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Analyzing Business Intelligence Maturity

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Abstract: Business intelligence has fundamentally changed how companies conduct their business. In literature, the focus has been on volume-operation companies that provide services to millions of customers. In contrast, complex-systems companies have fewer customers and pursue customer needs by providing more customized products and services. This paper presents the results of a case study conducted at a complex-systems company, with the overall aim to identify how complex-systems companies may take advantage of business intelligence. A framework was used to measure business intelligence maturity of the company. In addition, we also explain the current maturity level of the case-company, based on critical factors for success adopted from the literature. In doing so, we also contribute on important details regarding factors that must be considered by organizations, in order to leverage their analytical capability. Finally, we also propose topics that need to be further investigated, in order to increase current knowledge regarding BI usage and maturity in complex-systems companies.

Keywords: Business Intelligence, Business Analytics, BI Maturity, Complex-Systems companies

1. Introduction

The impact of information technology (IT) has driven organizations to seek new opportunities, strategies and tools to increase their competitive advantage and to cope with global competition (Friedman, 2006). One strategy that has received a lot of attention is business intelligence (BI).

BI is often described as an umbrella concept, covering different activities and technologies that, in one way or another, use data and information to enhance business performance and support decision making at all organizational levels, i.e., strategic, tactical, and operational level, (Turban, Sharda, Delen, & King, 2011). Usually, the hub of a BI solution is the data warehouse (DW). Data, internal as well as external, is

extracted from various source systems into the DW at a certain interval or at specific times (Ponniah, 2010; Davenport & Harris, 2007; Strand & Carlsson, 2008a; Strand & Carlsson, 2008b). When the DW has been populated with data, managers use various tools to analyze the information stored in the DW on a need to use basis (Elbashir, Collier, & Davern, 2008). Using the DW minimizes conflicts of information, and provides something that could be called "a single version of the truth" (Watson & Wixom, 2007). For clarification, we are aware of the debate whether the concept of Business Analytics (BA) is a subset of BI (Davenport & Harris, 2007) or an advanced discipline within the concept of BI (Laursen & Thorlund, 2010). In this work, analytics are viewed as an integrated part of BI and the terms will be used interchangeably.

In literature, companies like Harrah´s Entertainment (Wixom & Watson, 2010; Davenport & Harris, 2007), Amazon.com (Agrawal, 2009), Continental airlines (Anderson-Lehman, Watson, Wixom, & Hoffer, 2008), and Netflix (Valacich & Schneider, 2010) are examples of prominent companies that have matured in their BI application and thereby excelled into market leading positions. Still, these examples share the commonality that the companies are so called volume-operations companies (Moore, 2008), i.e. sale-transaction intense companies, providing standardized or marginally personalized products or services to up to millions of multi-transaction customers each year. These volume-operations companies have been dominating the BI literature and according to our literature study, they provide the empirical basis for most case studies on how BI is utilized in businesses today. In contrast, we have complex-systems companies (Moore, 2008), i.e. companies that provide customized services or manufacture products to businesses with the main purpose of interpreting customer needs into specialized solutions. Normally, complex-systems companies have a much smaller customer stock, constituted in a B2B-relationship, making most customers

highly important and with transactions of high order value (Moore, 2008). These types of companies not only have different business models, they may also have different BI needs. Furthermore, they have received very limited attention in the BI literature compared to volume-operations (Watson, 2008), and they need to be further studied to broaden knowledge on how various types of companies use BI when conducting their business.

Therefore, this paper presents the results of a case study conducted towards a multi-national complex-systems company, which acts as a subcontractor in a broad range of manufacturing industries. The case study had a dual purpose. Firstly, the case study aimed at investigating how a complex-systems organization used its BI-solution. Secondly, the case-study included measuring the current analytical maturity of the company at hand. The maturity analysis was included as a means to contextualize the usage and to identify opportunities as well as hinders perceived by the company. In a more general manner, the results of the case study also contribute in fulfilling a more overall knowledge-related need expressed by (Arnott & Pervan, 2008), concluding that research on decision support systems was partly disconnected from actual practice. Arnott and Pervan (2008) also emphasized the importance of increasing the number of case studies as a mean to improve the relevance of the research conducted within this particular area.

In following up the case-study, which had a strong focus on analytical applications of BI and the current maturity level of the company at hand, we also conducted an in-depth open interview with the CIO at the case company. The CIO was responsible for the BI project since its start more than 10 years ago. Thereby, the CIO could give valuable insight on the development process per se as well as the conditions that have influenced the company´s progress. Combined with the findings from the case

study, it allows us to explain and motivate the case company´s current maturity level. Also, in order to ground the findings in the current literature, we adopted the critical factors for success presented by Shanks & Bekmamedova (2012). In addition, explaining and motivating the case company´s current maturity also contributes with further details regarding factors companies must consider in order to increase their analytical capability. Thereby, this paper may be valuable to others interested in leveraging their BI investments. This is the main focus of the latter part of the paper.

The remainder of the paper is structured as follows. Section 2 introduces the theoretical background. Section 3 presents the chosen research approach. Section 3 describes the research method. Section 4 presents the case study including BI usage, BI maturity and key success factors. Finally, section 5 presents conclusions and ideas for future work.

