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Master's Degree Project in Innovation and Industrial Management

The impact of Big Data on the business performance of Swedish-based companies

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Abstract

Big Data has the power to transform entire business processes and improve current business activities. Many organizations seem to understand the benefits that Big Data can offer to their business, especially its meaningful potential business value but they find several difficulties in adopting it, mainly because they are struggling in finding ways of exploiting the derived insights to improve their business. New Product and Service Development are two very important business processes that have been proven to hold a considerable role on the viability of an organization and if these insights are capitalized, they can offer additional business opportunities. New data-driven and customer centered products as well as services can be developed offering a sustainable competitive advantage and new revenues streams to organizations aiming for an improved lifestyle to the society.

This paper attempts to conceptualize and explore the impacts of Big Data in the business performance, due to its high strategic potential and it also explores if and how Big Data and its related technologies are leveraged in the processes of New Product and Service Development. A qualitative study acts on combining prior Big Data studies with diverse Swedish-based firms from various industries that utilize Big Data aiming to explore and compare key essential features of Big Data especially with regards to its effect on business performance and its utilization in the New Product and Service Development. Furthermore, this research uses the grounded theory.

Empirical findings show that the companies which have implemented a data-driven strategy in their operations, are able to see a positive dependence of Big Data to their business performance, while the companies that have not established a data-driven mindset yet in the whole organization, try to tackle the challenge of lack of understanding of how to utilize Big Data technologies to create potential value and accomplish their business goals. Other crucial factors that affect the implementation of a data-driven strategy is the quality of collected data, availability of data, legal aspects of the data privacy and security and highly skilled personnel working with Big Data. Therefore, companies ought to think and make strategic decisions using a holistic view about Big Data integrating their employees, processes and technologies into their operations to achieve effectiveness and efficiency.

Keywords: Big Data, Big Data Analytics, Business Development, Data-driven innovation, Data-driven culture, Business Performance, New Product Development, New Service Development

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1. Introduction

1.1 Background and Problem Statement

During the last decade, society has witnessed a severe digital revolution which has transformed our lives. Every day we use several emerging technologies in this increasingly digitized world, such as social media, mobile phones, analytics software, cloud, 3D printing, nanotechnology, sensors, wearable and biomedical devices, generate a vast amount of structured and unstructured data. A touch on our mobile phone or tablet touchscreen, a click on our computer mouse or touchpad or a button press on our computer keyboard gives an immediate notification to organizations that we looked or used their services. In turn, these companies gather information about our behavior and preferences. Collection of all this data has taken on the name "Big Data", mainly because their massive, exploding and unprecedented quantity rules out the capability for traditional data-processing software tools to capture, store, manage and analyze it as a result of the aforementioned technologies as many researchers refer to (Gartner IT Glossary, n.d.; Manyika, 2012; TechAmerica Foundation, 2012).

Data-driven innovation is flourishing day by day having brought up several disruptive changes in the way companies create value (Xie et al., 2016). Big data can offer new business opportunities to firms and provide them with business value independent of the industry they belong to, as it has proven to have a strong effect on the sectors of health care, transportation, online advertising, energy management and financial services (Ragupathi et al., 2014, Al-Jarrah et al., 2015). If it is to be leveraged, they can provide significant competitive advantages to organizations, since they always strive to survive, differentiate and thrive in a highly competitive and fierce business global environment. The ability to analyze and examine Big Data through specialized technologies and tools and with whom firms can gain information and insights of what actions need to be implemented, and to make better and faster decisions and predictions in the short-and-long-term future is called and depends on Big data analytics, which is a strategic asset for many firms today. These insights can help them to better understand their customer needs and preferences, tap into new markets, and thus, generate new sources of profits, and improve firm performance (McAfee et al., 2012).

New product development (NPD), new service development (NSD) and servitization were chosen to be examined by this research, because they are business activities that are part of business development, which can affect the overall business performance. The concepts of NPD, NSD and servitization have allowed firms to maintain their competitive advantage by creating value for their customers and new revenue streams for themselves. Data can provide companies with creative initiatives and disruptive ideas and especially Big Data analytics is a valuable tool for this purpose, since it provides a pluralism of real-time information, insights and inspiration regarding value-added customer experience and several business opportunities. There is great potential for the deployment of information systems and statistical software to be combined with NPD, NSD and servitization, but there is limited research into the role of Big Data in this field from a management perspective. Since the trend of the implementation of Big Data analytics has already been grown, particularly in large corporations, the researcher finds it very interesting to examine and understand the worth of Big Data and Big Data analytics in the aforementioned fields.

1.2 Purpose of the Study and Research Questions

This paper will mainly combine the existing literature on Big Data, Big Data analytics, new product and new service development, and servitization with practitioners' points of view about these issues implementing a field study, in order to 1) identify the benefits and challenges that several Swedish-based companies face when attempting to leverage Big Data for creating new business opportunities and the ways they exploit insights from Big Data to improve their business performance, 2) examine the reasons behind

the difficulties a lot of companies face with Big Data analytics and new product and service development 3) whether Big Data analytics provide them with insights regarding new product and new service development, servitization, or other innovation processes, or not.

The objective of this research is to explore the role of Big Data from the perspective of business performance and New Product and Service Development regarding Swedish-based companies and how it is managed and being applied for improving business and operational activities, which is strongly influenced by New Product and Service Development. By having an overall image of the processes and the usage of Big Data in the New Product and Service Development process of the companies via the empirical findings and the related literature, the researcher aims to provide a basis on where Swedish-based companies (incumbent, small and medium sized, and start-up companies) should focus their efforts to tackle the challenges they face in handling and analyzing the massive and diverse data in order to become more data-driven and gain competitive advantage in their sector through their offerings. In addition, this research concerns not only the strengthening of the existing literature regarding Big Data and business performance, but also it can provide international companies that want to bestir themselves to the Swedish corporate scenery and specialize in Big Data with valuable information about the Swedish data-driven corporate culture.

Although the evolution of the Big Data concept has led the researcher to get engaged with this, the existing literature regarding the usage of Big Data in the New Product and Service Development was found out to be limited, while the one regarding the usage of Big Data in the enhancement of business performance was more than adequate. Moreover, most of the case studies that are presented within the literature regard US or US-based companies and it has not been given a sufficient attention to European and more specifically Scandinavian or Swedish-based companies. Therefore, the researcher's goal is to fill the gap in the literature trying to find out the managerial implications of an effective usage of Big Data by Swedish-based firms in the New Product and Service Development for a successful business performance and growth. Thus, by combining the exploratory research on the role of Big Data in business performance and specifically in the NPD and NSD processes with empirical findings from varied corporations, the researcher intends to address and answer the main research question:

- *What is the impact of Big Data on the business performance of Swedish-based companies?*

There is another sub-question which will be a valuable aid to the researcher in answering the primary research question:

- *What is the impact of Big Data in the New Product and Service Development of Swedish-based companies that affect their overall business performance?*

1.3 Empirical Setting

Sweden has a significantly strong position from an international perspective regarding organizations that are engaged with the Big Data initiative, Big Data analytics and their related areas. Their effective exploitation is rendered as extremely important and both Swedish private and public, international and local, incumbent and small and medium sized organizations within traditional industries, the increasingly advancing digital services sector and in other emerging businesses have it as a driver for creating competitive advantage and potential value. This group of organizations together with well-known universities and institutes form a group of interest about Big Data. In addition, Sweden appears to have a lot of strong private companies in data intensive sectors with an international interface, such as Ericsson, Volvo, Spotify, SKF, etc., and together with the country's extremely intensive GDP expenditures on innovation and entrepreneurship globally that can lead to a Swedish data-driven innovation, form the reason of selecting this setting for this research to be conducted.

1.4 Thesis structure

The paper will begin with a review of the different definitions, concepts and perceptions about big data and big data analytics, new product and service development, and their merits and challenges. In the second part, the analysis of interviews with expert managers from the companies of Vattenfall, Volvo Group, Fujitsu Sweden AB, Scania and Ericsson will be presented. The paper closes with the discussion of the interviews' findings combined with the theoretical contributions, some concluding notes and it provides guidelines for future research.

2. Literature Review

This part of the study will engage mainly with three different themes that were divided according to the interview guide that was used for conducting interviews with experts that work with Big Data inside their companies that are Swedish-based.

2.1 Big Data Understanding

2.1.1 Big Data Definition

Although Big Data is a widely used concept for improving business and operational performance, as it is evolving rapidly the last two decades, it remains confusing and unclear with regards to its universal accepted definition (Mayer-Schönberger & Cukier, 2013). However, Big Data is originated back to mid-1990s, according to a thorough bibliographic study of Big Data from 2011 to 2015 conducted by Mishra et al. (2017). Definitions of Big Data and its each feature may vary because they depend on how it is perceived and what technologies are being used by every industry or every organization. Every company or organization gives its own meaning on Big Data based on its size, complexity to analyze it and available technologies to manage and process massive data sets or face any other challenges may arise (Blackburn et al., 2017). Shi (2014, p.6) divides big data definition into two parts: one for academics, "Big Data is a collection of data with complexity, diversity, heterogeneity, and high potential value that are difficult to process and analyze in reasonable time" and one for businesses, "Big Data is a new type of strategic resource in the digital era and the key factor to drive innovation, which is changing the way of humans' current production and living".

Diebold (2012) mentioned that Big Data are probably originated from conversations among the Silicon Graphics Inc. (SGI) community in the mid-1990s, but it became pervasive in 2011 (Gandomi & Haider, 2015; Mishra et al., 2015). Gartner, Inc. (n.d.) was the first that gave a solid and the most widely accepted definition so far to the concept of Big Data characterizing it as "high volume, high velocity, and/or high variety data that require new processing paradigms to enable insight discovery, improved decision making, and process optimization", a term that the author of this paper also agrees with (Gartner IT Glossary, n.d.). TechAmerica Foundation gives its own definition: "Big data is a term that describes large volumes of high velocity, complex and variable data that require advanced techniques and technologies to enable the capture, storage, distribution, management, and analysis of the information" (TechAmerica Foundation's Federal Big Data Commission, 2012, p.10). Manyika et al. (2011, p.1) mentioned that "Big data refers to datasets whose size is beyond the ability of typical database software tools to capture, store, manage and analyze" without focusing on the data size, which is already increasing over time. Mayer-Schoenberger and Cukier (2013, p.11) state that "Big Data refers to things one can do at large scale that cannot be done at a smaller one, extract new insights or create new forms of value, in ways that change markets, organizations, the relationship between citizens and governments, and more". Another interesting definition given by Ohlhorst (2013, p.18) is: "Big Data defines a situation in which data sets have grown to such enormous sizes that conventional information technologies can no longer effectively handle either the size of the data set or the scale and growth of the data set".

Gobble (2013) referred to Big Data as the "next big thing in innovation", while Manyika et al. (2011) characterized it as "the next frontier for innovation, competition and productivity". Chen and co-authors (2012, p.1166), gave the definition below for Big Data: "Analytical techniques in applications that are so large (from terabytes to exabytes) and complex (from sensor to social media data) that they require advanced and unique data storage, management, analysis, and visualization techniques". Dubey et al. (2015, p.632) drawing upon the ideas of Sun et al. (2015) remarked Big Data as the "data whose sources are

heterogeneous and autonomous; whose dimensions are diverse; whose size is beyond the capacity of conventional processes or tools to effectively and affordably capture, store, manage, analyze, and exploit; and whose relationships are complex, dynamic and evolving". Most of the definitions presented in this section focus mostly on the characteristics of Big Data, which will be discussed further in the next part of the paper.

2.1.2 Dimensions of Big Data

Big data characteristics, which are also its challenges at the same time, remain also ambiguous. First, Laney (2001) suggested Volume, Variety and Velocity as three of the main challenges in data management. These three Vs were used as a common framework by many authors in the literature (Laney, 2011; Chen, 2012). Mishra et al. (2015) is based upon the work of Russom (2011) and presents several definitions of the three features. Volume, which is the most defining attribute of Big Data, represents the magnitude of data that is multiplied every year and is presented by Mishra et al. (2015, p.559) as the "large amount of data that either consume huge storage or entail of large number of records data". Variety reflects to varied data in type and source (structured, semi-structured or unstructured types of data from multiple sources, such as sensors, social media, digital devices, online stores, etc.). Mishra et al. (2015, p.559) defined it as "data generated from great variety of sources and formats contain multidimensional data fields". Velocity refers to the "rate at which data are generated and the speed at which it should be analyzed and acted upon" (Gandomi & Haider, 2015, p.138). Due to rapid technological advancements, quick accessibility of data requires most probably real time data and planning based on facts and evidence. Three more Vs were conceived as data's features: Value (introduced by Oracle), Veracity (introduced by IBM), Variability (added by SAS). The first one refers to the "economic value of different data" (Oracle, 2012, p.4), the second one, reflects the "unreliability inherent in some sources of data" (Gandomi & Haider, 2015, p.139) and a questioning data trustworthy or unreliability, as an evidence of the potential value of big data in information and the necessity of its integrity insurance. The third one represents the variance in the composition of data (Gandomi & Haider, 2015). Complexity was introduced by SAS as another dimension of big data revealing the difficulties of collecting, cleansing, storing and processing of heterogeneous and of huge quantity data. To sum up, organizations having a clear and overall image over these features and challenges can take advantage of Big Data and leverage it to acquire competitive advantage (Mishra et al., 2017).

2.1.3 Big Data Processes

Data processes vary among different companies and industries. However, according to Labrinidis & Jagadish (2012), as it is shown in the figure below and constructed by Gandomi & Haider (2015, p.141), data processes can be managed more easily for extracting insights after being divided into two categories: data management and analytics. The first group includes processes and related technologies for collecting and storing data in order to be retrieved for analysis, while the second one incorporates various techniques that can be used for analyzing and obtaining information from Big Data (Labrinidis & Jagadish, 2012 as cited on Gandomi & Haider, 2015).

