automation, remains quite infrequent.

Table 14 Purposes of BI utilisation in decision making

	Disagree	Somewhat disagree	Neither agree or disagree	Somewhat agree	Agree	Mean
As an objective and unbiased source of information.	0 %	0 %	7 %	68 %	24 %	4,17
To support other information sources	0 %	2 %	22 %	51 %	24 %	3,98
To dispute information from other sources	2 %	20 %	32 %	41 %	5 %	3,27
Interpret or alter the results to better suit your preconceptions.	0 %	27 %	27 %	39 %	7 %	3,27

The results about examining the purposes for which BI is used are described in Table 14 above. Nearly everyone (93 %) agreed to at least some extent that BI provides objective and unbiased information. It was also used as a support for other information sources by

76 % of the respondents. However, it was also viewed as a tool to dispute and replace information from other sources by 46 %. The before mentioned views can all be interpreted at least to some extent drawing on the objective nature of BI and information. Some more subjective and political uses were also identified as 46 % agreed to at least some extent that they interpreted or altered the BI outputs to suit their preconception of a problem. These results cannot be interpreted as suggesting that half of the respondents use BI in unjustified ways. It can also be argued that deficits in data or BI systems lead to outputs that do not reflect the questions under scrutiny correctly and a manager with a lot of experience can identify these short comes. This is to some extent supported by the positive correlation between modifying reports and data-related issues as the inhibitor of using BI (Pearson's rho=0,447, p=0,003). Nevertheless, this does indicate that there is a possibility and room for using BI outputs also in a more subjective way.

The benefits of a BI system in decision making can be equally difficult to quantify as was the case with organisational benefits. As such, the survey items relating to the benefits in decision making were narrowed to just a few easily understandable factors, namely the improvements in overall quality and the speed of decision making. Also included here is a question where the respondents were asked to evaluate the overall value of their BI system for their daily work (not limiting to decision making). Answers are outlined in Table 15 below.

Table 15 Benefits of the BI system from personal perspective

	Disagree	Somewhat disagree	Neither agree or disagree	Somewhat agree	Agree	Mean
BI improves the speed of decision making.	0 %	10 %	12 %	59 %	20 %	3,88
BI improves the quality of the decisions by supporting them with facts.	0 %	0 %	7 %	46 %	46 %	4,39
Overall, BI is valuable for your daily work	0 %	5 %	17 %	51 %	27 %	4,00

Of the respondents, 78 % agreed at least to some extent that BI improved the speed of their decision making and 93 % said the same about improving the quality of decision making. These are quite high figures and suggest that business intelligence is able to provide significant improvements to the decision making process. Interestingly, "only" 78 % considered BI valuable for their daily work overall. Perhaps the improved quality of decision making alone is not sufficient for BI to be valuable overall or the frequency of BI utilisation is so low that some of the respondents felt it was not providing value on a daily basis. However, in general BI is seen as valuable for the respondents as on average it was estimated to be somewhat valuable (mean=4,00).

There were no differences to be found between financial professionals and others regarding decision making in this sample but again this is not surprising given the small number of respondents.

5 CONCLUSIONS

5.1 Discussions

Chapter 4 examined the responses given by the survey participants quite meticulously but in this chapter they are attempted to weave together with existing literature. I will review the results in light of the BI process framework by Shollo (2013) which was introduced in chapter 3.1. First I will examine the rationales for utilising business intelligence in the first place, then go through the BI stack and finally consider the maturity and the benefits of the BI processes and the critical factors affecting them.

Preceding the actual use of the business intelligence system, there is a reason, a rational, for doing so. Nearly every of the organisations stated that the "efficient-choice"-rationales, as presented by Malmi (1999), were the reasons for using the BI system. These included improved business knowledge, better decision making and increased operational efficiency as well as creating competitive advantage and cost savings. Only few respondents gave hints that "fashion and fad"-rationales had influenced their BI systems but as Malmi pointed out in his study, humans tend to rationalise their choices even if their initial reasons would have been different. Previous findings by Hannula & Pirttimäki (2003) were along the same lines as the ones in this study as the most cited rationales were focused on realising upside benefits of the BI system, such as increased operational efficiency, rather than minimising the downside drawbacks, such as costs. This was also evident as the respondents indicated that the biggest challenges in realising benefits from the BI system came from data related issues and lack of knowledge on utilising BI.