2. Theoretical framework

2. 1 Maturity models

Maturity models can be used to analyze both strengths and weaknesses of organizations as a whole or within specific business functions (Mettler & Rohner, 2009). A number of maturity models are presented in the literature, but they do not specifically focus on complex-systems companies or the manufacturing industry. The Data Warehousing Institute (TDWI) has provided a maturity model which emphasizes data warehouse maturity where companies go through six stages: prenatal, infant, child, teenager, adult and sage (Eckerson, 2004). Williams and Thomann (2007) provide three levels of maturity where they emphasize the importance of looking beyond data warehouse maturity (Williams & Thomann, 2007). In general, the maturity models focus on certain aspects of BI, and none of them have a specific focus on manufacturing companies (for

further examples we refer to Rajteric, 2013). Still, for this work, the maturity model provided by Lavalle, Hopkins, Lesser, Shockley & Kruschwitz (2010) was adopted, since it is well established in BI literature and has a dominant focus on analytical capabilities. Furthermore, the origin of the chosen maturity model stems from the results of a broad worldwide survey conducted in the fall of 2010 by MIT Sloan Management Review, where 3000 executives, managers and analysts from 108 countries and 30 industries were asked about their analytical capabilities and to predict future trends. The third largest group of respondents was in the manufacturing business, making this maturity model more relevant for this research than the other available maturity models. Other maturity models often originate from volume-operation companies or have a strong data warehouse maturity focus (Rajteric, 2013). Moreover, none of them specifically aims at complex-systems companies or manufacturing companies. The results of the survey showed a high correlation between analytical usage and business competitiveness. Furthermore, the results clearly showed that top performing companies were using analytics in financial management and budgeting (Lavalle, Hopkins, Lesser, Shockley & Kruschwitz, 2010). Survey respondents were asked to rate their own analytical capabilities and that resulted in a maturity level model (table 1) with three levels of maturity; Aspirational, Experienced and Transformed (Lavalle, Hopkins, Lesser, Shockley, & Kruschwitz, 2010). Higher maturity in business analytics means the organization shifts towards the Transformed maturity level where analytics are used throughout the organization, prescribing actions and functioning as a competitive differentiator. At that level, insights are used to automate decisions and processes like cost management become less significant compared to other levels. Organizations at the Aspirational level, mainly use analytics to justify actions where cutting costs, efficiency and automation of existing processes are the main focus. The

survey also revealed that the top performing organizations used analytics foremost for financial management and budgeting (Lavalle, Hopkins, Lesser, Shockley, & Kruschwitz, 2010).

Table 1: Organizational maturity levels. Adapted from (Lavalle et al., 2010)

	Aspirational	Experienced	Transformed
Motive	Use analytics to justify actions	Use analytics to guide actions	Use analytics to prescribe actions
Functional proficiency	Financial management and budgeting Operations and production Sales and marketing	All Aspirational functions Strategy/business development Customer service Product research/development	All Aspirational and Experienced functions Risk management Customer experience Work force planning/allocation General management Brand and market management
Business challenges	Competitive differentiation through innovation Cost efficiency (primary) Revenue growth (secondary)	Competitive differentiation through innovation Revenue growth (primary) Cost efficiency (secondary)	Competitive differentiation through innovation Revenue growth (primary) Profitability acquiring/retaining customers (targeted focus)
Key obstacles	Lack of understanding how to leverage analytics for business value Executive sponsorship Culture does not encourage sharing information	Lack of understanding how to leverage analytics for business value Skills within line of business Ownership of data is unclear or governance is ineffective	Lack of understanding how to leverage analytics for business value Management bandwidth due to competing priorities Accessibility of the data
Data management	Limited ability to capture, aggregate, analyze or share information and insights	Moderate ability to capture, aggregate and analyze data Limited ability to share information and insights	Strong ability to capture, aggregate and analyze data Effective at sharing information and insights
Analytics in action	Rarely use rigorous approaches to make decisions Limited use of insights to guide future strategies or guide day-to-day operations	Some use of rigorous approaches to make decisions Growing use of insights to guide future strategies, but still limited use of insights to guide day-to-day operations	Most use rigorous approaches to make decisions Almost all use insights to guide future strategies, and most use insights to guide day-to-day operations

3. Research approach

The purpose of the paper is to analyze BI usage and estimate BI maturity within a complex-systems company. Precise measurement instruments and causal theories are not yet available for these purposes. We instead rely on the reports and experiences of our research subjects in the company, and our subsequent analytical interpretations of these reports. This requires us to adopt an interpretive position in treating subjective phenomena based on local perceptions (Orlikowski & Baroudi, 1991; Myers, 1999). Since the aims of the research are exploratory in nature and the phenomena studied are local, transient and emergent, we develop an interpretive case study, following the guidelines developed by Walsham (1995) and Klein and Myers (1999). An open-ended

strategy was therefore applied in collecting material, covering interviews as well as company-internal documentation, the company´s website and via the existing BI-solution and related analytical reports. Following an interpretative position, the interviews were also open-ended, with only a few semi-structured questions, allowing follow-up questions in order to allow the respondents to elaborate upon personal experiences and perspectives on their use of BI. In sampling respondents, a broadness of perspectives and responsibilities were the main argument, since the diversity was assumed to contribute with a rich material for understanding the current BI-usage as well as for evaluating the current maturity of the case company.