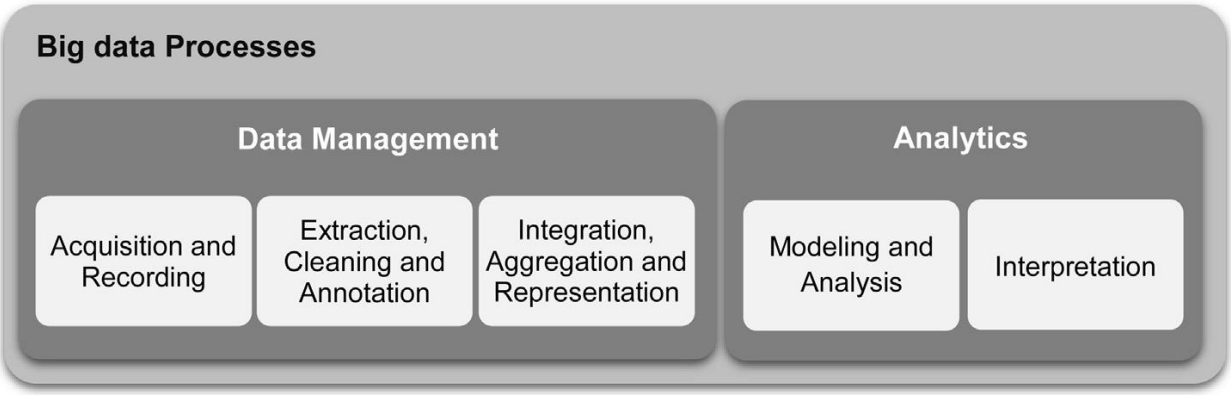


Figure 1. Illustration of Big Data Processes

"The increased volume and velocity of data in production means that organizations will need to develop continuous processes for gathering, analyzing and interpreting data. The insights from these efforts can be linked with production applications and processes to enable continuous processing" (Davenport et al., 2012). Therefore, companies by leveraging these processes will be able to achieve higher Big Data capabilities and optimize their functions.

2.1.4 Benefits of Big Data

Big data is changing the typical nature of business as we know it making it more digital and having a major role in every industry from "manufacturing to healthcare to retail to agriculture and beyond" (Marr, 2015, p.12). Big data can contribute to higher value through data discovery, generation, collection and exploitation methods. As we speak, Big Data is playing a major role in quick and effective decision-making and forecasting processes, such as business analysis, product development and other internal procedures (Wang et al., 2016). For example, in Manyika et al. (2011), McKinsey Global Institute reports that over half of the 560 examined US enterprises state that Big Data was a helpful aid for increasing their operational efficiency, choosing an appropriate information management strategy direction, and providing better customer service.

Davenport (2014), as cited on Lee (2017, p.299, 300), explicitly claims that "Big Data provides great potential for firms in creating new businesses, developing new products and services, and improving business operations, while the use of Big Data analytics can create benefits, such as cost savings, better decision making, and higher product and service quality". Big Data analytics can be described as a capability that "provides business insights using data management, infrastructure (technology) and talent (personnel) to transform business into a competitive force" (Kiron et al., 2014 as cited in Akter et al., 2016, p.2). LaValle et al. (2011) points out that Big Data analytics competence can create sustainable business value basing the decision-making on it. Wong (2012) admits that data gives the opportunity to firms to develop innovative products and services, such as innovative applications.

Empirical studies show that organizations that used data-driven decision making observed a 5-6% improvement in productivity, while those that employed business analytics and insights to provide differentiated products and services to their customers were among the top performers on their sector, since top performers approach Big Data analytics more actively and use insights in their daily operations, strategies and decisions (Brynjolfsson et al., 2012; LaValle et al., 2011). Moreover, Chen et al. (2012) point out that the implementation of Big Data in enterprises can result in superior production efficiency and competitiveness in many business aspects, such as on marketing, where companies can more accurately

make predictions about consumers' or customers' behaviors, on sales planning, where they can change their prices, on operation, where they can enhance their efficiency, allocate resources and reduce costs and waste, and on supply chain, where they can decrease the gap between supply and demand and offer better products and services.

Furthermore, according to Woerner & Wixom (2015) as cited in Günther et al., (2017, p.201), "organizations now have access to essential data needed to solve problems or gain insights that was not possible to collect before". Günther et al. (2017) also introduce the terms "portability" (the ability to remotely access and use digital data for not only one context of application but also for other contexts) and "interconnectivity" ("the ability to integrate data from various data sources) to explain how organizations can obtain value from Big Data. In the first case, data analysts and strategy makers across different organizations can have remote access of data and integrate them into their company's platforms or tasks, thus enabling an open-system sharing of data, which though can empower the challenge of data privacy and security, since data ownership is at stake and personal data can be leaked. In the second case, decision makers by extracting new useful insights from the combination of data from alternative sources, can upgrade their existing operational models and find new patterns. These features can influence potential data-driven organizational changes and a more unbiased decision-making, and their establishment can assist a transformation into a data-driven culture (ibid.).

2.1.5 Challenges in handling big data

Although there are many benefits and opportunities that Big Data application can bring to organizations, several challenges have been observed within the literature mainly related to its appropriate implementation into the business operations of organizations. For facilitating the reading of this study, challenges will be divided into three categories: data, process and managerial challenges. The first category is related to the data features that were described above (volume, variety, velocity, veracity, volatility and quality), the second one will highlight the techniques and procedures of collecting, integrating, editing and analyzing, and providing results which are an obstacle for several firms, and the third one will cover the business' struggle in implementing Big Data within its operations.

2.1.5.1 Data Challenges

Mishra (2015) mentions as technical challenges the management of different data types (structured and unstructured ones, variety), on-time response requirements (velocity), quick identification between reliable and unreliable data (veracity) and lack of sufficient sources for collection, storage and analysis of Big Data within a specific time frame. Volume was not regarded as a challenge for the authors due to the already existing and highly efficient IT infrastructure. Lee (2017) argues that finding the right people with advanced skills for forecasting needed to understand correlations and implement new models and techniques to transform structured to unstructured data is another difficult task for companies. In addition, data quality is required for an effective decision-making due to the high quantity of unstructured data and its collection from a wide bunch of sources (Gandomi & Haider, 2015). In addition, data quality is crucial, because if data are unreliable, imprecise or incomplete derived from many different sources, then false information will be generated, and this can have a negative impact on the quality of data-driven products and services for both organizations and society (Günther et al., 2017).

2.1.5.2 Process Challenges

Wang et al. (2016) argues and analyzes the challenges of data capturing, storage and security, data analysis and visualization due to data complexity and huge data sets, and design of system architecture or platforms for data processing. Therefore, data management is challenging for companies, since they engage with huge and semi-structured or unstructured data sets found in too many data warehouses and a company's capability to extract useful information out of data is affected negatively (Chen & Zhang, 2014). Morabito (2015) claims that companies find it difficult to tackle challenges in identifying the right data and address the potential advantages that the data can offer to them. In several companies, new methods, activities and tools are needed to be exploited to resolve the challenges of "data acquisition and warehousing", "data mining and cleansing", "data aggregation and integration", "data analysis and modelling" and "data interpretation" (Sivarajah et al., 2017, p.273, 274). These can deliver except for an efficient Big Data management and achieving an optimum impact and business value creation but also providing with technical solutions regarding Big Data processes.

2.1.5.3 Managerial Challenges

Businesses should have a specific type of data governance that gives access to relevant data to certain employees and staff depending on the reasons they want to use it (Sivarajah et al., 2017). In addition, several enterprises are not always able to find the appropriate analytics tools and data analysts with statistics, computer science and management knowledge, expertise that is required for Big Data analytics in order to understand and interpret data in ways that it can give meaningful business insights back to them (Lee, 2017). LaValle et al. (2011, p.24) pointed out that the biggest obstacle for most of the examined organizations was "the lack of understanding of how to use analytics to improve their business". Due to the evolving nature of Big Data technologies, companies should invest more in these and introduce innovative services to their operations in order to have the right IT infrastructure for Big Data analytics. This is a result of having unclear goal objectives in several Big Data projects (Lee, 2017). Furthermore, digital businesses need to respect evolving legal frameworks around data privacy and intellectual property (IP) protecting personal data, but data's privacy and security rendered as difficult due to the massive data volume and data complexity making it vulnerable to cyber-attacks. Maturity of Big Data technologies can lead to extensive collection of sensitive personal data, but lack of consent from individuals raises serious concerns about data privacy from the companies (Lee, 2017). The GDPR initiative, which highlights the human interference and consent on how several companies use their data putting some limitations on their practices, can be a potential solution to this challenge. Further, data security can lead to resistance of Big Data adoption and to financial losses and damage to a firm's reputation (Lee, 2017). Another challenge that is presented in the literature is the inadequate understanding of Big Data's potential value in the business processes by many executives inside companies (Morabito, 2015) and its sharing within different departments of a company or with other business partners due to lack of control over its usage and ownership (Sivarajah et al., 2017).

2.2 Big Data and Business Performance

Several research studies focused on the business implications of Big Data. Manyika et al. (2011) in McKinsey report underlined that Big Data can enhance productivity, efficiency, quality and competitiveness of both public and private enterprises' operations creating value for their customers. McAfee and Brynjolfsson (2012) indicated that Big Data can provide organizations with improved business opportunities, decision-making and firm performance by enhancing several internal activities and

processes, such as customer relationship management, and managers would be able to take decisions based on facts rather than their instincts, while Davenport et al. (2012) propose that Big Data is the basis for developing a wide variety of innovative services, which can lead to the creation of new corporate intangible assets thus enhancing the competitive strategy of a firm by exploiting combined information from several data sources and applications. Davenport (2014) claims that organizations may combine external data (data generated from external sources, such as purchased data, open data, sensor or IoT data) with internal ones (data collected from ERP and transaction systems, and sales, financial or other departments) to extract value out of it becoming a valuable tool available for decision makers inside organizations. In this context, Big Data is closely connected on how organizations form their strategies using specific measures and indicators that provide input to the strategic decision-making (Pfeffer and Sutton, 2006) and how they assess and act upon the behaviors of their internal and external environment. By utilizing these strategies effectively, modern firms can improve their inspection of insights for different attributes and their accuracy of predictions for future events (Constantiou & Kallinikos, 2015), but Big Data models and tools should be also improved continuously and significantly to support the decision-making and the business objectives in order for the challenges that were described above to be resolved.

According to Brown et al. (2011, p.2), competencies in Big Data can challenge competition by "transforming processes, altering corporate ecosystems, and facilitating innovation", not only for private companies, but also industry-wide and nation-wide since effective improvements in productivity, innovation and competitiveness can be observed out of its effective exploitation (Mishra et al., 2017). Recent studies on business implications of Big Data claim that it is a valuable tool for perceiving better the business environment (Davenport, 2014), however, Constantiou & Kallinikos (2015) underline that the competence of having the right strategy tools is not sufficient for interpreting Big Data trends with regards to new business opportunities. Data's potential value can be optimized if organizations introduce effective IT tools and technological procedures to convert this highly diverse data into meaningful insights (Gandomi & Haider, 2015).

Furthermore, several studies have highlighted the crucial impact of Big Data analytics to firm performance. Their relation together with their alignment to the business strategies tends to improve sales, profitability and market share (Manyika et al., 2011) and return on investment (ROI) (McAfee and Brynjolfsson, 2012), which are important indicators of measuring firm performance and in addition, can bring high sales and market share growth (Akter et al., 2016). Data mining and Big Data analytics technologies can provide hidden patterns and valuable recommendations of business performance elements (Campos et al., 2017). Wixom et al. (2013) indicate that leveraging insights from Big Data analytics can improve business performance by enhancing the productivity of both tangible (e.g. usage of more digital reports than paper ones) and intangible (e.g. company reputation) assets. As LaValle et al. (2011) indicates one of the greatest opportunities but also challenges is the adoption of Big Data analytics into daily operations to attain business goals, which should be defined before extracting insights.

2.2.1 Data-driven Decision-Making

However, a prerequisite for these actions to be established inside companies is the corporate top management to strongly agree and support a data-driven culture and decision-making, as they can drive growth, increase the strategic value of a firm and enhance its business performance (Wong, 2012). Organizations have the opportunity to leverage data and analytics to become data-centric regarding to various strategies and decision-making, but this requires sacrifices, such as changes in a firm's mindset and culture (ibid.). Business Intelligence (BI) is a valuable tool for decision makers. In Frolick & Ariyachandra (2006, p.42) is defined as "a broad category of applications and technologies for gathering, storing, analyzing, and providing access to data to help enterprise users make better business decisions". However, although it provides companies with the right methods and technologies to draw Big Data insights and

optimize their decisions, its drawback is that it is not systematically aligned with the implementation of the strategic business goals (Frolick & Ariyachandra, 2006). Further, a firm needs to introduce and exploit some organizational capabilities (KPMG report, 2015). For example and according to some worth mentioning points of the report, it is important for a company to be able to distinguish between structured and unstructured data and then apply this knowledge to improve the business structure, the decision making based on market predictions and their financial/investment insights. If companies understand the knowledge that Big Data offers, they can gain insights which capability gaps are needed to be filled and on the competitive advantage that products and services can be offered, and thus leverage that information in enhancing the production. Big Data can also play a significant role in recognizing fast developing and financial opportunities, thus making the decision-making process more effective. Finally, it is important to pinpoint that the developed understanding of Big Data in combination with the more effective decisions, can help a company yield more efficient metrics and indicators in order to measure profit and success compared to other companies in the market. Brynjolfsson et al. (2011) examined 179 large enterprises and found out through an econometric analysis that adopting a data-driven decision-making has resulted in 5-6% higher output, productivity, market value and profitability metrics, such as Return on Equity (ROE). If we take into consideration the ideas that Barton et al. (2012) propose, we can find out that with the appropriate handling of empirical data, several organizations can convert information to actions. In this way, the decision-making processes become more efficient and faster, and at the same time, they are able to augment the precision of predictions and formulate plans for different situations. However, in order to take advantage of the full potential that this data can offer, they propose several requirements needed to be established mainly from the top management that will help that effectivization. Firstly, introduce and support a structured planning of how data scientists can collaborate with employees from other departments to use in practice Big data, its analysis and apply the extracted insights in real-life cases, secondly, educate the employees to understand how to utilize and manage the Big Data technologies and capabilities in order to manage better different projects and optimize various processes, and thirdly have the appropriate IT infrastructure (Barton et al., 2012).

2.2.2 Measures of Firm Performance

"Performance measurement focuses on the insights, inferences, and analysis of the processes or events that have taken place to measure corporate performance" (Appelbaum et al., 2017, p.35). According to Simons (2002), performance measurement systems help managers to track whether the implementation of business strategic goals by comparing real-time results is achieved or not (Sharda et al., 2013). A performance measurement system typically comprises of setting business goals together with periodic feedback reports that signifies any progress that occurs (ibid.). In this section, there will be presented in summary the most important performance metrics found in the literature.