Data is arguably the backbone of any business intelligence system (Baars & Kemper 2008; Bhimani & Willcocks 2014, CGMA 2013; LaValle *et al.* 2011). Traditionally business intelligence activities have relied mostly on internal structured data in the IT systems, combined with experience and insight from the organisation (Davenport 2013; Hannula & Pirttimäki 2003). Today however, the organisations are utilising a wide variety of different data types and sources. External structured data usage is already widespread among the surveyed companies and internal and external semi-structured data is also being used quite extensively, roughly by half of the respondents. All the different types and sources of data do not necessarily need to be incorporated in to organisation's IT systems as long as they are systemically utilised in the business intelligence processes, ensuring that

organisations use all the operationally and strategically relevant data that is available. It is of course difficult if not impossible to evaluate whether or not the data potential is exhausted to the point that the marginal costs exceed the benefits but the fact that a wide variety of data types and sources are used, indicates that the potential is acknowledged and acted upon in the companies.

The analysis of the data, or transformation in to information, is conducted in a variety of ways in the organisations. Traditional spreadsheets continue to dominate as the ubiquitously utilised form of analysis but dedicated data visualisation tools were also used in eight out of ten surveyed organisations and specialised analysis tools in six out of ten. This may be due to the increasing number of different data types and sources as traditional analysis methods provided by spreadsheets no longer cope with the changing requirements. One in four organisations also indicated that they performed advanced analytics as part of their BI processes. These methods include data mining, predictive analytics and other methods that are often coupled with large sets of data. These findings are largely in line with previous ones by Kiron *et al.* (2011) where these different methods were quite similarly distributed across organisations. Only a handful of organisations indicated that some type of machine learning or automatized optimisation was ~~in~~ implemented. They present the current cutting edge technologies and require rigorous IT systems and it is thus not very surprising that their deployment is not very widespread. It should be noted however that merely applying advanced tools and technologies does not create value for the organisations as the survey did not find any significant correlation between the tools used and the benefits reaped. Information technology systems play an important but ultimately a secondary role in the value chain of an organisation by supporting the primary activities as Porter (1985) puts it. Thus they are required for creating the value but do not *drive* the value-creating process.

Shollo (2013) and Davenport (2010) criticise the often assumed view that once business intelligence tools are in place, they are utilised and therefore provide benefits to the organisation. The survey conducted for this study focused on exploring one of the most cited uses of BI: decision making. Following Davenport's framework for coupling BI with decision making, a great majority of respondents utilised the loosely-coupled approach as they often relied on generic reports in supporting decision making. Still, half of the respondents also utilised BI with tighter coupling, structured human decisions, by using customised analyses and reports for certain problems and even creating ones themselves but the tightest form of coupling, automated decision making, remained quite infrequent among the respondents of this study. The results suggest that the decision makers do actually utilise BI rather frequently but the question remains; *how* is it used?

The ways for using BI in decision making were also explored to some extent in the survey by examining the different roles proposed by Shollo (2013). She adds several, less rational, uses of BI to the often assumed view as a purely objective information source. Business intelligence was indeed seen mostly as an unbiased information provider as nine out of ten respondents agreed with this view. However, more political and possibly biased uses of BI also emerged as more than half of the respondents admitted that they interpreted or even altered the BI outputs to better confine to their views of the matter. This does not necessarily translate in to an explanation of BI as a misused tool but can also indicate that it is not being trusted entirely and its suggested results are often taken with some reservations. The reasons can be multifaceted and perhaps the aforementioned

challenges in data quality and lack of knowledge on applying BI attribute to it as well. A more in depth study is certainly required to further examine these perspectives.'