The research started with a literature review followed by establishing the interview protocols. Data collection was through interviews, followed by content analysis where specific categories of usage started to emerge. Based on the BI usage, an estimation of BI maturity was established. In addition, new empirical content (from the follow up interview described below) was then reviewed for verification and refinement (see figure 1).

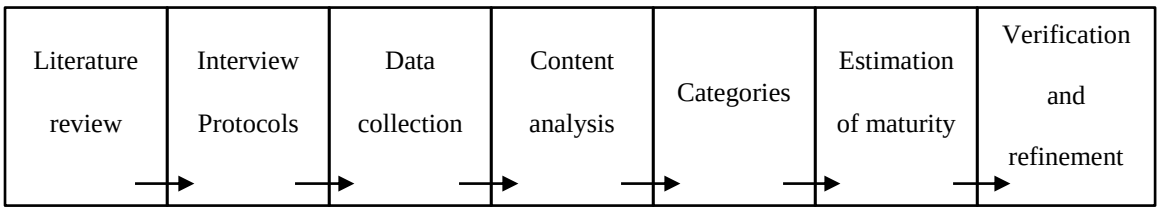

Figure 1: The research process

A total of 9 + 1 (follow up interview with the CIO) respondents were interviewed. R1 is a division manager within one of the four product areas. R2 is a product line manager responsible for a product group. R3 is a market service manager and an analyst supporting the CEO and other managers. R4 is a quality and environmental manager responsible for internal product quality and external environmental factors. R5 is the company´s purchase manager responsible for the

procurement of all direct materials and buying already built components. R6 is the controller, responsible of providing reports for decision support, improving cost and result management and improving economic reporting. R7 is the finance manager responsible for accounting and being an economic advisor in strategic decisions. R8 is a director and part owner of the company, with various responsibilities in many areas of the business. R9 is the CEO with the overall responsibility of the company's well-being and development. R10 is the CIO responsible for the company´s IT department and project owner of the BI initiative.

The interviews were done at the location of the respondents and all interviews were recorded and transcribed with an average interview time of 72 minutes. All respondents were also granted the opportunity to review the transcripts and approve for analysis. Finally, all interviews were conducted in Swedish; consequently, all quotations presented in this paper have been translated from Swedish to English. The data analysis was based on content analysis as described by Krippendorff (2004) where a number of usage areas emerged from the coding. These areas came up frequently during the interviews and therefore became the bases of the analysis.

During the interviews, a number of application areas started to emerge, showing examples of how the Company is taking advantage of BI. Many of these areas correspond to the internal application processes identified by Davenport and Harris (2007), as opportunities to compete on analytics. These areas became the basis for the analysis of the current BI usage, and the findings of Davenport & Harris (2007) were used as a reference where applicable. These areas also provided insights related to the current BI maturity. Here, it may be relevant to pinpoint that since the respondents are representing different functions in the Company, a lot of the material underlying the analysis is rather diverse as it covers many important business functions. The diversity

contributes in bringing interesting details into light and makes the case more thoroughly described and exemplified as well as helping triangulating the case.

4. Case study

4.1. Case study details

The company has chosen to be anonymous and will hereafter be referred to as the Company. It was established in 1955 and is a subcontractor towards e.g. the automobile industry. It has around 450 employees worldwide. There are five production plants, two main sites in Sweden, one in Brazil, one in USA and one in China. There are 16 subsidiaries in 16 countries (e.g. Japan, Italy, India, France and Australia) that function as sales offices. Most product development is done in cooperation with their customers in a B2B-relationship and the case company provides highly customized services and products. Exact figures on the number of customers, transactions and annual deals made are not granted information, but the intervals indicated by the Company´s representatives are well in alignment with the intervals for complex-systems companies indicated by Moore (2008). Thereby, the company meets the criteria for a complex-systems company. In addition, the case company has had a strategy for the last decade in investing in and developing a BI-solution, which is also granted with support from top-level management. Due to the contextual setting of the company, and the fulfillment of basic success needs for investing in a BI-solution, we argue that the case study is fully relevant for exploring BI-usage in a complex-systems company.

4.2 Current BI usage

Financial BI support

The financial area is one of many internal processes usually supported by BI tools. All respondents express MS Excel as the primary tool for economic calculations within the Company. This was no surprise since MS Excel is considered to be a very typical BI analytical technology (Davenport & Harris, 2007). All respondents also claim that they use Excel in one way or the other. In example, the product line manager uses it to, e.g., estimate investment costs for machines, the procurement manager uses it to calculate future procurement costs, and the controller uses it for data quality assurance. Still, the finance manager prefers the central ERP system from a data quality, trust perspective or *"I rely on the numbers there"* as quoted from the finance manager.