The term Business Performance Management (BPM) is a model that firms usually use for measuring, monitoring and managing business performance through several business processes, methodologies, metrics and technologies (Sharda et al., 2013). It encompasses three key components (Colbert, 2009 as cited in Sharda et al., 2013): 1) A specific group of integrated and analytic processes that focuses on financial and operational activities. By incorporating these processes firms can achieve an optimum performance by setting certain goals and objectives (strategize), implementing different drivers to meet these objectives (plan), monitor how actual performance is accomplished periodically (monitor) and take corrective action (act and adjust). 2) Tools for defining strategic goals and then measuring and manage performance to attain these goals, 3) A set of processes, from operational planning to continuous reporting, modelling and monitoring of Key Performance Indicators (KPIs), all linked to organizational strategy that provide value to the business. Through KPIs, firm executives are able to measure and extract the most important performance insights that enable executives to understand the performance status of their businesses. In addition, they can monitor internal business activities and take the best possible decisions and actions to enhance their business performance, closely aligned with the general business goals (Tedeschi & Spann,

2013). They measure diverse operational areas, such as customer performance (metrics for customer satisfaction, speed and accuracy of issue resolution, and customer retention), service performance (metrics for service-call resolution rates, delivery performance, defects rates and return rates), sales operations (new sales channels), and sales plan or forecast (metrics for price-to-purchase accuracy, forecast-to-plan ratio) (Sharda et al., 2013).

Business analytics is a pervasive tool in many companies' strategic analysis and employed for assessing the firm performance. It is defined as "the use of data, information technology, statistical analysis, quantitative methods, and mathematical or computer-based models to help managers gain improved insights about their operations, and make better, fact-based decisions" (Davenport & Harris, 2007, p.7). These include a wide range of approaches, technologies and tools, such as data mining, machine learning, unstructured text analysis, artificial intelligence, business intelligence, data visualization and other tools that can provide organizations with insights from huge, complex, internal and external data sets (Davenport, 2013). Wang et al. (2016) defines data mining as "the collection of artificial intelligent techniques that mine hiding knowledge and patterns from given data and includes classification, regression and clustering". Machine Learning is another part of artificial intelligence, which has the ability to "understand" patterns of behavior from the collected data. Once the algorithm understands how these behavior patterns function, it can produce valuable conclusions that can help in many business aspects. These tools can help them also to make more accurate, smarter and faster decisions in every Big Data procedure, such as data acquisition and storage, data cleaning, data analysis, data visualization and those insights can be used for creating predictive models that can be applied and facilitate business and other processes or accomplishing several business objectives (Blackburn et al., 2017). It can also improve decision-making and increase organizational gains (Sivarajah et al., 2017). Saggi and Jain (2018) summarize three types of analytics:

- Descriptive analytics use raw data to find out what has happened in the past to define the state of a business situation that can be developed further, and its tools are descriptive statistics, Key Performance Indicators (KPIs), dashboards or other kinds of visualization
- Predictive analytics use raw data to find out what might happen in the future (forecasting and estimation of future events). Predictive and probability models, forecasts, statistical analysis are tools that are commonly used.
- Prescriptive analytics use data to identify the actions that are likely to result in the best and most effective outcomes under predetermined conditions with limited costs and business risk. Social media can be used for projecting changes in market or customer behaviors or in business, economic and governmental level.

The last category of analytics should be prioritized in strategic analysis in order for companies to accomplish a higher rate of operational benefits, but they require high-quality planning and resources, effective execution, a data-driven culture inside the company and monitoring of the employees' actions (Davenport, 2013). Predictive analytics combining machine learning algorithms with insights from descriptive analytics can predict how the future performance would look like (Appelbaum et al., 2017).

Several literature sources mention the "Balanced Scorecard" (BSC) as the most widely utilized and popular tool for monitoring and measuring different corporate performance objectives, which uses financial, customer, internal process, and learning and growth metrics to help managers reach to a decision whether the business activities require changes for achieving the objectives, strategies, mission and vision of an organization or not (Kaplan & Norton, 1992, 1996, Campos et al., 2017, Appelbaum et al., 2017, Sharda et al., 2013, Frolick & Ariyachandra, 2006).

The **financial** metrics that are included on the BSC are related to cost efficiency, revenue growth and risk mitigation, thus aim to increase the shareholder value (Kaplan & Norton, 2001, Appelbaum et al., 2017) such as cash flows, sales growth, gross margin, market shares, return on equity (ROE), risk assessment or cost-benefit data (Kaplan & Norton, 1992). If this kind of output is timely and accurate and accessible

towards the whole organization through a centralized corporate database, an efficient financial reporting can be achieved (Sharda et al., 2013).

From the **customer** perspective, several metrics are focused mainly on the customer satisfaction and feedback, and how companies can create value for them, where indicators are formed in terms of the variety among customers and the processes that are used for providing products or services to these diverse customer clusters.

The **internal business process** perspective focuses specifically on the different reasons and ways business processes are important for a firm and the enhancement of their efficiency. Managers with these metrics have the opportunity to monitor how well their internal business procedures and functions are running, and whether the outputs of these processes (i.e. products and services) are aligned with their customer expectations.

The **learning and growth** perspective aims to provide metrics to guide managers for training employees, acquiring new knowledge and facilitating internal communication among employees for driving innovation and organizational shift. These actions adjust human and IT resources with the strategic demands of an organization to achieve its mission and vision. Examples of these metrics may be employees financial upgrade if they meet their assigned targets or market share of new products (Kaplan & Norton, 2001).

Six Sigma is another widespread adopted tool by several organizations, but most of them do not use it as a performance measurement system, but mostly as a process improvement methodology that enables them to examine closely their processes related to a company's profitability, pinpoint problems, and apply remedy strategies. Should it is used as performance measurement system, its logic is the reduction of defects in a business process as much as possible and the acceleration of improvement in overall business performance.

2.3 Big Data and New Product and Service Development

2.3.1 Overview of New Product Development, New Service Development and Servitization

Many firms have acknowledged product development as an important source of increasing their competitiveness and gain a sustainable competitive advantage (Cooper, 1990), since the evolving diversity of products, deterioration of product life cycles and globalization of markets (Salgado et al., 2017). New Product Development (NPD) is described mainly as a business process by several literature sources (Salgado et al., 2017; Ulrich et al. 2003; Coughlan, 2014) following a set of steps and activities and it is considered as a critical one, because it illustrates the success of a company (Salgado et al., 2017). NPD is defined as "the stages, activities, tasks, steps and decisions involving the development of a new product or service, or an improvement to an existing one, from initial idea to product discontinuation" (Salgado et al., 2017, p.141). It is vital for firms to define and understand their strategic business objectives and directions contributing to new product success before they initiate the process.

Empirical studies focusing on Big Data from a management perspective have pointed out the effect of Big Data on firms' NPD and on improving their innovation processes (Davenport, 2012; Manyika et al. 2011; Gobble, 2013; Tan et al., 2015), which can lead to potential competitive advantages. Wong (2012) highlights the fact that with massive amounts of data companies can have an enhanced product development, while Tan et al. (2017) relate NPD mostly with customer satisfaction and mention quick problem-solving, shortening of the cycle time, close interactions with customers and reducing costs as the most fundamental propositions for a successful overall NPD process. Zhan et al. (2016) analyze three ways that Big Data can support NPD: a) "generation of ideas and concepts" (collection of information out of various Big Data sources to create new business opportunities and generate novel ideas for products), b)

"design and engineering" (a digital product co-creation with customers) and c) "test and launch" (individuals have the role of end customers providing their feedback for the product). George et al. (2014) indicates that the data volume and the value of "outliers" are extremely important, whereas "outliers", a term borrowed from statisticians, refer to divergent individual behaviors that are exciding the limits of a normal distribution in the population of Big Data. These outliers can represent a rather important and potential source of a social or economic modification with long-term consequences on the business environment and thus they may be the premise for identifying new business opportunities in fields such as product and service innovation or new product and service development (Constantiou and Kallinikos, 2015).

Generation of new insights by firms or understanding about their products, customers and markets, can lead to positive impacts on business process innovation on firm and supply chain level, allowing them to attain competitive advantage (Zhan et al., 2017). In addition, the same authors (p.522) point out the vital role of Big Data as a supporting tool for companies to accomplish three key success factors in product innovation management: a) "accelerating product innovation processes" by increasing the velocity in product innovation projects, b) "customer connection", and c) "building a stable and diverse innovation ecosystem". These actions can result in the quick launch of new products to market, visibility of a product's weaknesses' during its development cycle, additional functionalities to a product that customers are willing to pay a premium amount of money for eliminating unwanted features and the identification and prioritization of customer needs and preferences for specific markets. Davenport (2013) underlines in his article that an effective use of generated data and extraction of information has several benefits in new product innovation and service offerings. LaValle et al. (2011) recommended the application of Big Data and its analytics to firm strategy practices in order to extend their typical information channels regarding the business environment enabling companies to remain competitive by proceeding to disruptive innovation or other changes to their products or services offering them continuously to the market.

New Service Development (NSD) is "the development of new service products with intangible core attributes which customers purchase" (Johne and Storey, 1998 as cited in Qiang, 2013, p.4). A new service is defined as "an offering not previously available to the firm's customers that results from either an addition to the current mix of services or from changes made to the service delivery process" (Menor & Roth, 2007 as cited in Qiang, 2013, p.4). Goldstein et al. (2002) (as cited in Qiang, 2013, p.4) defines NSD as "the overall process of developing new service offerings and is concerned with the complete set of stages from idea to launch (Cooper et al., 1994). Service innovation refers to innovation in services, which focuses on how firms design or improve service concepts to satisfy the unmet customer needs. It may not yield into a sustainable competitive advantage, since they are not patentable and can be imitated by other individuals or organizations. As Qiang (2013) claims, the differences between NSD and service innovation are slight and are based on the meaning and the used processes.

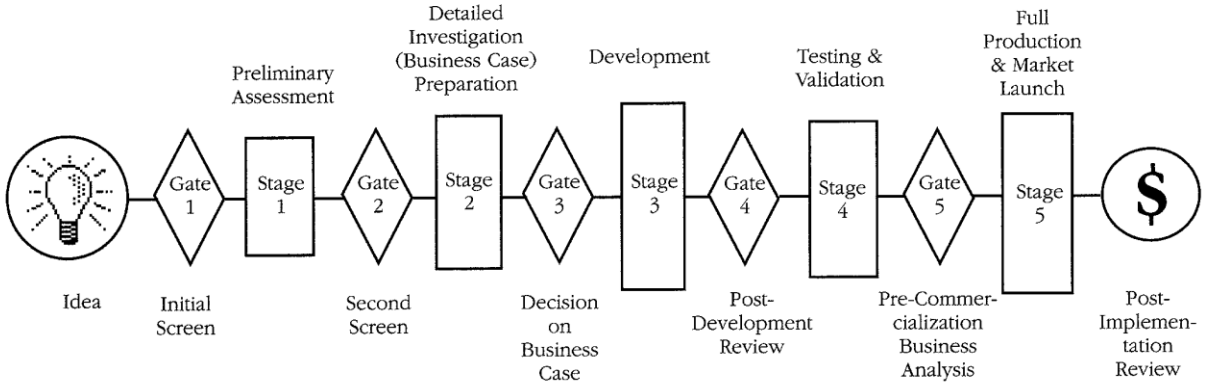
Servitization is another differentiation strategy of sustaining competitiveness for organizations. It refers to "the process where firms set out to create greater value by increasing the services they offer" (Vandermerwe & Rada, 1988). More and more companies today seem to have included servitization in their products to retain their customers and keep them satisfied adopting service business models. Opresnik and Taisch (2015, p.182) claim that "Big Data exploitation strategies can be the next step of the value creation after a manufacturing enterprise has servitized its products", as the more servitization is used, the more customers can be retained, thus more data can be collected and new information can be used effectively, which can give competitive advantage, as data's analysis can provide valuable insights on taping into new markets that competitors have not discovered yet or the possibility to create new or customer-centered products or services. In their article, they propose several ways of how manufacturing companies can use the four Big Data characteristics (Volume, Velocity, Variety and Veracity) to connect with and leverage the fifth one, Value. Finally, Barton and Court (2012) and Wamba et al., (2015) claim that extracted knowledge from Big Data can become a useful beginning for modern companies.

2.3.1.1 New Product Development models

There are different NPD models that exist in the literature, but in this section the focus is only on two models, which are found to be fairly widespread across organizations. Ulrich and Eppinger (2003) propose a six-stage model, which consists of the following phases: 1) Planning phase (Idea generation and evaluation of business opportunities), 2) Concept development (transformation of ideas into concepts with more analytical information), 3) System-level design (specifications about the functionality and components of the product), 4) Detail design (necessary processes, tools and business actions for the product development) 5) Testing and refinement (construction of prototypes) and 6) Production ramp-up (gradual initiation of production).

Stage-gate system is another widespread model that is utilized by many corporations for managing, directing and controlling their product-innovation efforts with effectiveness and efficiency (Cooper, 1990). This system/process is divided into a predetermined set of stages or work stations, where specific actions are employed by managers from different departments of an organization, and between each of them there is a quality control checkpoint or gate. These gates have different structure. A specific amount of criteria is defined that the product has to pass to move to the next work station ("go or kill" decisions regarding the possibility of the project continuation or its elimination). These criteria tend to mitigate the risks and uncertainties of the projects (Cooper, 2008). The exact design of the Stage-Gate system is illustrated in Figure 2 below (ibid.).

Figure 2
An Overview of a Stage-Gate System



3. Methodology

3.1 Research Strategy

The overall purpose of this study is to highlight in what ways Big Data influence the improvement of business performance of several Swedish-based firms and in particular their New Product and Service Development. Thus, the research is focusing more on understanding how these firms apply Big Data in their operations, what challenges they face and their key success factors in business aspects. Therefore, a qualitative strategy is the selected method for this research and it is more relevant than a quantitative one. Whiting et al. (2012, p.22) mention that "qualitative research seeks to understand the subject being investigated and provide explanations of the behaviors or experiences of individuals or groups". Hence, by implementing a qualitative strategy, a deeper understanding of the studied organizations can be achieved through their executives' shared opinions and experiences regarding Big Data and Big Data analytics.