The reasons for using BI in decision making were clear among the respondents as nearly everyone found BI improving the speed or quality of the decision making process. Eight out of ten also found BI to be valuable for their daily work overall which is to say that at least on personal level, the benefits of BI are being realised. But as promoted by Shollo (2013) and Davenport (2010), the benefits seem to be realised only through actually using the BI tools. Individuals making more frequent use of BI also perceived stronger benefits for them and better usability of the BI system likewise seemed to have an effect on the perceived benefits, much like Isik *et al.* (2011) also found in their study. This linkage between using the BI systems and perceiving the benefits from it calls for further examination on how exactly are the benefits realised and why others are not using the BI systems, hence also not receiving the benefits from it.

Above, I described the BI "stack" from data to actually using it. Another interesting perspective in regards with the explorative nature of this study is the maturity of the BI systems in organisations. The examination of the maturity of BI systems builds on the maturity model originally developed by Eckerson (2004) which has been further developed by TDWI (2012). Organisations in this study appeared to have somewhat mature BI systems as most of the organisations have established processes for storing, analysing and using the information. This in turn suggested that organisations are probably reaping benefits from business intelligence as well.

Nearly every organisation in the survey indicated at least some benefits from their BI systems but the strength of these benefits varied. Benefits relating to realising the upside potential (*e.g.* increased revenues or improved coordination with customers) appeared to be more substantial than those concentrating on minimising costs. Previous studies have found several critical success factors affecting these benefits derived from the BI systems (Elbashir *et al.* 2008; Isik *et al.* 2011; LaValle *et al.* 2011; Yeoh & Koronios 2010). This study fell mostly in line with previous findings as organisational, rather than technological, factors were found to be important for the benefits perceived. Organisational importance (including top management support) and culture were both found to be closely related to perceived benefits for the organisation, results akin to what has been suggested previously in the literature. Even if the technological aspects did not arise as significant factors, they should not be discarded as entirely unimportant. However, the findings do further underline the importance of organisational factors of the BI system and suggest that they are more important for the overall success than the technological ones. The distinction between technological and organisational perspectives is however not as strict as presented above but rather they are interrelated and the nature of their relationship is not likely to be depicted in fullest of diversity in a simple survey study (*c.f.* Granlund 2011).

5.2 On reliability and validity

The reliability of this study has been taken in to consideration by measuring the phenomena under scrutiny with several items on the survey form and forming sum factors from these items. Internal consistency of the factor has been verified with Cronbach's alpha whenever possible and the interpretations and conclusions are made

only from statistically significant results. However, the small number of respondents in the survey (n=41) does result in inherent randomness and reliability issues in the data. Therefore, even the statistically significant results do not have the explanation power they would in a more comprehensive sample and on the other hand, possibly significant results are quickly discarded as insignificant in the event of a couple of contradicting responses. Also, not everything was possible to measure with several questions and sum factors and these items carry more reliability risk. For example, the technological factors of the BI system were often measured by only one item on the survey form and this may potentially have impacted negatively the statistical significances of these factors as more randomness is included in the measures.

Validity is always an important and challenging aspect when conducting studies in social sciences because the phenomena can often be interpreted in a variety of ways. In this study, the validity has been improved by careful literature review, covering the most important perspectives to business intelligence. By careful construction of the survey form and operationalising the concepts – such as organisational importance and usability of the BI system – meticulously, it has been further assured that the validity of the study is as high as possible. However, some possible biases remain and possibly the most important one is a consequence of low (~2%) response rate. There is a risk that only those who have interest in and possibly more positive experiences with BI have been filtered as the respondents of the survey. This could result in overly positive conclusions regarding the utilisation and the benefits of BI in organisations and effectively skew the results. However, the fact that some less positive responses were included in the sample, does suggest that this is not entirely the case. Another possible bias stems from the roles of the respondents in the organisation. They were exclusively from top management and executive positions in different functions which means that their view might differ from that of blue-collars. For example, they may view BI as very important for their business processes but those lower in the organisation do not view it useful at all. Also, the top management may view their support for fact-based decision making culture stronger than what the others perceive it. This is taken in to account by interpreting the results of the survey specifically from the viewpoint of the organisation's top management.