The central information system of the Company is called M3 (Movex), but that does not appear to be useful when doing calculations. As the controller says *"I do not use M3 much, I have it exported to Excel"*. Movex is mainly used for data input, but is *"not suited for analysis"* continues the controller. Excel provides opportunities to do calculations with large amounts of rows and to find errors in the data. For example, in Excel, product margin can be easily viewed using pivot tables, sorting from high to low, and if the margin of a product is suspiciously high in Excel, someone has made an input error in the Movex system as described by both the product line manager and the controller. Excel can therefore be used to assure the data quality according to the controller. Furthermore, one of the major tasks described by the controller is follow up on bookkeeping practices in the sales offices. This involves cost management and as exemplified by Davenport and Harris (2007) companies that have effective analysis and management of costs can use that for strategic purposes, for example by helping

influence customer behavior and pricing, finding the price that the customer is willing to pay.

When deciding on strategic issues like the development of a new product or whether or not to establish a new sales office or a production plant, the purchase manager says profitability calculations are done in Excel providing the main decision support to the board of directors. Ideas regarding these issues float around through e-mail and oral communication for a while, but when they reach a point where quantitative analysis needs to be done; again Excel is the main support system.

When monitoring progress and financial key performance indicators, the usage seems to be divided between using Excel, Microsoft Reporting Services and Cognos, all well established BI systems. Information regarding sales is sent by e-mail to the analyst and the controller who compile the Excel sheets into a single file with total sales. All employees of the organization then receive reports on a monthly basis with sales information and other key performance indicators originating from the sales offices. Other reports regarding production can be accessed on-demand to see if products are being produced according to plan. The Product line manager says this creates the opportunity to act fast when something is not following the budget. According to Davenport and Harris (2007), having this kind of constant progress monitoring with respect to key performance indicators is critical to strategy execution.

Product line managers´ use reports in the Cognos system in a similar way as described by the controller to monitor the financial aspects regarding products, incoming orders, sales numbers, production costs, production schedules and product margins. In fact, Cognos is also used to assure data quality, e.g., by viewing graphs and to do drill downs on peak areas to see if something is suspicious in the data. This could be things like inconsistency in product margin or an unusually larger order. Getting data

for these reports means a lot of e-mail communication between the sales offices and headquarters according to the controller. Excel sheets are sent and then manually compiled by the analyst, requiring a lot of costly manual labor. Furthermore, the analyst described difficulties regarding data quality. Same products could be called different names and some fields might not be filled out according to the wishes of the headquarters.

The data input is done using the central Movex system and stored in the central DW. By using Cognos, division managers do not only see key performance indicators, but they may also spot anomalies in a similar way as the controller describes when using Excel. The Cognos reports can be drilled down to specific products to find errors and production planning can be viewed. The purchase manager uses MS Reporting Services for various reports regarding procurement and to analyze the current inventory value. The difference between the reports used in MS Report Services and the reports available in Cognos is unclear. Overall, it seems that there are three major tools for financial monitoring depending on the individual preferences of the user. However, although the purchase manager uses reports from Cognos, they are still exported to Excel for data manipulation.

Davenport and Harris (2007) have emphasized that there are other aspects of financial analytics that companies need to address. These involve explaining financial performance from factors that are considered non-financial. This involves asking questions like "which activities have the greatest impact on business performance?" and "how do we know whether we are executing against our strategy?" (Davenport & Harris, 2007, p. 61). According to the CEO, when the board of directors makes a strategic decision, the company uses reports to monitor if sales and production volumes are according to plan *"we constantly use measures to verify that we are following our*

predictions, if the profitability is according to plan and if we have the growth as predicted" as put by the CEO. That way the company follows the results of the strategic decision.

Prognosis and planning

An analysis of the collected material shows that when a division manager views the production plans, intuition and experience are used to estimate if that plan is realistic or not. The production plans need to be carefully monitored as they are based on previous orders, and not all sales offices order in the same way. One example was given by the product line manager, when one sales office sent in an unusually large order and the system continued to use that number of products when predicting the next six months. The product line manager knew that this particular sales office usually orders once every quarter, so the production plans need to be spread out on three months instead of one.

Creating sensible prognosis is very difficult and demands a lot of data (Davenport & Harris, 2007), and as explained by the finance manager *"the only thing you can rely on is that it will never be as you expect it to be"*. According to both the controller and the finance manager, prognoses are mostly done when budgeting for the coming year. During that process of developing the prognosis, a thorough inspection is done on all products within each product group. Excel is, again, the main decision support tool, but Movex also has an important role. Production- and division managers provide Excel sheets with expected sales and procurement of raw materials for example within their product categories. A vast majority of the data comes from the sales subsidiaries by e-mailing Excel sheets. The data is then imported into Movex and various computing is done and then the data are exported back to Excel. This data provides the bases for all production planning in the coming year.

Predicting what is going to happen is probably more useful than reporting and explaining what already happened, but prediction is a difficult process that requires complex analysis and data (Davenport & Harris, 2007). There are essentially two major problems the company faces when developing a prognosis and predictions. One of them is the fact that sales offices have difficulties in getting accurate data from their customers explains the product line manager. The other problem expressed by all of the respondents, is the fact that the organization cannot easily access the data stored in the sales offices. Although all respondents expressed the problem of not being able to access the data of the sales offices, none of them particularly described it as a problem with respect to prognosis except by one respondent. The controller described how there is a risk that the main production plant could be producing products that end up on the shelves of the sales offices and stay there until they become obsolete. This fact can skew the production plans as the company is selling unwanted products to their sales subsidiaries. This is a well-known dilemma in literature (Davenport & Harris, 2007).