An inductive approach in qualitative research is a concept-and theory generating one from the extracted data that needs to be identified, examined and discussed further by the researcher (Bryman & Bell, 2011), while the deductive one relates theory and research in which relationship the latter is conducted with references to hypotheses and ideas yielded by the former (ibid.). Thus, the latter approach is used mostly in quantitative strategies, where these phenomena are observed. An empirical study that uses the inductive approach base the findings on tools, such as observation and interviews. These tools are important in the qualitative research as they care more humanistic i.e. the researcher comes in contact with the phenomenon or the people directly and looks for ways to produce meaning. These methods distinguish themselves from the "cold", number-based method of deductive approach that does not take into consideration the human insights, values and understanding of a phenomenon. In this case, an inductive approach is considered more applicable, not only because the research is aiming to gain knowledge on Big Data's influence on business operations and on the data management and analytic capabilities of a specific number of business organizations, but also due to the fact that it will yield practical recommendations in this end of this paper without testing any hypotheses or validate any existing variables or theories. Except for an inductive approach, there will be used a grounded theory approach in this paper for analyzing the collected data aiming to the generation of theory (ibid.).

The theoretical background that was chosen for this study is grounded theory. According to the originators of this theory (Glaser et al., 1968), grounded theory is a theory mostly found in qualitative research that has as goal to generate and formulate a new explanatory theory out of the gathering and analysis of empirical data. Research processes when using ground theory may involve collection, coding and sorting the data and then try to construct a theory that is a product of the researcher's interaction with the participants (Strauss & Corbin, 1997). In this study, grounded theory it is used from the researcher in order to conceptualize the usage of big data in Swedish based companies by using data from people working inside those companies and it is an effort to deeply understand and explain this phenomenon.[1]

3.2 Research Design

In this section, a robust research design is going to be presented that fits with the aforementioned research questions and logic behind Big Data and business performance. The research design that will be used in this study is the comparative design and it will take the form of a multiple case study, since the number of examined cases is more than one. In this case, there are five different cases-interviews from five different enterprises, whose representatives were asked targeted questions about the role of Big Data in their

[1] More on grounded theory on Glaser, B. G., & Strauss, A. L. (2017). Discovery of grounded theory: Strategies for qualitative research. Routledge.

companies' business performance and New Product and Service Development. This design is being followed by acquiring relevant input and knowledge from a variety of sources and comparing the findings with the final goal to comprehend in detail if, why and for what reasons Big Data are employed and included in the operations of these five firms. Generally, this model is adopted for comprehending social phenomena better when two or more meaningful and contrasting cases are compared, and it is a valuable tool for the researcher to come up with relevant findings and recommendations.

3.3 Research Method

According to Dubois and Gadde (2002), researchers have at their disposal multiple ways of exploring hidden insights and meanings. Yin (1994) claims that exploring and studying multiple cases that their agents are not directly connected to each other (serve as different sources of information), may strengthen the powers of argumentation of the findings/conclusions. For this reason, both primary and secondary sources are used by gathering different perspectives in order to formulate a holistic understanding of the research topic.

3.3.1 Secondary Data Collection

Secondary data is collected initially in the form of existing literature related to the area of study. Relevant literature was found on several academic electronic databases of GUNDA, the library of University of Gothenburg, Scopus, Google Scholar, SAGE Research Methods and Science Direct. Some of the most important keywords that are used to explore the existing and most influential literature and condense the volume of the search results are Big Data, Big Data analytics, Business Performance, Business Strategy, New Product Development, New Service Development, Benefits of Big Data, Challenges of Big Data. This literature had the form of journal articles, magazine articles, books, master theses, reports and textbooks. Their citation frequency, the reputation of the authors, date of publication and content relevance are taken into account when deciding whether they are useful as data sources. However, the literature that was selected in this study was in the English language and articles on the topic that was written in other languages were not taken into consideration due to practical difficulties. Moreover, the researcher managed to find other relevant literatures in the secondary data collection process through the reference list in the initial literature. This method is proved to be an effective way of having a wider view of the research areas and have more literature sources for a study.

3.3.2 Primary Data Collection

Apart from the secondary data that was retrieved from the existing literature, the researcher focuses in collecting primary data in the form of interviews. A basic process when using grounded theory is the gathering of data that is derived from the direct communication of the researcher with the participants. Although observations, field notes and video recordings are important and popular tools in qualitative research, due to practical reason, it was decided that the researcher would conduct interviews with the participants in order to have a deeper understanding of the discussed problem.

3.3.2.1 Semi-structured interviews

According to Fylan (2005), the interview approach is one of the most important, enjoyable and interesting ways of collecting data when conducting qualitative research. A specific design of the interview process is conducting conversations in a semi-structured way. The semi-structured way of interviewing is described by Fylan (2005) as simple conversations that the researcher has an idea of what he/she wants to explore, but at the same time the conversation is flexible and free, whereas the responses from the participants can

vary significantly between each other. In contrast with structured and unstructured interviews, the semi-structured ones do not have a strict structure like a verbal questionnaire and the same time they are not so free regarding the order of the questions and the topic explored.

In this specific study, the interviews were conducted using the semi-structured way because it allows a certain flexibility to the questions and the participant answers, but at the same time, they are focused on the topic of the effect of Big Data in business performance, and in New Product Development and New Service Development. An interview guide was generated (see Appendix A) as a coordination tool with open questions related to the topic discussed. If, during the interview process, any participant did not understand the question or requested more information, then the researcher had the flexibility to provide supplementary questions in order to ease the process. It was deemed that the semi-structured way, was the most suitable in this study as the participants had the opportunity to express and elaborate their opinions on the topic. For the researcher, it was the most appropriate tool for understanding "Why" and "How" questions in a deeper and meaningful way. At the same time, it gives the researcher the opportunity to ask further questions if he/she deems that a question was not elaborated enough and/or if they want to learn more about an interesting view that is expressed. Furthermore, the researcher had the flexibility to not ask some of the questions listed in the guide if he thinks that they were answered in previous questions.

According to Baxter & Jack (2008), the way we analyze data in a case study can be very different as it is dependent on the specific characteristics of the case. This study is focused on profound understanding of how the Swedish-based organizations use Big Data and try to find a meaning in order to answer the research questions that were proposed. Therefore, the goal of the study is not to generalize or propose a universal model on how Big Data should be used, rather than exploring and elaborating on the current techniques.

3.4 Research Quality

One of the main challenges that the researcher has to deal with in qualitative studies is establishing confidence and trust on the theoretical explanations that are proposed by the researcher in order for the reader to understand the examined concept. In this context, according to Bryman and Bell (2011), reliability, validity and replication are the most distinguished criteria that are used for the assessment of a management or business research. However, there is a disarray among scholars in their use in quantitative or qualitative research, especially for the former two concepts. Some of them believe that they can be applied to qualitative research while others argue that they are relevant only to quantitative research (Bryman & Bell, 2011). This paper will follow the second trend and propose the alternative concepts of trustworthiness and authenticity for evaluating qualitative research, as they were introduced by Lincoln and Guba (1985) and Guba and Lincoln (1994). It was decided to follow these patterns because advocators of the first trend apply some slight alterations to the concepts of reliability and validity for conducting qualitative studies into their papers (Bryman & Bell, 2011). The reason why Guba and Lincoln differentiate themselves from other scholars is that reliability and validity reveal only one social truth with regards to management or business research, while via trustworthiness and authenticity a researcher can identify more than one, namely researchers can suggest several concluding points or theories (ibid.).

3.4.1 Trustworthiness

As it is reported in Xerri (2018), the trustworthiness of the research is highly relevant to evidence that based on the participation of the researcher on the field research. Each research's trustworthiness is based on four aspects, according to Lincoln and Guba (1985): credibility, transferability, dependability and confirmability, which each one of them parallel a corresponding aspect of quantitative research (Bryman & Bell, 2015). Authors mention that **credibility**, which is a substitute for internal validity, consists of two main tasks: conducting research in a credible way, namely an accurate and richly describing way of explaining the phenomenon in question, and describing thoroughly the collected data (Given, 2008). Having

semi-structured interviews with five executives from five different Swedish-based companies helped the researcher to form a more thorough understanding of the topic and comprehend managerial details around it. Moreover, face-to-face interviews were beneficial in building trust not only with them but also with their answers on several questions concerning the study's research questions that were shared with the researcher. **Transferability** is a parallel concept with generalizability (Given, 2008) and entails "the extent to which findings from a qualitative study are useful in understanding how people experience the target phenomenon in other settings or under other conditions" (Monsen & Van Horn, 2008, p. 74 as cited in Xerri, 2018, p.39). That can be accomplished via a detailed narration of the research participants' views and experiences which can be transferred and applied in different contexts by other researchers (Bryman & Bell, 2011). **Dependability** parallels reliability and it entails the consistency of a research process (problem statement, selection of study participants, interview transcripts, data analysis, deriving findings, etc.) in an appropriate way. Thus, other scholars can be reassured if the consistency of this study is valid and all steps of a research process have been followed in order for a similar process to be implemented in a future research. **Confirmability**, which is a parallel concept of objectivity, is used to assure readers or other academics that the researcher has not been biased by any personal values, opinions or other influences during the research process and that "the interpretations and findings match the data" (Given, 2008).

3.4.2 Authenticity

Another important element of qualitative research is authenticity. The researchers' aim in applying authenticity to their studies is to ensure that both the conduct and the assessment of their research are plausible and have an impact regarding both the research participants' experiences and views, and the various societal issues. It entails five aspects, according to Guba and Lincoln (1985): **Fairness, Ontological authenticity, Educative authenticity, Catalytic authenticity and Tactical authenticity**. The **first** aspect shows the fair representation of all different points of view, concerns and perspectives about social matters during the research process. The **second** aspect helps a study's participants to better understand the social environment and the social aspects of the topic in question, while the **third** one helps them to appreciate better the different perspectives of other members of the society, such as cultural, social or organizational ones. The **fourth** feature refers to the degree to which the research has been an influence for a research's participants to take actions and change the status of their society, while the **fifth** aspect tends to engage the participants with taking the appropriate steps to act upon that change as members of the society trying to have a positive impact on that shift.

3.5 Data Sample Method (or Research Process)

As it was mentioned above, in addition to the literature review, this study relies on semi-structured interviews with five practitioners from Swedish-based firms (further information about the profile of each interviewee are provided on the below table) of a range of sectors. All of the interviews were recorded. The choice of collecting data through semi-structured interviews is based on the fact that they facilitate a strong element of discovery, while its structured focus allows an analysis in terms of commonalities (Ayres, 2012). According to the semi-structured way of conducting interviews (Ayres, 2012), questions were the same for every participant and the interviewees were helped by supplementary questions if they needed more elaboration on the questions. Every participant could express freely their own opinion without restrictions throughout each interview. The researcher could keep track of the discussion and constrain the respondent in the subject and not let the discussion get out of the limits of the topic. Moreover, if the researcher felt that any interviewee presents a difficulty in understanding the question, then additional explanations and elaboration were provided to him for facilitating the whole process. Furthermore, if the participants felt they needed to add more information that are not along with the context of asked questions, then they had the freedom to do so. These interviews included open-ended questions to have the opportunity exploring emerging big data trends and issues in depth, as it commonly happens in quite new to research areas. The

interviews focused on how the examined companies leverage Big Data inside their companies and specifically in the New Product and New Service Development processes, what effect has a Big Data implementation to their business performance, and in NPD and NSD, what kind of challenges they face in collecting, analyzing, getting insights and using effectively Big Data and what skills or resources are needed for tackling these challenges. The companies were selected meticulously on the basis of size, geography and their core business. It was examined thoroughly through extensive research on companies' reports and website information that work with Big Data, ensuring also that the study participants represent a diverse variety of occupations and organizational positions and have experience in working with Big Data technologies. The case companies are also incumbents on their respective sector and have introduced digitalization and digital services to their operations.

3.6 Participants' Profile

The researcher initiated contact with several companies based in Sweden by seeking contact information with Big Data practitioners through the Internet, the LinkedIn platform or e-mail, having sent a small informative text about the topic of the project and its purpose. However, only five of them showed interest about the research project. Interviewees were invited to participate in the interviews through e-mail or a direct approach (message) through LinkedIn, which is a social networking business-and-employment oriented service, having made the access for business professionals and experts more efficient. Three of the interviews with the experts were conducted face-to-face, one via a regular phone call, and one via a Skype call between February and March 2018. Each interview lasted between 30 to 60 minutes and they were conducted orally in the English language. The recording and the transcription of the interviews were accomplished through two different mobile applications that were also used for the analysis and interpretation of the findings. All the participants were male, being employed in private organizations of a wide range of sectors including automotive, energy, telecommunications and retail industry. The details of the conducted interviews and the profile of the interviewees can be seen in table 1 below.

Company	Respondent's Full Name	Respondent's Job Position	Respondent's Job Position Duration	Location	Date	Type of Interview	Duration
Vattenfall	Yasith Wickramasinghe	Director of Customer Insights for the Consumer Sales Nordic	4 months in this position, 7 years employed in Vattenfall	Stockholm	16/02/2018	Skype	30 min
Volvo Group	Staffan Viden	Vice president for manufacturing technologies	2 years in this position, 30 years employed in Volvo Group	Gothenburg	21/02/2018	Face to Face	60 min
Fujitsu Sweden AB	Kjell Munther	Sales CTO of Scandinavia	1 year in this position, 7 years employed in the company	Gothenburg	01/03/2018	Face to Face	36 min
Scania	Gunnar Löfgren	Digital Officer of Commercial Operations	9 months in this position, almost 20 years	Stockholm	12/03/2018	Phone	30 min

			employed at Scania				
Ericsson	Henrik Stenhoff	R&D Line Manager for Data Analytics Innovation	1 year in this position, 15 years employed at Ericsson and working with R&D	Gothenburg	16/03/2018 and 23/03/2018	Face to Face and Phone	37 + 16 = 53 min

Table 1. Overview of Study Participants

3.7 The Interview Questions

It is worth mentioning that all interviewees in the beginning of each interview were asked if they agree to share their full names or if they wanted an anonymity to be kept, but they had no problem of having their names into the paper, unless the study would be published out of the academia. The questions constructed and asked by the researcher were divided before each interview in order for the study participants to have an overall image of what kind of questions they were supposed to answer, and they concern how they perceive Big Data, what challenges or benefits they have using them, how they use them to improve the performance of their businesses and what their impact is on the New Product and/or Service Development. In addition, it is worth mentioning that during the interviews and in accordance with the participants' answers, not all questions of the interview guide were asked, since some of them were answered in another question. The researcher did not intend to tire the participants by making them repeat their answers. Therefore, some questions of the interview guide were skipped or joined with others. Before the contact initiation with several companies, the researcher, after deciding on conducting a qualitative research, proceeded with the writing of an interview guide (it is available in the Appendix A) with several questions concerning the research questions and it was clearly divided into three large thematic categories, in order to be able to conduct a more efficient analysis of the results and for the participants to understand better the dynamics of the project.