5.3 Future research opportunities

This study has but scratched the surface of business intelligence in Finnish organisations and there remains an ample amount of research to conduct. Firstly, an in-depth examination of how and for what purposes is BI used in organisations is needed to further clarify its role in the decision making process and in organisations overall. Also, more emphasis could be given to how controllers and other finance professionals view BI as only five respondents from finance function were included in this study. Arguably, modern finance function could benefit from BI *e.g.* in budgeting, forecasting and performance management and it would be interesting to examine to what extent this is the case in today's organisations.

I'd like to conclude by hoping that in part, this study has forwarded the agenda of bringing research closer to practitioners and that the findings are of relevance for larger audience than the academia alone.

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APPENDICES

Appendix A Survey form

Background Information

Please provide us with some background information on you and your organization.

1. What is your responsibility area in the organization? *

- ◯ Top management
- ◯ Finance
- ◯ IT
- ◯ Sales
- ◯ Marketing
- ◯ Business Development

2. What is your title?

_____

3. In what industry do you mainly operate? *

- ◯ Manufacturing
- ◯ Retail Trade and Wholesale
- ◯ Consulting and research
- ◯ Agricultural, forestry and fishing
- ◯ Construction
- ◯ Accommodation and food services

- ◯ Information and communications
- ◯ Financial and insurance
- ◯ Health and social service
- ◯ Mining and quarrying
- ◯ Electricity, gas and steam
- ◯ Water supply and waste management
- ◯ Transportation and storage
- ◯ Administrative and support service
- ◯ Other services

4. What is the approximate yearly turnover of your organization? *

_____ million euros

5. What is the approximate number of people working in your organization? *

_____ people employed

6. Our strategy emhasizes (we are aware that details of strategies vary a lot, thus choose the closest option of the generic strategies): *

- ◯ Cost effectiveness
- ◯ Differentiation and or new product / service innovations
- ◯ Both of the previous options

7. Uncertainty in your organization's competitive environment *

	Very low 1	Low 2	Medium 3	High 4	Very high 5
The level of uncertainty in organization's competitive environment is:	◯	◯	◯	◯	◯

Business Intelligence

Business Intelligence (hereafter BI) refers to the programs and processes used to access and analyse data and information. Mostly BI covers traditional reporting and analyses used to understand operations and environment, such as customer profitability or investment calculations. Alternative terms that may be used when referring to BI are for example Reporting, Analytics, Decision Support Systems or Customer/Competitive Intelligence.

8. What are the most important drivers for using BI? Please choose all that apply.

- [ ] Increased business knowledge
- [ ] Improved operational efficiency
- [ ] Better decision making
- [ ] Cost savings
- [ ] Creating competitive advantage
- [ ] Competitors use it
- [ ] Curiosity towards new tools and technologies
- [ ] Consultant advice
- [ ] Other _____

9. What are the factors that impair the use of BI? Please choose all that apply.

- [ ] Increased costs
- [ ] Unsufficient or bad quality data
- [ ] Limited knowledge on applying BI
- [ ] BI offers limited business benefits
- [ ] Other _____

10. Business Intelligence (the hardware, software and dedicated analysts/data scientists) are funded primarily from: *

- ◯ No separate funds
- ◯ Departmental budget
- ◯ Divisional budget
- ◯ Organization's IT budget
- ◯ Organization-level BI budget

11. Please select all tools and techniques that are used in your organization: *

- [ ] Excel-sheets
- [ ] Data visualization tools that aid in presenting the data
- [ ] Data analysis tools that allow manipulation of the data

- [ ] Data mining, predictive modelling or other type of advanced analytics
- [ ] Machine learning
- [ ] Optimization through automated algorithms, neural networks

Business Intelligence in your Organization

If you work in a unit of a large organization, you may focus on the country- or business unit-level that you are part of.

12. Types of data

Below is a table describing different data types. Structured data is found in databases, while unstructured data can be anything from e-mails to video. Internal data is created inside the company while external data comes from outside the organization.