As described above, information is sent by email in spreadsheets because the main office cannot access the data from the sales offices. This means that there is possibly a huge potential to use more sophisticated prognosis in the future if the information stored in the sales offices can be imported into the DW, e.g., analyze the development of customer segments.

Manufacturing and quality

For many manufacturing companies, the production is the core of business. At the same time, the respondents express the priority of having sales offices close to the customers. That provides a basis for supporting large companies operating in a global manner, as explained by the CEO *"they can have the design department in one place and the production in another and we can support both"*. Moreover, the sales offices can be

used as platforms to enter new markets and establishing novel production facilities. Finding these new markets and locations for sales offices is mostly done by oral communication with sales representatives or at exhibitions. BI tools do not seem to be used for market analysis regarding new markets by the company headquarters, but the tools may be used to provide indications on such opportunities. The main focus of a manufacturing company is of course on production, but to gain some extra competitive advantage, companies might need to "get outside" of manufacturing so to speak. That could involve using analytics to analyze markets and price trends (Davenport & Harris, 2007). Today these trends and market analysis are usually done by the sales subsidiaries, but maybe in the future, some analytic tools can be used by the headquarters to help with the analysis resulting in faster decisions when appropriate. According to the empirical material, these types of analyzes are initiated by headquarters and then given to the sales subsidiaries as projects.

When the quality- and environmental manager wants to analyze defect rates, reports are exported to Excel for calculations and compilation. The company has a process to handle customer claims, but the quality- and environmental manager describes it as both times consuming and expensive. Customers return their products at their local sales office and then the product is shipped to headquarters for registration and analysis. This can be expensive, especially when considering the fact that there are 16 sales subsidiaries positioned world-wide, covering countries such as Brazil, China, and Australia. All of them send the products back to headquarters where they are analyzed and registered. When the problem is found, a report is sent back to the sales office via email, explaining the problem/cause and what actions to take. The report is then often forwarded to the customer. Once a month, an employee of the quality- and environment department compiles various Excel sheets for a monthly report on

customer claims. Currently, this is a time-consuming task and the quality- and the environmental manager claims that since the company is constantly expanding, this may become an even bigger problem in the future. Especially since the quality- and environmental manager claims that: *"there is too much workload included already".* Having some sorts of automated system that monitors these claims, could become important as the company grows he continues.

According to the controller, the company is overlooking its inventory in an effort to find products before they become obsolete. Producing products that end-up on the shelves in various sales offices can provide skewed sales information for headquarters as they sell their products to the sales subsidiaries. *"We could be producing products that are not needed anymore"* says the controller. This spawns the following questions, as put forward by the controller: *"are the products old and just lie there?; Is there someone else within the group that can use these products?; and can we offer the products to an old customer on reduced prices or do we need to throw them away?"* These questions require data from the sales offices regarding their inventory status, but retrieving this data is a complex process. The controller sends out an Excel template by e-mail that needs to be filled in by the sales offices. An alternative method, which is also used, is that the controller travels to the sales offices and tries to get the data out of their systems on-site. Davenport and Harris (2007) call this problem the configuration problem, which occurs at the intersection of sales and manufacturing, influencing the entire supply chain. This is the problem of making sure that the products offered are the products that the market wants. Many companies compete on configuration, some do well, and others fail like some of the well-known car manufacturers in the U.S. The mismatch between cars produced and customer desire created big problems for both Ford and General Motors. Deere and Company on the

other hand used analytics to analyze its´ inventory and configuration complexity. Two production lines were analyzed to find the optimal configuration resulting in a 15% increased profits of these two lines. Furthermore, the analysis resulted in 30 – 50% less number of configurations offered to customers (Davenport & Harris, 2007).

4.3 Analytical maturity

A framework to measure organization´s analytical maturity is presented in (Lavalle, Hopkins, Lesser, Shockley, & Kruschwitz, 2010). In an attempt to estimate the level of analytical maturity of the company in this study, the model, Table 1, will be used for guidance.

Motive: when companies use analytics to justify actions, they have already made decisions and use analytics to look back to see what happened. Those companies are categorized as Aspirational organizations. In this case the Company has matured from using analytics to justify actions and now even uses analytics to guide certain actions.

Functional proficiency: This category measures the ability to use analytics in specific functions within the organization. Aspirational companies use analytics mainly for financial management, budgeting, operations, production, sales and marketing. These areas are all mentioned by the respondents as being important areas. In the Experienced category, companies are using analytics as part of their strategic decision-making process and for business development. Furthermore, analytics are used for customer service and product research and development. Analytics seem to be more and more used for strategic decision-making, but quite late in the decision-making process. This concurs with Davenport and Harris (2007), when they say that companies that use spreadsheets usually do not use them until “the last mile” (Davenport & Harris, 2007, p.

168) in the decision making process. It could therefore be argued that the Company would fit the Aspirational category, with a slight touch of being Experienced, mainly because of their business development efforts.

Business challenges: If the primary business challenges involve reducing costs, with revenue growth as secondary, a company is considered to be Aspirational. To reach the Experienced level, companies have revenue growth as a primary driver for analytics and cost efficiency as a secondary one. In this case the company has put a lot of weight on revenue growth. Many of the respondents indicate product margins as one of their key performance indicators and describe how they need to make sure that products are increasing revenues. It is however hard to say that the company could fit entirely into the Experienced category because of the way actual sales numbers are brought in. Therefore, the company will be classified as Aspirational.