3.8 Ethical Considerations

Since the data collection was accomplished in an empirical way, ethical issues have arisen with regards to the research participants. Following data analysis, the participants will be informed about the results of this study and the whole paper or summary of it will be created and distributed to them after the completion of the project.

4. Summary of Empirical Findings

In this section, the findings from the conducted semi-structured interviews will be presented in the following tables and will be divided into 21 categories: 1) Related role of the interviewee to Big Data, 2) Big Data definition, 3) Ways of collecting data, 4) Data Management and Quality Verification, 5) Big Data objectives, 6) Data-driven culture, 7) Data-driven influence on daily business operations, 8) Ways of measuring business performance, 9) Creating business opportunities through Big Data, 10) Improving Business Performance through Big Data, 11) Insights form Big Data analytics, 12) Data-driven decision-making impact in business change, 13) Machine Learning usage, 14) New Product and Service Development process, 15) Impact of Big Data in improving value offerings 16) Implementation of Big Data in the NPD/NSD processes, 17) Benefits and Challenges of Big Data in the NPD/NSD processes, 18) Rating of company's utilization of Big Data in the NPD/NSD processes, 19) Usage of Big Data Analytics tools in the NPD & NSD processes, 20) Actions for improvement of the management support towards Big Data implementation in the NPD/NSD processes, 21) Key Success Factors.

1) Related role of the interviewee to Big Data

The interview guide began with this question, as it is highly relevant to the topic, because it reveals the relation of each participating executive to this study through their work positions inside the respective organizations.

Interview Participant	Answer
Vattenfall	➢ I'm responsible for looking into data to find customer and consumption behaviors and give them advice on how to save electricity and be more sustainable. ➢ When it comes to business development, looking at the consumption patterns and their behaviors, can also help understanding the demand and supply process better
Volvo Group	➢ Looking for and preparing for implementing new business opportunities. ➢ There are positive opportunities in the area of Big Data and its technologies, such as Machine Learning (ML), Artificial Intelligence (AI) or Big Data Analytics (BDA), and especially on production scheduling, possibility for further enhancement of prediction processes or working with maintenance in a more predictive way by forecasting possible issues before they occur.
Fujitsu Sweden AB	➢ I am a link to the Japanese and European IPs (Intellectual Property) and solutions and between our sales organization, the innovation and delivery units that support the business to work with new areas, such AI, IoT or industry 4.0 and automation in different aspects. ➢ My role is not specifically related to Big data and BI, but everything is connected nowadays, and the value of connection is the data that is created, and we take decisions based on that.
Scania	➢ I am supporting digitalization and business development in all aspects trying to make enablers for digital solutions, like robotics, advanced analytics, data management and other services that are used inside our organization.
Ericsson	➢ I am part of Ericsson Garage where we work with new innovations. There are different parts that work with building businesses within Ericsson and I am taking part of the analytics part there. ➢ Also, we are exploring new areas, so we continuously identify unknown and valuable things by getting insights from products that provide to our

	customers, and then we can sell these products to our customers in a new way or sell insights to them. Working in that way, we are able to find new insights that bring us all the way to the customer and to new businesses.

2) Big Data definition

In the beginning of the first part of the interview guide (Big Data understanding), participants were asked how they perceive, understand and define generally the Big Data concept. The following answers are the result of their thoughts about defining Big Data.

Interview participant	Answer
Vattenfall	➢ Big data is a couple of components ➢ It can be unstructured data and it has to do with volume, velocity ➢ How you define it is based on your business need
Volvo Group	➢ A huge amount of data that is used in many of our processes and from AI, Machine Learning to traditional analytics.
Fujitsu Sweden AB	➢ Large amount of collected unstructured data that are not necessarily used but stored normally in a customer environment.
Scania	➢ Huge amounts of data that a normal user cannot handle it within Excel or Word, etc. and special tools are needed for it.
Ericsson	➢ Big Data is a huge amount of networks, customer data and performance measurements where you can see big trends or correlation or clusters that you could not have seen when you actually have a small fraction of data.

3) Ways of collecting data

This section will present in which ways the five organizations collect data according to their executives.

Interview participant	Answer
Vattenfall	➢ With the General Data Protection Regulation (GDPR) clause in mind, which is a European legal compliance initiative, we collect data together with external companies or from our own channels, meaning our web pages, telemarketing, customer service, media agencies. ➢ Buying customer data to a certain extent. ➢ Collection of operational data about how our customers have payed their invoices, what products they purchased and how much electricity they consumed.
Volvo Group	➢ Access to data from 700,000 vehicles that are connected through fleet management systems.
Fujitsu Sweden AB	➢ CRM (Customer Relationship Management) systems collect data, but we collect data internally in the operations and ERP (Enterprise Resource Planning) systems. ➢ Tailor-made systems that are built for providing solutions to our customers, which can either be found in our data centers or in our customers' environment depending on what they choose to do. ➢ Sell servers and provide infrastructure services to our customers where they store data. ➢ For our own purposes we have databases for different aspects where we collect data supporting normal business processes inside the company.
Scania	➢ Collecting data from both customers and our products, namely connected vehicles, trucks, buses and industrial marine engines.

	➢ In R&D data are related with our products and their quality, with our customers' purchases and preferences, and HR-related data. ➢ For production purposes. For example, how the tightening and screwing of all the bolts is achieved during the production so every worker can follow up.
Ericsson	➢ From our mobile operators around the world and that is data of how our networks are performing.

4) Data Management and Quality Verification

In this section, several methods and tools of data management as well as ways of assessing Big Data quality are discussed by the five participating executives to the interview.

Interview participant	Answer
Vattenfall	➢ As for the Nordics' part of Vattenfall, there is a centralized data warehouse and ➢ Cloud-based solutions that we are building even more.
Volvo Group	➢ There is a certain process, which starts with setting up an objective. If data elements are above a certain percentage, we can verify data's quality manually, but when sometimes the data are not so good as we want, the algorithms have to manage it. ➢ There are different approaches for different types of errors or problems with data, but there are a lot of projects where we try to clean up the data because we have traditional databases today with many rows and columns and then we try to populate these where data is missing but that is not necessary for every kind of data. It depends on the data and how we use it. Then we make sure that when we introduce a follow-up on new data, it is correct from the beginning. One way with BDA is to find this abnormality, because we want to predict that.
Fujitsu Sweden AB	➢ For infrastructure services, I do not think we look particularly into the quality of the data because it is not our assignment. ➢ We look at big data at ERP systems where we have databases. Our customers take responsibility about the quality of the data, and not Fujitsu. ➢ There was a transition from Microsoft CRM to Salesforce and a cleaning activity moving all the data to the new system and an attempt to have some data quality parameters but that depends on the software we use.
Scania	➢ Most of the data today and IT systems are developed for a specific process where you have someone responsible for the process. ➢ There is a need to change that data are not collected for a specific purpose but to be used properly and overall within Scania. ➢ There should be someone responsible for collecting the right information, not just for the quality of a specific process but the overall quality inside Scania.
Ericsson	➢ Together with the usage of tools for data collection and storage, we can also see if data are correct and have good quality. ➢ Security and automatization of data are very important. ➢ Performance data that is collected has quite sensitive information as different operators can be compared with each other, so there is a need for anonymizing the data.

5) Big Data Objectives

In this section, the interview participants share their respective organizations' objectives of using and utilizing Big Data and what purposes fulfill with generated insights from BDA.

Interview Participant	Answer
Vattenfall	➢ To observe customer experience and be relevant to our customers when it comes to our communication touchpoint and also on time to them when they need us because we don't want to disturb the customer with messy data or information. ➢ To find out how we perform on the market, meaning how are the profit margins going, how much wide our customer base is, etc.
Volvo Group	➢ Collecting data from our connected vehicles is utilized in a good way to offer our customers advantages or business opportunities, such as self-driving vehicles, autonomous cruise controls or automatic breaking of vehicles or other more advanced functions. ➢ Based on our experience, there are attempts to make a vehicle to behave in a certain way and to indicate computers and machines to take all this input and make rational decisions based on that, a process which is closely related to Big Data.
Fujitsu Sweden AB	➢ Regarding our customers, the purpose for gathering data is helping them make right decisions. So, by collecting and analyzing this data we give them the ability to make business decisions, to change market direction, to do the right purchases, to do the right interactions, etc. ➢ From our side, our only purpose is to run our business in the most efficient way as possible, to minimize the duplication of data, and to minimize the number of different systems and therefore the number of internal databases.
Scania	➢ There is a need to follow the GDPR rule and other laws regarding data. ➢ Our top management decided all data should be shared for analytical purposes minding legal aspects, but there is still room for improvement.
Ericsson	➢ Having insights derived from data about how our products are used but also being sure they are working properly, we can maximize their performance and security in order to have better functionality, automatization and intelligence. ➢ Automate our operations in a much higher extend to provide us insights of how things are and what problems we face regarding our mobile networks, so we can help our customers to actually have better mobile networks with better performance, less maintenance and less operation costs.

6) Data-driven culture inside the company

The participants in this section were asked whether their company has established a data-driven culture throughout the organizational scheme or not and in what ways that has impacted each company.

Interview Participant	Answer
Vattenfall	➢ The concepts of data-driven decision-making and data-decision culture are on an initial stage now because we had a different focus before.
Volvo Group	➢ Some departments are more data-driven than others but now we have started getting the proper infrastructure and becoming more organized around data.

	➢ In the next five years we would be able to do plenty more things.
Fujitsu Sweden AB	➢ We have not done it in Sweden yet. ➢ We are looking definitely at many Key Performance Indicators (KPIs), especially financial ones, but data are not monitored every day and we are not such a data-driven business, so we are not using the data in other aspects.
Scania	➢ Talking a lot about implementing a data-driven culture. A digital awareness day for the management team of commercial operations and a similar workshop for the whole R&D department about the need of sharing data, which is our main target, have been organized.
Ericsson	➢ We have just started. My type of organization is very valuable for spreading and helping the rest of Ericsson to become a more data-driven company and have that culture because it is valuable for us. ➢ We need to add on data science competence to be transformed into a data-driven company, which is our target.

7) Data-driven influence on daily business operations

The executives in this question answered whether Big Data influence the daily operations of their respected company and in what extent.

Interview Participant	Answer
Vattenfall	➢ From a customer perspective, the most relevant we are to our customers, the most trust and appreciation they will have for our company.
Volvo Group	➢ It's being used mainly in different pilots in order to learn more and be sure how we should implement it on a wider scale. ➢ Through using the data collected from 700.000 connected vehicles on a daily basis in the sales or service department, messages are sent out to different dealers if there is a problem with these vehicles, we contact the owners and recommend them coming in for a service.
Fujitsu Sweden AB	➢ A data-driven approach can lead to predict many things in a much better way, it is the key for analytics, but also the basis for customer communication in the future.
Scania	➢ Great influence in the market, and our customers have more access to our data in a good way, so they want us to develop even more. ➢ More descriptive analytics and development of our competences and skills in doing advanced analytics, to do more predictive analytics and analyzing advanced analytics cases.
Ericsson	➢ No data to that question

8) Ways of measuring business performance inside the company

The second part of the interview guide (Big Data and Business Performance) begins by questioning the participants about what kind of different ways, methods and tools they use to measure business performance.

Interview participant	Answer
Vattenfall	➢ By gross margins, ➢ Customer base and ➢ MPS (Master Production Schedule), which measures the emotional connection with the product and the brand after the market.

Volvo Group	➢ Every division and unit have certain KPIs, but they focus mostly on customer satisfaction. ➢ In the top level there is profit, cash flows and other financial measurements. ➢ On a team level there are KPIs related to your task or role inside the company and these measurements are trying to guide employees if they are performing on an acceptable level or if they need to improve.
Fujitsu Sweden AB	➢ Through different KPIs. ➢ Financial performance is measured in different aspects, like revenue streams, profitability, cash flows, etc. ➢ Quality indicators for projects and regular customer services. ➢ Customer performance is measured by the regular activities, like employees' surveys, and by a tool called "team barometer", with whom it can be analyzed how the employees realize the daily situation and the employee environment.
Scania	➢ Phase, phase of hours, workshop hours, phase of trucks, phase of cars, and financial things like ROI.
Ericsson	➢ There are people putting requirements in what we should focus on, which type of products we should bring to the market according to different business cases.

9) Creating business opportunities through Big Data

In this section, participants answer how Big Data supports their organizations to create new business opportunities in many areas they focused upon.

Interview Participant	Answer
Vattenfall	➢ No data for this question
Volvo Group	➢ Use of data-related technologies based on our vehicles and customer experience, to offer new services to our customers that will generate revenues for us. ➢ On manufacturing, our goal is to have higher output with the same input in order to increase profit levels by reducing cost levels.
Fujitsu Sweden AB	➢ Extensive work on the areas of IoT, AI and since these areas are connected with Big Data, we collect a lot of information about business processes within our customers' companies.
Scania	➢ The sense of Big Data is about collecting the status of the vehicles, which is remote diagnostics connected to the vehicle. Then either there is contact with the customer or an already maintenance plan.
Ericsson	➢ Discovery of new things and innovations. ➢ Through Big Data, getting new insights about new product development and new business models that we weren't aware before is possible as well as earning money in a totally new way that we were used to before.

10) Improving Business Performance through Big Data

In this section the participants present their views on how Big Data is applied, managed and used in order for their companies to improve their business performance.