The types of data that are used in your organization's BI systems: (Please select all that apply)

	Structured	Un-structured
Internal	☐	☐
External	☐	☐

13. Regarding the scope of Business Intelligence in your organization: *

	Disagree 1	2	Neither agree or disagree 3	4	Agree 5
Business Intelligence (or similar) activities are mainly organized as a separate, centralized department or function.	○	○	○	○	○
BI is used in every division of your organization.	○	○	○	○	○
BI is used for answering specific business problems, rather than only generic reporting.	○	○	○	○	○
BI is designed to support specific strategic goals.	○	○	○	○	○
Different division can access each other's data when necessary.	○	○	○	○	○

14. Organizational importance and top management support *

	Disagree 1	2	Neither agree or disagree 3	4	Agree 5
BI is considered a high priority by top-level management.	○	○	○	○	○
BI is regarded as a strategical asset in your organization.	○	○	○	○	○
Fact-based decision making and operational improvements are encouraged by executives and managers.	○	○	○	○	○
In your organization, fact-based decision making culture is promoted.	○	○	○	○	○

15. For your organization as a whole: *

	Disagree 1	2	Neither agree or disagree 3	4	Agree 5
BI reduces costs	○	○	○	○	○
BI increses revenues	○	○	○	○	○
BI improves coordination with suppliers	○	○	○	○	○
BI improves coordination with customers	○	○	○	○	○
BI supports and enhances business processes rather than just generates information of them.	○	○	○	○	○

Personal perspective

Please answer the following question from your own perspective and your daily work in mind.

16. You use the following BI applications: *

	Never 1	Rarely 2	Sometimes 3	Often 4	Very often 5
View static reports (snapshots of a situation at a given time, e.g. last months sales).	○	○	○	○	○
Create static reports e.g. certain customer's sales.	○	○	○	○	○
Analyze historical trends and issues using visualization or statistical tools.	○	○	○	○	○
View analyzes created by others.	○	○	○	○	○
Monitor on-going business processes. e.g. progress towards daily sales goal.	○	○	○	○	○
Anticipate or model future outcomes through predictive analysis or forecasting.	○	○	○	○	○
Automate decisions or processes (e.g. grant credit to a customer based on an algorith).	○	○	○	○	○

17. When using BI: *

	Disagree 1	2	Neither agree or disagree 3	4	Agree 5
The data is of good quality (accurate and comprehensive):	○	○	○	○	○
The applications are user-friendly.	○	○	○	○	○
The applications fulfill your information and analysis needs.	○	○	○	○	○
It is easy to gather all the data required for reporting or analysis.	○	○	○	○	○
It's easy to share the analyses and insights with other users.	○	○	○	○	○
Different software integrate well with each other when needed.	○	○	○	○	○
Applications can use many different data sources when	○	○	○	○	○

needed.

Business intelligence in decision making

For the next questions, please consider your own decision making and how you use information to support it.

18. The ways you utilize BI in decision making: *

	Never 1	Rarely 2	Sometimes 3	Often 4	Very often 5
Use readily available generic purpose reports. (e.g. last months sales)	○	○	○	○	○
Use reports that are created with a special purpose in mind (e.g. who are the most profitable customers).	○	○	○	○	○
Create analyses yourself to answer emerging problems.	○	○	○	○	○
Use automation by utilizing algorithms and rules to make recurring or simple decisions.	○	○	○	○	○

19. For what purposes do you use BI in decision making context? *

	Disagree 1	2	Neither agree or disagree 3	4	Agree 5
As an objective and unbiased source of information.	○	○	○	○	○
To support other information sources (e.g. your own experience and opinions).	○	○	○	○	○
To dispute information from other sources (e.g. someone else's opinion).	○	○	○	○	○
Interpret reports and analyses to suit your (predetermined) perception of a problem.	○	○	○	○	○
Modify a report/analysis to better support your preconceptions.	○	○	○	○	○
Answer specific business problems (e.g. what type of projects are the most profitable?).	○	○	○	○	○

Analyse questions relating to organizational strategy.	○	○	○	○	○

20. For you personally:

	Disagree 1	2	Neither agree or disagree 3	4	Agree 5
BI improves the speed of decision making	○	○	○	○	○
BI improves the quality of the decisions by supporting them with facts.	○	○	○	○	○
Overall, BI is valuable for your daily work (not limiting to decision making).	○	○	○	○	○
Other: _____	○	○	○	○	○