Key obstacles: Aspirational companies' key obstacles are found to be lacking executive sponsorship and that the organizational culture does not encourage information sharing. The organizational culture in this case does not seem to be an obstacle, but getting the information is. A key obstacle for Experienced companies tends to be a lack of skills within the line of business. Other frequent obstacles are that the ownership of the data is unclear and that data governance is ineffective. The analytical skills of the sales subsidiary's employees are unknown, but at headquarters, where the analytic processes are performed there does not appear to exist any lack of skills. Data ownership and data governance could on the other hand be an obstacle. The Company has subsidiaries in many countries, and needs to adapt to different rules regarding data communication. In some countries, there are national laws that you are not allowed to transfer financial

information between two companies in two different countries. The company is to a certain degree both categories, but to be able to move from one level to the next, all obstacles within a level need to be addressed and solved. The company would therefore be placed in the Aspirational category.

Data management: Aspirational companies have limited ability to capture, aggregate, analyze or share data and information and that does apply to the company in this work to a certain degree. Sharing and capturing data regarding production is not a problem. Although the actual sales figures from the subsidiaries arrive by e-mail and in Excel sheets, they do arrive once a month. The company could be viewed to have good and strong ability to capture all data except actual sales. The effectiveness of information sharing could in some cases be said to be limited. This is expressed by the CEO who says that the company needs to find better ways to share information. The problems of capturing data from the sales subsidiaries put the company in the Aspirational category, but if, e.g., sales data and customer claims were to be automatically imported to the central DW, the company could reach the Experienced level.

Analytics in action: Companies that lack rigorous approaches to make decisions and rarely use insights to guide future strategies or day-to-day operations are considered to be Aspirational. In this particular case, the company seems to use some rigorous approaches to make decisions, but as explained by all of the respondents, they use their experience just as much as hard facts when making decisions. Most analytical activities are based on reports regarding productivity, products, sales and various profit calculations. Although the company does not seem to use analytics to guide future strategies extensively, some strategic projects are currently being implemented where

analytics are being used to find decision-making materials. The company could be categorized as Aspirational, but on its way to the Experienced category if insights are more applied to guide future strategies.

Based on the analysis, the results are displayed in Table 2. The company in this case study seems to be more in the Aspirational category but slowly moving towards the Experienced category. In some areas, e.g. key obstacles, the company seems to almost fit into all categories, but to be able to advance from one category to the next, all requirements must be met. There are many possibilities to improve and mature in analytical usage and the company seems to have many of the prerequisites to do that.

Table 2: Analytical maturity based on the analysis (from Lavalle et al. 2010)

	Aspirational	Experienced	Transformed
Motive		Analytics are used to guide certain actions (e.g. strategic decisions)	
Functional proficiency	Analytics used for financial management, budgeting, operations and production		
Business challenges	Main focus on cost efficiency and cost management More focus is being put on revenue growth		
Key obstacles	Main obsticle for further maturity is how information is shared Data ownership is problematic due to locations of the sales offices.		
Data management	Ability to effectively share information is limited		
Analytics in action	Analytics used late in the decision-making process Employees use experience just as much as hard facts when making decisions		

4.4 Explaining and motivating the current analytical maturity

In the previous chapter, the analytical maturity of the case company was extensively evaluated and motivated. Still, since the case company had been on their BI endeavor since 2000, we were interested in broadening the discussion on why the progress was at current phase, what areas they could focus on to increase maturity, and

if there were opportunities and hinders that the company are facing that had not been considered or handled. According to Lavalle, Hopkins, Lesser, Shockley & Kruschwitz (2010), the best performers in their study were using analytics in financial management and budgeting. That area of usage seems therefore to have come furthest (according to the survey) and could therefore provide guidance on what areas the company should focus on when establishing a strategy to develop BI maturity. Therefore, to ground the discussion in existing literature, we have chosen to apply the critical factors for success (CSF) with business analytics system, presented by Shanks & Bekmamedova (2012). Other published work on critical success factors (Yeoh & Koronios (2010) and Olszak & Ziemba (2012)) focuses on CSFs for implementing BI systems; however Shanks & Bekmamedova (2012) have presented results from a project where they studied a large Australian financial services firm and found critical success factors that helped increase analytical maturity. In addition, when appropriate, we also use complementary theory as a means to introduce different perspectives and for being able to make the discussion concerning our case study as detailed and extensive as possible.

Shanks and Bekmamedova (2012) propose the following factors as critical for being able to achieve long-term success and evolution of a business analytics system:

- High-quality technology and data infrastructure
- People with business analytics, banking and interpersonal skills
- Embedding business analytics within the business
- Continuous evolution
- Senior management support and involvement

These critical factors are proposed as a theoretical framework for process oriented evolution of BA capabilities to explain how benefits are achieved

incrementally over time (Shanks & Bekmamedova, 2012). In the following sections we discuss the findings from our case study in light of the factors given above?