Interview Participant	Answer

Vattenfall	➢ By getting more insights or behavior patterns, trends can be monitored quite accurately because of the data volume, pattern recognition, and predictive and proactive analytics, which have been quite important. ➢ It helps us understand what to anticipate and improve.
Volvo Group	➢ There are already many pilot programs, but on an exploration phase. Financial performance looks the most promising.
Fujitsu Sweden AB	➢ Big Data being used within the financial performance helps us monitor how we are doing on a regular basis, but is not used neither in HR nor in the employee productivity nor in the customer satisfaction.
Scania	➢ In the Rich Communication Services (RCS) there is a clear change of our business model.
Ericsson	➢ Intelligence in our products comes from feedback from data and our operations. ➢ Automate processes much more and reduce the amount of people needed for the work.

11) Insights from Big Data Analytics (BDA)

Interviewees present in what ways their companies apply and exploit the different insights that they collect from Big Data analytics and what their usage is in business operations.

Interview Participant	Answer
Vattenfall	➢ In BA (Business Area) markets, an area which is engaged with electricity trading and is the heart of commercial and wholesale activities, ➢ BA wind from wind farms, ➢ BA customer and solutions, ➢ BA in R&D and ➢ Partial BA in offerings related to heat.
Volvo Group	➢ Benefits on the finance department, where the forecast for the next quarters is done much more precisely and ➢ In HR, BDA is used to foresee who is the best person to employ.
Fujitsu Sweden AB	➢ BDA is used in improving our product development for our customers. ➢ In the field of AI, the availability of big amounts of data is critical for us to develop this kind of services.
Scania	➢ Within R&D especially for the quality of the vehicle ➢ It has also started to be used within the market insights.
Ericsson	➢ Within R&D to make our products more intelligent, ➢ In the financial sector ➢ In HR ➢ The main purpose and the most prioritized activity is within our product development where our effort is targeted on delivering value-added and more intelligent products and by selling them in a higher price to increase our revenues ➢ In our operations, where a lot of people working for becoming more efficient, our goal is to reduce the amount of people working there and save money.

12) Data-driven decision-making impact in business change

In this section executives share their opinions of how data-driven decision-making can affect business change.

Interview Participant	Answer
Vattenfall	➢ It is interesting to define how decision-making based on data can be applied in different business scenarios. For example, how we can increase profitability or how we can reduce our internal costs or how we can reduce the waste towards the customers or how we can increase customer engagement is different. ➢ It is very dependent on every case.
Volvo Group	➢ We are experimenting a lot and very interested in.
Fujitsu Sweden AB	➢ I am sure it can result in business change in the future both for us and our customers. ➢ If a proper infrastructure and availability of information are used for taking new decisions or changing our customers' direction or offer to the market, it can lead to a quality improvement of our customer delivery and of our production processes, and a quick reaction on data in earlier stages, for example, before a defect occurs.
Scania	➢ Instead of just base our decision upon assumption that people have a lot of experience and then build from data, we will also be able to question the decision in a good way and therefore we can have more people involved into decisions, with different competences and skills who would be able to make better decisions.
Ericsson	➢ There are many things that changed our business, but I'm not aware of the different business models out there at Ericsson.

13) Machine Learning (ML) Usage

Participants in this question shared their views and describe about how their companies make use of Machine Learning to facilitate their everyday operations.

Interview Participant	Answer
Vattenfall	➢ Detect maintenance wind measures and creation of digital twins on wind turbines to find out if maintenance operations can be done faster so there is no loss of generation capacity. ➢ Maintenance process is more cost effective as we can find out as much accurately as possible how to reduce some maintenance trips and costs. ➢ Detect chain preventer to understand based on certain events or triggers or sequence how the customer behaves to see if we can trigger chain preventer activities.
Volvo Group	➢ For predictive analytics and we want the computer to help us. ➢ For making better decisions as a complement to our current decision-making. When it comes to self-driving vehicles, it will be a combination of utilizing ML and human capabilities.
Fujitsu Sweden AB	➢ AI has ML and we are building applications together with our customers in different aspects, but they are not used yet. ➢ It is an improving process and it is for simple things, like chat boxes where we have more supervised learning. ➢ For a specific case, we trained the system to judge what kind of defects would occur in a much better and faster way that would be done manually. ➢ It is a key component and is based on the availability of Big Data.
Scania	➢ We have just started using ML in some of our projects, but we are looking into ways of improving its usage.

	➢ Within quality reports, there are a lot of reports in different languages and there we will try some ML using Watson.
Ericsson	➢ It is used more and more in BDA. ➢ For automating and making predictions of different things ➢ In operations to automate our processes in a smarter way, ➢ In our mobile networks and Radio Access Networks (RAN) where we could build better and more intelligent products, ➢ In the IoT, where we try to connect and move a lot of intelligence into the cloud and to produce cloud products, ➢ For predicting the capacity (how much capacity we want by using the cloud- that is called "capacity prediction"). ➢ In energy efficiency to save and reduce energy and build products that use less energy and to reduce our energy consumption. ➢ Ericsson Siri, a digital personal assistant by having filmed the bay station and knowing there is a problem shows several solutions about fixing it and advice the people exactly what to do.

14) New Product or Service Development Process

Here it starts the third part of the interviews with the five executives with questions concerning the relation of Big Data with the New Product and Service Development processes of the five companies. The participants in this particular question describe the procedures their companies have established with regards to New Product and Service Development, how these are managed and what departments are responsible for them.

Interview Participant	Answer
Vattenfall	➢ R&D is working mainly with it. ➢ In our business, a new product is like geothermal heating or wave energy generation, so there are different processes there. However, an electricity contract is also a product so there are different processes to create these. Thus, it depends on the product.
Volvo Group	➢ There is a very structured process. A normal product development starts having an innovation period where we have idea generation that we can implement in our products, then the product development phase starts putting a target that should meet all these objectives by this date and with that cost, etc., and finally comes testing before launch on the market. ➢ We are looking for new opportunities around the world, see what others are doing outside of our industry, and then we can use emerging technologies to do that.
Fujitsu Sweden AB	➢ A very structured Japanese way, which is called Monozukuri (Japanese word), which entails very detailed processes, but they take place in Japan where the production and R&D is. ➢ It is more about IT collection of information about the performance and status of our different factories all over the world.
Scania	➢ There is a product development process that is used for new products, which includes a decision process. It is divided in different stages and then decisions should be made before going to the next stage. ➢ In the beginning, there is brainstorming and trying to define what is all about, but if it is a quality issue, then it is red error and it has to be taken care of directly. The same process is followed for new service development.

Ericsson	➢ Our research area with 800 employees working 3 to 5 years ahead are trying to find and build new products and services, such as 5G. They continuously foresee things that will come in the future and be prepared for them securing the Ericsson's main goal which is to have the technology leadership. ➢ We start from idea generation, then we do some initial proof of concepts to build some sort of minimal viable product. We find out in the process if this is something to build a business or not or just we learn from it, so we don't continue with this project. ➢ Different organizations inside the company are focusing to develop their products as best as possible and a new phase has started where we see which technology is usable in every industry, so we find new ideas and areas, like IoT, where everything can be connected within the automotive, healthcare, utilities and other types of sectors. We work with them and thereby evolve with them, combining our knowledge and having the mobile networks as the business core which provides value.

15) Impact of Big Data in improving value offerings

In this part, it is illustrated how each company makes efficient and effective usage of Big Data to enhance their value offerings.

Interview Participant	Answer
Vattenfall	➢ No data were retrieved
Volvo Group	➢ Some small-scale service offerings and many ongoing ideas and initiatives.
Fujitsu Sweden AB	➢ It is a valuable tool for developing new products and services in the areas of IoT, AI, ML, supervised or unsupervised depending on the availability of Big Data. ➢ This availability helps us to draw conclusions and take decisions out of data.
Scania	➢ Driving Coaching is an initiative that coaches the drivers how to use the vehicle. That would be impossible if we did not have Big Data.
Ericsson	➢ Providing insights to our customer units and thus more value for the customer. ➢ Useful to make new businesses.

16) Implementation of Big Data in the NPD/NSD processes

The following part tries to examine in what ways the case companies make use of Big Data or BDA in their NPD/NSD processes and whether their processes are data-driven or not.

Interview Participant	Answer
Vattenfall	➢ Leverage of Big Data especially in hardware intense projects, like putting requirements to a new wind turbine box or putting up a grid for geothermal.
Volvo Group	➢ It is an area we are still exploring. ➢ We would like find ways to predict things earlier and faster to take correct actions before it has to drop out. ➢ We try to utilize Big Data in all fields.
Fujitsu Sweden AB	➢ We are not doing that so much here in Sweden. The R&D and innovation is much more developed in Japan and outside of Sweden, but I think

	we're trying together with our partners to develop new applications for AI. ➢ It is the availability of data that makes us be able to provide and create applications helping our partners to do judgments and make decisions.
Scania	➢ Acquired knowledge about how the vehicle is being used, and thereby identifying ways of how to develop products and services and what conditions the product should be able to stand for.
Ericsson	➢ Feedback from BDA from our customers' networks can enable the creation of value-added products for them, the earlier identification of several things, securing our products behave in a way that we want them to behave and the takeover of more services by using the collected data and thus expanding to the service sector. ➢ Providing analytics as a service which is called "Ericsson Expert Analytics" and is a platform analytics tool that is sold to operators and they can build upon that. ➢ Exploration of more new businesses in areas we have not identified today, expansion of deliveries, built of more intelligent products and automation of operations that are made by humans.

17) Benefits and Challenges of using Big Data in the NPD/NSD processes

The following section attempts to grasp the benefits or challenges the interview participants have thought, expected or experienced from the usage of BD and BDA in the NPD/NSD processes.

Interview Participant	Answer
Vattenfall	➢ We can understand, predict the trend and therefore know how we can act for that. ➢ There are many facts that pinpoint one investment and it depends on a campaign's customer behaviors and their feedback.
Volvo Group	➢ Misunderstanding of how we could use data and sometimes lack of imagination of how to use it. ➢ Even if there are people to come up with an idea, collect data about it in a practical way, put it in a database and process it with Hadoop or other tools in an efficient and effective way inside Volvo Group, they are often and already busy with other tasks. ➢ IT engineers can be easily trained to use these tools, so it is possible for them to use data to predict certain things. ➢ If it is not possible, we should ask another company to help us. We are on a deciding phase about finding a partner or not. ➢ When vehicles will become very autonomous, additional software development is required, but its management may be difficult for doing it alone. ➢ Collaboration with other companies and having control over the product will be a big question, because we are not used to work in partnerships, like sharing the revenues, etc.
Fujitsu Sweden AB	➢ Gain a quicker product life cycle or product development life cycle due to having the right data and the right amount of it, thus shortening the way to the market from innovation and idea generation to product market launch. ➢ Legal aspects of not connecting the data to the person.

	➢ Collecting customer data in a very quick way requires some development or additional actions from many companies all over the world.
Scania	➢ Better analytics helps to fix any quality problem arises. ➢ The whole maintenance problem nowadays is based on how vehicles are being used.
Ericsson	➢ In the service development, data is used to automate things and decrease feedback loops. ➢ Identify problems in real time analyzing the PowerPoint presentations that our customers create for us. Thus, solution of these problems and making new deliveries before the customer realizes that there is a problem, is our vision. ➢ Big Data has helped us to increase our efficiency, save money, remove a lot of manual work and easily identify these problems by just having the right data. ➢ More efficiency in our product development and service delivery, but also, better products with high quality and better intelligence. ➢ Based on the data we build insights and we can have new businesses.

18) Rating of company's utilization of Big Data in the NPD/NSD processes

In this section, participants give their answers about how they rate the utilization (successful or unsuccessful) of making use of Big Data in the NPD/NSD processes.

Interview Participant	Answer
Vattenfall	➢ Sometimes it has been fruitful but sometimes it is bogus. ➢ Having access to data, monitor a trend or predict or implement a preemptive analysis has been very informative in our decision-making process. The process is the same with services as well.
Volvo Group	➢ If we talk about self-driving vehicles, we are very successful, and we are among the leaders in the world. ➢ We are not very advanced in utilizing Big Data in our NPD process, because people who work with autonomous vehicles, are not so aware of that area, namely they are not Big Data or Machine Learning specialists.
Fujitsu Sweden AB	➢ My Japanese colleagues with experience of over 30 years in Big Data utilization use data in a decent and relevant way. ➢ We can always improve but I am sure we have it as a key component in NPD processes.
Scania	➢ We are successful, but we can always improve. We are just in the beginning. ➢ It's impossible to quantify results now.
Ericsson	➢ It is successful, but we have just started it. ➢ I am not aware of any specific metric used inside Ericsson.

19) Usage of Big Data Analytics tools in the NPD & NSD processes

Here the interviewees share what types of BDA tools they make use of generally inside their companies, and especially in the NPD/NSD processes.

Interview Participant	Answer
Vattenfall	➢ Main use of Microsoft Stack, Hadoop and Google Analytics, from whom collection and leverage of insights is accomplished.

Volvo Group	➢ Data generated from our connected vehicles are used for providing better services to our customers and to improve our products for the future.
Fujitsu Sweden AB	➢ Use of many tools except for Cognos and SAP ➢ Cognos is used in Sweden too.
Scania	➢ Use of R, Python, and other coding languages, and Hadoop. ➢ Our goal is to extend our usage of tools in the future using the latest technology in order to stay competitive.
Ericsson	➢ Spark to work with data and do more complicated analysis if it is needed. ➢ Tableau is used as data visualization tool. ➢ Storage of data in Hadoop clusters that is used as an infrastructure tool.

20) Actions taken for improvement of the management support towards Big Data implementation in the NPD/NSD processes

This question is highly related to whether there is support from the top management towards a data-driven culture inside the case companies and BD implementation in NPD/NSD processes or not.

Interview Participant	Answer
Vattenfall	➢ Data-driven decision-making process and ➢ Treating data as an enterprise asset have been set and supported from the top managers.
Volvo Group	➢ In the manufacturing area, Big Data is utilized for generating benefits, but no precise actions yet on how to implement it. ➢ Exploration of different alternatives and recommendations to the top management on how we should do this in the next years.
Fujitsu Sweden AB	➢ It is a question outside my competence or knowledge, because we do not have any product development here.
Scania	➢ I am not aware of that.
Ericsson	➢ A roadmap for increasing our efforts and use data in a wider context in product development to increase efficiency much more.

21) Key Success Factors (KSF) of using Big Data in the NPD/NSD processes

The executives in this part share their experiences and views about what key success factors Big Data can provide their companies with both in general and regarding NPD/NSD processes.