Appendix B Correlations between organisational benefits

			BI reduces costs	BI increses revenues	BI improves coordination with suppliers	BI improves coordination with customers	BI supports and enhances business processes
Spearman's rho	BI reduces costs	Correlation Coefficient	1,000	,120	,374*	,233	,369*
		Sig. (2-tailed)	.	,455	,016	,143	,018
	BI increses revenues	Correlation Coefficient	,120	1,000	,158	,424**	,142
		Sig. (2-tailed)	,455	.	,323	,006	,377
	BI improves coordination with suppliers	Correlation Coefficient	,374*	,158	1,000	,368*	,294
		Sig. (2-tailed)	,016	,323	.	,018	,062
	BI improves coordination with customers	Correlation Coefficient	,233	,424**	,368*	1,000	,108
		Sig. (2-tailed)	,143	,006	,018	.	,503
	BI supports and enhances business processes	Correlation Coefficient	,369*	,142	,294	,108	1,000
		Sig. (2-tailed)	,018	,377	,062	,503	.

Appendix C Correlations between usability factors

			The data is of good quality (accurate and comprehensive)::	The applications are user-friendly.	The applications fulfill your information and analysis needs.	It's easy to share the analyses with other users.	BI system integration (sum factor)
Spearman's rho	The data is of good quality (accurate and comprehensive):	Correlation Coefficient	1,000	,555**	,522**	,254	,416**
		Sig. (2-tailed)	.	,000	,000	,109	,007
		N	41	41	41	41	41
	The applications are user-friendly.	Correlation Coefficient	,555**	1,000	,628**	,391*	,693**
		Sig. (2-tailed)	,000	.	,000	,011	,000
		N	41	41	41	41	41
	The applications fulfill your information and analysis needs.	Correlation Coefficient	,522**	,628**	1,000	,515**	,574**
		Sig. (2-tailed)	,000	,000	.	,001	,000
		N	41	41	41	41	41
	It's easy to share the analyses with other users.	Correlation Coefficient	,254	,391*	,515**	1,000	,457**
		Sig. (2-tailed)	,109	,011	,001	.	,003
		N	41	41	41	41	41
	BI system integration (sum factor)	Correlation Coefficient	,416**	,693**	,574**	,457**	1,000
		Sig. (2-tailed)	,007	,000	,000	,003	.
		N	41	41	41	41	41

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Appendix D Contingency table of using analyses

Items are from question 16 in Appendix A Survey form

Count		View analyzes created by others.					Total
		Never	Rarely	Sometimes	Often	Very often	
Analyze historical trends and issues using visualization or statistical tools.	Never	2	0	0	0	1	3
	Rarely	0	1	1	3	0	5
	Sometimes	0	2	3	3	2	10
	Often	0	0	7	8	2	17
	Very often	0	0	1	3	2	6
Total		2	3	12	17	7	41

Appendix E Correlations between different perspectives of scope

Items are from question 13 in Appendix A Survey form.

			BI is designed to support specific strategic goals.	BI is used in every division of your organization.	BI activities are organized as a centralized function.
Spearman's rho	BI is designed to support specific strategic goals.	Correlation Coefficient	1,000	,092	,056
		Sig. (2-tailed)	.	,568	,729
		N	41	41	41
	BI is used in every division of your organization.	Correlation Coefficient	,092	1,000	-,024
		Sig. (2-tailed)	,568	.	,882
		N	41	41	41
	BI activities are organized as a centralized function.	Correlation Coefficient	,056	-,024	1,000
		Sig. (2-tailed)	,729	,882	.
		N	41	41	41

Appendix F Correlations between usability, utilisation and value

Items are from questions 16, 17 and 20 in Appendix A Survey form.

			Overall value of BI	Usability	Utilisation
Spearman's rho	Overall value of BI	Correlation Coefficient	1,000	,444**	,531**
		Sig. (2-tailed)	.	,004	,000
	Usability	Correlation Coefficient	,444**	1,000	,333*
		Sig. (2-tailed)	,004	.	,033
	Utilisation	Correlation Coefficient	,531**	,333*	1,000
		Sig. (2-tailed)	,000	,033	.