High-quality technology and data infrastructure

O´Donnel, Sipsma & Watt (2012) have shown that data management is a top three priority among business intelligence practitioners and much of the interest is directed towards data quality and data access/availability. Watson and Wixom (2007) also emphasize the importance of data quality as a key to BI success. Data quality and data availability were also highly important issues that emerged from the case study. The case-company had, as previously described, problems in acquiring all the data they needed to populate the data warehouse. Internationally distributed sale sites created major hinders for an enterprise-wide, integrated data storage. Still, acquiring the data from a technological perspective was not the major obstacle and the financial manager expressed that once the data was integrated, it was trustworthy and reliable. The real challenge was rather defining how the data should look like and making sure that various staff members understood different concepts in a similar way. As an example; when head office was discussing manufacturing margin, the sales offices weren't necessarily calculating the margin in the same way, according to the CIO and the same products could have different names as explained by the analyst. This is supported by the controller who described how following up on book keeping practices was one of his major tasks to ensure alignment with head office. The CIO emphasized that defining data and agreeing on interpretations of various concepts was a lot more challenging than the technical side of populating the data warehouse. In addition, the CIO also indicated that varying national legislate aspects, regarding data storage and reporting to tax authorities, also contributed with pitfalls when trying to populate an enterprise-wide DW.

If trying to explain the current standing in the case company, with this particular success factor proposed by Shanks and Bekmamedova (2012), one must conclude that the company still is far from being sophisticated in this matter, since they clearly have problems with both defining data and incorporating data into the data warehouse. Thereby, in order to leverage current maturity, the case company is advised to resolve these issues. A lesson learned according to the CIO is that companies need to emphasize more on the human part with respect to data quality; specifically on data definitions and concept understanding. From a pure technological point-of-view, there seems to be no issues. The data warehouse was up and running and many employees were using well established BI tools like Cognos, Excel and MS Reporting services. This is not to be taken for granted, since O´Donnell et al. (2012) presents evidence that many BI managers are struggling with users´ unwillingness to use the BI-tools directed to them.

People with business analytics, professional and interpersonal skills

The results of the case study reveal that the people in the company, in general, had strong professional (Shanks and Bekmamedova´s case study is from a financial organization, in being general, we have replaced the concept banking to the more general concept profession) skills and good interpersonal skills, whereas analytic skills was limited to an elite group of personnel closely related to the development project. During the interview with the CIO, it became evident, that training the appropriate personnel in business analytics related topics was a top priority in the current development plan for the project. This is not unusual, O´Donnell et al. (2012) has shown that engaging and user training is a top three priority among business intelligence practitioners. As demonstrated above, the usage of BI tools seems to depend on individual preferences. The product line manager used Cognos, the purchase manager used MS reports while the controller relied on Excel. However, according to the CIO, it

is not necessarily the tools that the users need more training in, rather, it is getting better at analyzing the data provided by the tools. Having the competence to understand and interpret the data in a correct and useful way is more important than knowing how to get the reports on the screen according to the CIO. Furthermore, Shanks and Bekmamedova (2012) emphasize on having good communication skills to be able to communicate the potential of BA and what effects BA can have on business processes and decision-making. To be able to communicate the benefits, these persons need, besides general communication skills, to also have profound analytical skills and an in-depth knowledge of company products (Shanks & Bekmamedova, 2012). In the case company there seems to be a limited amount of people that have both extensive analytical skills and in-depth company product knowledge. That could be preventing better communication regarding the possibilities of enhanced BA usage. The company supplies thousands of different products and has many product and production managers responsible for various product groups. Having an in-depth company product knowledge as descried by Shanks and Bekmamedova (2012) can be a real challenge when the company provides that high amount of various products. However, as expressed by the CIO, as soon as the managers for central processes, such as sales and purchase, started to demonstrate the value of the new BA capabilities, other managers started to catch on and demand similar solutions adapted to their needs. According to the CIO, the sales manager and the purchase manager were the strongest communicators of the benefits that could be achieved by BA, and had the most skills both regarding analytics and company products.

Embedding business analytics within the business

Investing in BI solutions are massive undertaking and the mere time duration of these projects raises several important issues that need to be handled, if organizations are to

achieve the benefits accounted for in literature and by practitioners. Firstly, the CIO constantly returned to the need of establishing an analytical culture, when asked about crucial issues that need to be dealt with if becoming successful. The CEO and the quality manager also emphasized that the company needs to improve the overall internal flow of information to increase effectiveness. This included both between the sales subsidiaries and internally in the head office. In literature, regardless if the noun used is an attitude, commitment, perspective, culture, mindset or even approach, many advocate the same need (Davenport & Harris, 2007; Watson & Wixom, 2007; Wixom & Watson, 2010; Shanks & Bekmamedova, 2012). Watson and Wixom (2007, p. 98) even express that: "Senior management should […] insist on the use of information based decision-making". Still, as indicated by Lavalle, Hopkins, Lesser, Shockley, & Krunchwitz (2010), changing how decisions are made, from personal experience/gut-feeling to insight driven, is very hard, especially if the data counters long accepted facts. Therefore, reaping low-hanging fruits is a common advise proposed in literature (e.g. Davenport and Harris, 2007; Lavalle, Hopkins, Lesser, Shockley, & Krunchwitz, 2010), for any organization developing a BI-solution. This was also done in the case company. The CIO expressed that the lowest hanging fruit in the case company, when advocating for investing in a BI-solution, became the potential benefits of being able to integrate sales data from various internationally distributed sales subsidiaries. The CIO explained that before they had a BI-solution, managers in the company were often debating what the monthly sales reports actually meant, complained that the reports were practically useless, and definitely did not support any insight driven approach. The CIO also contrasted the pre-BI complaints, by indicating that once the BI solution was up-and-running, it only took a short while before managers in different positions started asking for sales statistics. Furthermore, they started to require a much higher frequency of the