Interview Participant	Answer
Vattenfall	➢ Data quality, understanding your data, cataloguing it, getting all the information in one place. ➢ Understanding how to use it is the trickiest factor otherwise you go into different interpretations all the time. ➢ Having a common governance, a data-driven culture and mindset, and understanding of working with data is very important.
Volvo Group	➢ First, you should have relevant data and you can understand how to combine different data in order to predict certain things. ➢ It doesn't matter if you have data or not, you can buy a lot of data today, like weather data. But why should you buy that if you do not know how to use it? ➢ We are learning every day and improving our ways for using them, because generally that will distinguish several companies from others.
Fujitsu Sweden AB	➢ Co-creation of products and services together with our customers or finding new ways of collaborating with them.

	➢ The availability of Big Data is the foundation, because with that, the creation of new services based on the performance or on analytics, or on patterns that you can draw out of the data is easier.
Scania	➢ Lack of sufficiency of Big Data quality. ➢ Good awareness about data analytics cases and description of data effectively to make it possible to use it.
Ericsson	➢ Improvement of our products in intelligence, quality ➢ Built of smarter networks and products, ➢ Insights for exploring unknown business areas ➢ Continuous improvement and advancement in order to increase efficiency in product development and leverage more insights for improving our products.

5. Analysis

In this section of the study, the findings from empirical data (interviews with study participants) will be compared among each other. Afterwards, the same procedure will follow with the comparison of these data with the theoretical findings from the literature review. All this data will be coded into three different categories according to the interview guide that is available on Appendix A and the most important points of each category will be cross-analyzed and discussed.

5.1 Big Data Definition

This study has compiled a series of quite modern definitions within the current decade that were given for Big Data from multiple literature sources (Manyika, 2012; Gartner, 2012; Shi, 2014; TechAmerica Foundation, 2012; Mayer- Schoenberger, 2013; Ohlhorst, 2013; Chen et al., 2012; Dubey, 2015). The retrieved results from the literature do not show any coherence among them, because some of them focus on the size of Big Data (data volume) justifying the reason of being called "Big", and there are some other views that support the rest of Big Data features to justify the term "Big" and the methods that come with them, such as collecting, processing, analyzing and acquiring insights out of them, perhaps because the challenge of handling the vast amount of data has been overcome by several corporations.

As it was mentioned before, the term "Big Data" is quite abstract and there are quite a few generally accepted definitions for Big Data. Interview participants express different meanings of what Big Data and its dimensions are, depending on each one's experience from working with Big Data, but their views seem to converge in the perspective that Big Data is closely related to its volume and variety admitting that "Big Data is huge amount of collected unstructured data". Moreover, they acknowledged that there is a need of more advanced tools to effectively utilize Big Data and apply their insights on their operations.

A presentation of the perceptions of each company representative about Big Data and a comparison with the presented literature with these empirical findings will follow. It is worth mentioning that all participants found it difficult to establish a proper definition for Big Data. Specifically, the interviewees from Vattenfall and Fujitsu Sweden AB refer to Big Data as unstructured data that have to do with volume and velocity, but the first claims that their definition is based on every company's business need, while the second mentions that they can store and use the information whenever it is necessary. Their views seem to correspond with that of Shi (2014), that distinguishes the Big Data definition into one for academics and one for business purposes. Scania's representative refers to Big Data as huge amounts of data that special tools are needed to handle it and traditional software, like Word or Excel cannot, while Volvo Group's interviewee claims that Big Data is a huge amount of data that is utilized in many of the company's processes and tries to contrast it with the trend technologies of Artificial Intelligence (AI), Machine Learning (ML) and traditional analytics, which are hugely affected by Big Data. Scania's participant seems to agree with the majority of definitions presented in this paper and given by Gartner (2012), TechAmerica Foundation (2012), Manyika (2012), Ohlohorst (2013), Dubey (2015) and Chen et al. (2012), all referring to Big Data's massive volume, velocity, complexity and variability that require advanced technological techniques and tools to capture, store, manage and analyze this data and draw new information. Ericsson's participant refers to Big Data as a huge amount of data derived from networks, customers and performance measurements whose collected insights can be utilized from companies to foresee several big trends, correlations or clusters, while with a small portion of data that would be impossible. His view seems to agree mostly with that of Mayer-Schoenberger (2013), who believes that people working with large-scale data can extract new insights or create new value channels for organizations, markets, individuals and governments.

In the organizations of every interviewee, Big Data is utilized mostly for making several internal processes more efficient, for business purposes, for facilitating and accelerating decision-making and for commercial purposes, meaning that through their analysis they can collect valuable insights in order to provide better and in accordance with their customer preferences, products and services. Thus, the information provided by tapping into Big Data is utilized in several functions of their corporations, from financial and marketing to Research & Development and Business Development departments. Therefore, this presupposes that most of the interviewed enterprises have high technological capabilities and have invested in acquiring advanced tools to edit and analyze Big Data, in storing a huge variety of data sets and in using the generated insights to different functions for various business applications, like NPD and NSD.

5.2 Big Data and Business Performance

Business Performance Metrics

There are several ways, methods and tools, with whom businesses can measure and thus improve their performance. Vattenfall measures its performance by gross margins, customer base and Master Production Schedule (MPS). Volvo Group's interviewee distinguishes three levels of business performance: on a divisional level where every division has its certain Key Performance Indicators (KPIs) focusing on customer satisfaction, on a top management level where profit, cash flows and other financial measurements are important, while on a team level, task or role-related measurements are implemented for realizing every employee's performance. Fujitsu measures its performance through financial KPIs, such as revenue streams, profitability and cash flows, quality KPIs for projects and customer-related services, and employees' performance is measured by employees' surveys or via their own tool called "team barometer". Scania's performance measurement is accomplished through different phases, which are periods or stages of change or development, such as phase of hours, workshop hours, phase of trucks, phase of cars, and financial metrics, such as Return on Investment (ROI). Ericsson's representative claims that the top management put requirements on what they should focus on and which types of products they should bring to the market, but he is not aware of any specific business-related performance metrics.

According to the practitioners' views, all companies use different metrics for different purposes for measuring their operations, but the results show that every company makes a partial use of the Balanced Scorecard that was mentioned in the literature and uses metrics for some of the perspectives. Vattenfall, Volvo Group, Fujitsu Sweden AB and Scania converge in using financial KPIs to measure their financial performance, Vattenfall, Volvo Group, Fujitsu Sweden AB in using customer-related KPIs, while Volvo Group and Fujitsu Sweden AB in using KPIs for employees' performance. Only Scania is using KPIs for internal processes. Therefore, the more utilized KPIs are for financial and customer-related purposes and also these two indicate the high importance and value of a good financial situation and stability, and customer satisfaction by the respected companies. Furthermore, business analytics may be used in some extent from the companies to take advantage of their collected data and implement its visualization.

Impact of Big Data in improving Business Performance

Vattenfall can monitor trends quite accurately by generating more insights or behavior patterns from the high data volume, pattern recognition, and predictive and proactive analytics. This helps them to respond to any market pressures and optimize their business processes. These views are in accordance with the ones of Davenport (2012) mentioning that insights' extraction from BDA can offer new business development opportunities to companies and with these of Constantiou & Kallinikos (2015) pointing out that implementing BDA strategies enhance the visibility of insights and prediction of future events. Moreover, Appelbaum et al. (2017) claim that combining data derived from internal and external sources, analyzing and interpreting it, can lead to the formation of historical patterns or future trends by several companies,

namely applying business analytics, which can provide them with additional value (Davenport, 2014). Volvo Group are still on an exploration mode executing some pilot programs and focusing mostly on the financial performance. Big Data seem to have the same impact for Fujitsu, which are able to monitor only their financial performance by utilizing Big Data, and not in other business functions. Scania sees potential changes in their business model through utilizing Big Data in their Rich Communication Services (RCS), while Ericsson is able to include more intelligence to their products which is derived from analyzing customer and operations feedback, to automate their processes more and reduce the amount of employees needed. The last two views reveal that Big Data capabilities can have positive impact in facilitating innovation, productivity, competitiveness and several internal activities and operations, and in identifying new business opportunities as it is mentioned in several literature outcomes (LaValle et al., 2011; Brown et al., 2011; McAfee & Brynjolfsson, 2012; Constantiou & Kallinikos, 2015).

Firm's Data-driven culture

Data-driven culture inside a company can improve not only its overall business performance but also its different functions' performance (Constantiou & Kallinikos, 2015). Some interview participants of the studied companies in this paper admit that the data-driven transformation has not begun yet, while others mention that it is on an initial stage. In the first category, Fujitsu Sweden AB and Scania are included, while Volvo Group, Ericsson and Vattenfall are pertained to the second group. Fujitsu have not established a data-driven culture in Sweden yet, but their representative insists that a data-driven approach can lead them to more efficient predictions and communication with customers. Scania want to become more data-driven in the near future through several awareness workshops that are organized inside the organization for all employees to understand better the value of data and the need of sharing it across the company's functions. According to their representative, it is a necessity not only to be the first player in the information ecosystem for sharing data in order to retain their customers and not just being a hardware supplier, but also to develop even more their descriptive and advanced analytics competencies and skills. On the other side, in Volvo Group, some departments are more data-driven than others having been supported by the appropriate data-driven infrastructure. For instance, they generate data from many pilot programs, thus being able to learn how to use it on a wider scale, and from their 700,000 connected vehicles on a daily basis, which helps the sales or service departments to note any possible problems with the vehicles. The whole company aims to become more data-driven in the following five years, according to their representative. Vattenfall's executive claims that they have recently initiated an introduction to the concepts of data-driven decision-making and data-decision culture. Ericsson has just started becoming more data-driven and the department of the company's interviewee (Software Analytics Innovation) helps the whole organization towards this goal, but he claims they need to improve their data science competencies to attain this target. Therefore, some studied firms have just started becoming data-driven and others are planning on being based on data in the near future. Thus, the transition of their business towards a more data-driven landscape and mindset has been continuous but gradual at the moment. This initiative is rendered as a challenge for establishing a data-driven culture inside a company within the literature, due to the lack of understanding of how to utilize Big Data technologies (LaValle et al., 2011), or what is the data's potential business value (Morabito, 2015) or the unclear Big Data goal objectives (Lee, 2017).

Data-driven decision-making's effect on business change

According to the literature, data-driven culture can affect positively a faster, improved and based on facts decision-making and thus its business performance (McAfee & Brynjolfsson, 2012). Vattenfall's executive claims that data-driven decision-making depends on different financial-and-customer related cases, for example, decisions on how they can increase profitability or reduce internal costs or increase customer engagement. Volvo Group is still experimenting on this issue, while Fujitsu's representative mentions that with the right infrastructure and information availability, they can improve their customer delivery and production quality while avoiding potential product defects as a result of their fast reaction to their data.

Scania's interviewee points out that by implementing a data-driven decision-making approach, they can base their decisions on data, involve more employees with different competencies and skills to decisions and improve their quality. Ericsson's participant is not aware of any business changes that have occurred inside the company due to data-driven decision-making, because he is engaged mostly with the technical part of Big Data and Big Data analytics. The results indicate that some of the examined companies have targeted in what areas they aim to utilize data-driven decision-making (Vattenfall, Fujitsu Sweden AB, Scania), but it seems its overall establishment is still a challenge for them. However, as suggested by the literature, the studied companies can utilize specific measures and indicators they are already using, like the Balanced Scorecard (BSc) or KPIs, to form more effective data-driven strategies and provide input to strategic data-driven decision-making (Pfeffer et al., 2006), and combine internal with external data to extract value for making decisions (Davenport, 2014) or the implementation of decision-making based on data.

Creating New Business Opportunities via Big Data

Finding new business opportunities to the marketplace is another aspect of how a firm can improve its business performance (Constantiou & Kallinikos, 2015). Volvo Group use data-related technologies based on their vehicles, thus, producing new services benefitting the customer while tapping into new revenue streams. On the manufacturing department, which is the area of the study participant, Big Data help them having higher output with the same input to increase the profits by reducing their costs. Fujitsu Sweden AB collect a lot of insights about their customers' business processes by utilizing IoT and AI, which are related to Big Data. Scania leverages Big Data by collecting data from their remote diagnostics related to vehicles for realizing their status, so they are closer to their customers and can offer customer-customized services, such as service or maintenance plans. Ericsson is getting new insights about NPD and new business models through Big Data that they were not aware of in the past, so they can develop new revenue streams. Therefore, from the above results it can be observed that Big Data has played a major role for each company to develop new business opportunities by leveraging insights from various data, and thus developing new or more customer-centered products and services aiming to higher revenues, cost deterioration, and tapping into new markets. This comes in accordance with the benefits that Big Data and BDA offer and described more extensively in the literature review part, such as in new product or service development (Tan et al., 2017), in improving business operations and in cost savings with high output quality (Davenport, 2014), and in customer service (Manyika et al., 2011).

Utilization of Machine Learning (ML)

Vattenfall utilizes ML to realize if maintenance operations can be accomplished faster, which maintenance processes are more cost effective and how the customers behave. Volvo Group uses ML for predictive analytics, making better decisions complementing their decisions made by individuals. In the near future, a combination of ML with human capabilities will be used in self-driving vehicles. ML is a component of Fujitsu's AI and they are building applications together and in accordance with their customer needs. It's used also in communicating with customers faster and digitally and in detecting defects before they occur based on the availability of Big Data. Scania does not use ML, but they want to initiate using it in the near future within quality reports in different language, according to their executive. Ericsson leverages ML in BDA, in automating processes, in making predictions, in their mobile networks and Radio Access Networks (RAN) for producing more intelligent products, in IoT where they produce several cloud products, in energy efficiency for their operations and for their products and in offering solutions to problems that are occurred and advising people what to do. As we can see, firms leverage ML for different purposes, such as improving decision-making being based on facts and having less human interference, developing applications, products and services for creating customer value, interacting with customers faster to prevent any possible product defects, automating internal operations and in making predictions, which are all ML benefits.

However, there is also an adoption challenge for some companies, but they have the advantage of being aware of how to utilize this technology.