reports, and the reports actually became a baseline for decision-making even at the board-meetings. Although many of the senior managers in the case company have started to use the BI solutions it cannot be said that the company has managed to create an analytical culture or managed to incorporate analytics into business strategy. The usages seem to focus more on looking in the rearview mirror and seeing what has happened instead of looking forward and use analytics to guide business decision.

Continuous evolution

When looking forward and discussing evolution of BI usage the analyst describes the need to integrate the various systems into one homogeneous environment to facilitate information gathering from the external sales subsidiaries. This is supported by the purchase manager who said it was very important to import more data from the sales offices to the data warehouse. The CIO on the other hand, emphasizes on the fact that the company has made an effort to standardize data definitions and providing templates, but the real problem is increasing user analytical capabilities.

As companies gather more information, the more important it becomes to have a specific information agenda (Lavalle, Hopkins, Lesser, Shockley, & Kruschwitz, 2010). According to Lavalle, Hopkins, Lesser, Shockley, & Krunchwitz (2010), having an information agenda involves creating an information foundation that is integrated, consistent and trustworthy. Without information agenda, the alignment between IT and business goals will be skewed. Those who manage data and information will not provide the support needed for those who drive the business and set business strategies. Having wide-ranging information agenda for the organization as a whole creates the foundations for analytic activities that support business goals at any given time (Lavalle, Hopkins, Lesser, Shockley, & Kruschwitz, 2010). According to Lavalle, Hopkins,

Lesser, Shockley, & Kruschwitz (2010) the company should have information governance policies, data architecture, data currency that spans from historical data to real-time data, data management processes and analytical tool kits based upon individual needs. In the case company they had been working on creating information policies by defining data and communicating with the sales offices and from a technological point of view they have been working on data architecture, data currency and data management. But that seems to have been something mainly done in the IT department as there seems to be no clear overall strategy regarding the information agenda.

Senior management support and involvement

Watson and Wixom (2007, p. 98) states that: "For BI to be useful on an enterprise basis, it must be driven from the top". Initially the main champion for the BI project was the CIO. As described above, initially the focus was on the sales process as it would have the greatest effects on the company. This can be seen as some sort of a "proof-of-concept" or as described by Davenport and Harris (2007) as the "prove-it detour". Davenport and Harris (2007) provide four essential steps to take when going the "prove-it detour". The first step includes finding a sponsor and a business problem that demonstrates the effects of analytic capabilities. This project had the CIO as a sponsor, ensuring that it would get the resources needed according to the CIO. The next step is to implement a BI solution in a specific project or a process. This concurs with the CIOs description on reaping low-hanging fruit as a way to gain momentum in their BI endeavor. The third step is to document the benefits and share with key stakeholders. As described above by the CIO the managers of the company complained about their reports before the BI initiative, but after demonstrating the new reports the project started to gain momentum and managers from various departments in the company

started to demand similar solutions for their departments. That concurs with how Davenport and Harris (2007) describe the final step of the prove-it detour. Companies should continue to build on smaller, localized successes until there is an acceptance in the company that this is the way to go.

5. Conclusions

In this paper, a complex-systems company has been studied with respect to its current usage of BI tools and its BI maturity level. To the best of our knowledge, no similar study has been reported in the literature regarding BI usage in complex-system companies. Thereby, our work contributes in increasing the knowledge regarding BI application in complex-system companies. However, a single case study is limited to the particular settings and context of the company at hand, making generalizations inappropriate. Therefore, further studies towards complex-system companies are needed, in order to describe how this type of companies makes use of BI.

We have provided details that explain the current maturity level of the case-company. From a technological point-of-view, there are no major problems. However, the current maturity level after 10 years is due to pitfalls such as:

- Conceptual modelling, how to define data, and make sure that various staff members interprets the concepts in a similar way.

- National legislates aspects, how to store and report data with different national legislations, e.g., storage and reporting to tax authorities in an international setting is problematic when populating an enterprise-wide DW.

- Analytical culture, how to increase the analytical capabilities among the staff.

Our results also show that the case-company is rather immature, still working on fulfilling most of the critical factors for success brought forward in the previous section. Therefore, we advocate that further research is needed to verify if complex-systems companies are less BI mature. Even more interestingly, if it turns out to be true, it would be important to investigate why.

One could speculate if varying analytical maturity stems from differing business models and ways to conduct business. Volume-operations companies may need to mature faster with respect to their analytical usage, as they often build their business models on analytical technology, whereas complex-systems companies, as demonstrated in this case study, still may be successful in their particular industry, merely using their BI tools for modest analytical and explanatory purposes. However, we find no evidence in literature presenting well-grounded reasons and therefore, this particular topic needs more attention.

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