5.3 Big Data and New Product and Service Development

Process for New Product or Service Development

R&D department in Vattenfall is working mostly with the NPD and NSD and these procedures vary depending on the nature of the product or service. Several parts inside the firm are running agile, so product implementation tooling is not necessary. In Volvo Group, the NPD/NSD process is very structured and iterative. A normal product development starts with an innovation period where generating ideas for potential products begins, then the product development phase starts setting a target that should meet several objectives (such as dates and costs), and finally comes the product testing before its launch on the market. They are also looking for opportunities around the world and outside of their industry to utilize technologies in developing new products or services. For instance, they use the Delivery Versus Payment (DVP) process, which is based on different gates and development loops to make sure that progress is made all the time using their own tools or bought tools from their suppliers. Fujitsu is also using a very structured manufacturing Japanese method, called Monozukuri, but is based in Japan where the production and R&D functions are located. Monozukuri literally means "craftmanship" in the English language and is roughly translated as "the act of making". It is the overall production process and it includes not only the machines, tools or methods that are used during the production, but also the different feelings that are created throughout the procedure, such as satisfaction and pleasure with a tangible outcome (Wallenius, 2018). It is also related to the continuous improvement of the production system and processes that will yield excellent products. Moreover, according to Ito et al. (2017), Fujitsu is planning to revolutionize its Fujitsu Production System (FJPS) by introducing a "smart Monozukuri" which will be based on several innovations ("Production Process Innovation", "Supply Chain Process Innovation", "Development Process Innovation") focusing on its customers, its development and production sites and society. Hence, the "smart Monozukuri" aims to "interconnects departments and plants as well as suppliers, partners, and customers via a virtual environment" (Ito et al., 2017, p.10). Scania's NPD and NSD process is divided in certain stages, where decisions are taken before going on the next stage, and which starts with brainstorming. Ericsson has different organizations inside the company that use NPD and NSD processes to develop their products or services as best as possible, which initiates from idea generation and then a proof of concepts is followed for producing viable products and services. During the process, there are stages in order to find out whether they should continue with a particular project or not or learn a lesson from it. The company's technological competencies, capabilities or tools can be usable in every industry, so they collaborated with companies from several fields to combine their knowledge and accomplish a mutual evolvement. Therefore, the NPD and NSD processes of Volvo Group, Scania and Ericsson are similar and mainly based on the Stage-Gate model. Moreover, they seem to use this seven-stage new product development process introduced by Cooper that divides the innovation process into a set of parallel activities. "A stage-gate system is both a conceptual and an operational model for moving a new product from idea to launch" (Cooper, 1990). The "gates" operate as quality control checkpoints that require specific criteria to be fulfilled before the project is allowed to proceed further. This development process is iterative and highly structured and is usually adopted by several companies for mitigating risk and increasing efficiency (Veryzer, 1998).

Implementation of Big Data in the NPD & NSD processes

Vattenfall leverages Big Data in hardware intense projects, while Volvo Group is on an exploration stage, preferring to exploit Big Data for predicting things earlier and faster and making correct actions before defects occur. Fujitsu's R&D department in Japan utilizes Big Data trying to develop new applications

about AI for their partners to make correct judgments and decisions. Scania collects insights from Big Data analytics about the usage of a vehicle and thereby they can identify ways of how to develop their products and services in the best possible way and what conditions of them they should fulfill and enhance. Ericsson is utilizing feedback from BDA from their customers' network, which enables them developing value-added products, identifying several things earlier, their products following a specific behavior and takeover of more services helps them to expand in the service sector. They also provide a platform analytics as a service (Ericsson Expert) to their clients and they are able to explore newer unidentified businesses, expand their deliveries, build more intelligent products and find the right methods and tools to automate their operations. Therefore, in this section, participants are in accordance with the benefits of Big Data related to the creation of new products, services and applications, based on their customers' preferences.

Benefits of using Big Data in the NPD/NSD processes

Vattenfall's participant pinpoints that via the utilization of Big Data in the NPD/NSD process they are able to understand and predict trends though a preemptive analysis, and therefore, plan and make actions of how to act upon them. Volvo Group's interviewee does not see any advancement of his company in utilizing Big Data in the NPD process, because employees working with them are not specialists in that field and they use it only for self-driving vehicles. Fujitsu's interviewee mentions that Big Data is a key component of NPD processes so that they can gain a quicker product life cycle or product development life cycle due to having the right and right amount of data, thus shortening the way to the market, meaning from innovation and idea generation to product market launch. Scania's interviewee thinks that if they develop better BDA, they could tackle any quality problem before it arises. Ericsson utilizes data in the NSD to automate processes and decrease feedback loops. They are also able to identify problems in real time by analyzing the PowerPoint presentations provided by their customers and they want in the near future to solve these problems and make new deliveries to their customers, before they realize the problem. Participants seem to agree among each other and also with the benefits that were reviewed on the literature review session claiming that through Big Data and their technologies, they can predict trends for NPD/NSD, take faster and more effective decisions and actions about their NPD/NSD processes, they can identify quality issues on their products/services before they occur and finally they can co-create products taking as an advantage their customers' involvement (Zhan et al., 2016; Tan et al., 2015).

Challenges of using Big Data in the NPD/NSD processes

Vattenfall's representative mentions that there are different aspects that one investment depends on and the main one is customers' behavior and their feedback, so investing in the development of a product or service depends mainly on the customer. Volvo Group's participant claims that there is a misunderstanding or sometimes a lack of imagination inside the firm of how to utilize data. Moreover, there are only a few competent people that can leverage Big Data and the management of the additional software that is necessary for autonomous vehicles would be difficult, so the solution that the participant proposes is collaboration with other companies to help them in that part, but their partnership will be in question, since the control of a product or service will be at stake. Fujitsu's representative thinks that potential legal aspects may be incurred from not connecting data to every individual and also some kind of development or actions are required from every company for solving the massive data volume. Scania's representative mentions that they face a maintenance problem which is based on the usage of vehicles. Thus, legal aspects, lack of understanding of utilizing Big Data, customer behavior and maintenance issues are mentioned as the challenges that firms have to tackle to optimize Big Data usage, which are also highlighted by several literature sources (LaValle et al., 2011; Lee, 2017; Sivarajah et. al, 2017; Morabito, 2015).

Actions for improvement of management support towards big data implementation in the NPD/NSD processes

Vattenfall's representative mentions that treating data as an enterprise data is supported by the top management, as well as a data-driven decision-making. Volvo Group's executive mentions that in the manufacturing field, Big Data utilization will help them gain benefits, but its implementation is still in question and the top management still explores different alternatives and recommendations. Ericsson is having some kind of roadmap for increasing their efforts of using data in a wider context in NPD to increase their efficiency. This part is highly related to the data-driven culture that whether has been developed inside an organization or not and its implementation is highly dependent on the top management. The results show that Vattenfall and Ericsson leverage their Big Data capabilities to assist NPD and NSD processes, while in Volvo Group is still on an exploration mode, because they probably have not implemented data-driven culture and decision-making processes, which affects positively NPD and NSD.

Key Success Factors (KSF) of using Big Data in the NPD/NSD processes

In this part of the analysis, participants were asked to identify which are the key success factors for successfully establishing Big Data and its related analytics and technologies. A data-driven mindset and a fact-based decision-making process are more effective, according to McAfee & Brynjolfsson (2012). Vattenfall's participant sees as important KSFs of using Big Data in the NPD/NSD process the data quality and the understanding of using it and cataloguing it in one place. Having a common governance, a data-driven culture and mindset, and understanding of working with data and analyzing it is very important. Fujitsu's executive mentions that the availability of data is the foundation of utilizing Big Data in the NPD/NSD processes, because the creation of new services based on the performance or on analytics, or on patterns that you can draw out of the data is easier. Moreover, the co-creation of products and services together with their customers or finding new ways of collaborating with them is crucial factor of utilizing Big Data. Ericsson's executive indicates that improvement of products in intelligence and quality, built of smarter networks and products, leverage insights for exploring new areas and for improving their products, and continuous advancement for increasing efficiency in NPD are crucial KSFs for his company. Therefore, these three views stress out that data quality and availability are essential for Big Data employment. If data is imprecise, then inaccurate information will be generated, and this can have a negative impact on the quality of data-driven products and services for both organizations and society (Günther et al., 2017).

Volvo Group's interviewee mentions by having relevant data you can understand how to combine different data in order to predict certain things. Continuous learning and improvement of using it will distinguish them from other companies, offering them a competitive advantage. Scania's representative claims that they should focus more on having sufficient Big Data quality. Good awareness about data analytics cases and an effective description of data can make it possible to use it in the NPD/NSD processes. Manyika et al. (2011) mentions the requirement of highly skilled personnel that will utilize successfully Big Data technologies and also argues that organizations need to change, perceive and adapt to the Big Data trend and employ data-driven strategies to their business processes.

6. Conclusions

A total overview of the empirical findings (interviews with the executives) shows that all of the examined Swedish-based companies have identified the appropriate Big Data technologies that are needed to manage the huge volume, velocity and variety of data, and drawing valuable insights and information from its analytics, are familiar with the idea of implementing them in a wide spectrum of their operations, which will yield a huge amount of business opportunities and create high potential business value for both them and their customers. However, those that utilize Big Data seem to apply it at a slow and cautious pace and those that have not utilized it yet, face problems perhaps due to the lack of a clear strategy around it or the struggle in establishing an organizational change, which indicates that firms in Sweden have great room for improvement in effectively implement and integrate Big Data.

Regarding the impact of Big Data on business performance, empirical findings conclude that the chosen case companies use a wide variety of methods, tools and metrics to measure the different aspects of business performance, but they focus mainly on the financial performance and they give a secondary role to the employee, quality and customer satisfaction performance using mainly Key Performance Indicators (KPIs) as measurements. Insights from Big Data can assist them in improving their overall business performance by boosting their NPD and NSD and other business processes, discovering new business models and innovations, anticipating possible product defects and monitoring potential trends. Furthermore, data-driven decision-making together with a proper data infrastructure and data availability can drive them in product and process quality enhancement.

In this study, a list of different definitions of big data that are encountered in the literature is also presented. However, the researcher selected the ones that he deemed appropriate within the business perspective in order to provide a basis for analysis. Exploring these definitions together with the empirical findings leaded the author to meet his goal of answering the main research question of this research, which is "*What is the impact of Big Data on the business performance of Swedish-based companies?"* and to understand how the case companies perceive Big Data and its functions. The definitions that were presented in the literature and the interviews' findings demonstrate a divergent meaning which reveals that the definition shifts accordingly for every industry, company, department or any other business activity and according to data's size, the complexity to analyze it and the available technologies that determine these actions. However, these different points of view about Big Data seem to be bridged on its huge volume, variety and velocity that is a benefit and a challenge at the same time, on the existing technical or managerial challenges that large corporations face and on the boundless business opportunities that can offer in many different sectors and organizations. Moreover, both literature sources and empirical findings show that data availability, quality and security are deemed as very important aspects of Big Data. These features can bring a more effective extraction of valuable insights, which in turn can lead to an enhancement of decisions based on statistics, dashboards and facts, more efficient operations and to yield new trends, concepts or ideas about business development and more customer-centered products and services. Thus by motivating a data-driven decision-making strategy and a data-drive culture, an organization can reach its strategic goals. These actions can generate a sustainable competitive advantage for organizations that are utilizing Big Data effectively and in addition, they can unlock and compete in new markets.

As mentioned above, Big Data can affect positively the business performance and thus business development. Therefore, exploring the research sub-question of this study, which is *"What is the impact of Big Data in the New Product and Service Development of Swedish-based companies that affect their overall business performance?"* the combination and analysis of several literature sources and interview results regarding New Product and Service Development show that Big Data, its related areas and Artificial Intelligence can bring several benefits to companies. Big Data has an influence on the NPD and NSD processes of the examined companies, but some of them have just started utilizing it and try to improve their utilization, while others have it already as a key component. The two models of NPD that were

discussed further in the literature review as well as the performance metrics, the Business Performance Management (BPM) model and the Stage-Gate model, and the Key Performance Indicators (KPIs), appear to be mostly employed by the case companies, a conclusion derived from their executives' description of the procedures they follow on the NPD and NSD processes.

The analysis showed that although the Big Data definition is quite abstract yet even among the five practitioners, they seem to share the view that Big Data is characterized by huge amount of unstructured data for which more advanced tools and mechanisms are needed. The five case companies seem to use some components of the Balanced Scorecard to measure their overall business performance and different KPIs to measure the performance of each department being focused on the financial one. Collecting and analyzing Big Data has a positive impact on their business performance, since it helps them to generate insights, with which they can recognize different patterns, predict future trends, improve and automate their internal processes and can become more competitive by identifying new business opportunities and focus their business development on new or more customer-centered offerings. Practitioners acknowledge a plethora of exciting opportunities in their respected industry together with an increasing capacity of several tools and technologies (BDA, ML, AI, Business analytics) to collect, store and analyze data, but they admit that they are just in the beginning of this journey. A data-driven culture can also improve the firm performance, but the empirical findings showed that three out of five firms have just implemented a data-driven transformation being supported by the top management, while the other two will proceed implementing it in the near future. Data-driven decision making, which is a part of a data-driven culture, has not clearly applied by any company, thus it is still a challenge for them, but they seem to be aware of practical ways to leverage it in the future. The same situation applies with Machine Learning. Companies seem to know how to reap its benefits, but its adoption is rendered as a challenge. In addition, all the examined have very structured NPD and NSD processes and most of them utilize the Stage-Gate model, which is consisted of different checkpoints and criteria that allow a project development to proceed. The case companies apply Big Data in the NPD and NSD processes for predicting problems before they actually occur, make faster and more efficient decisions and actions, identifying ways of optimizing their products and services by exploiting their customers' feedback and tapping into new businesses. The benefits and key success factors they see in NPD/NSD process after using Big Data is having their products a quicker life cycle or product development life cycle deciding faster a market launch, they can understand and predict trends based on products or services, can realize product quality issues, such as product problems or errors, before they occur. These benefits are described also as the key success factors of successfully employing Big Data, BDA and its technologies. The challenges they face derive from the fact that an investment in a product or service development requires customer feedback, so they should be fast in identifying the different kinds of feedback, misunderstanding of how to utilize data efficiently, data huge volume, variety, privacy and security and maintenance issues. The reasons behind those challenges are the lack of a clear strategy around a Big Data implementation, including planning, investment in resources, coordination of different people and functions inside a company and control, the difficulties of finding highly skilled data scientists with the appropriate knowledge that can understand the data features (challenges) and its high potential value it can offer from a business perspective and, finally, the complexity of complying with several legal aspects and frameworks, such as GDP regulations, which may grow in the future, in order for corporations to keep data privacy and security without breaking any law.

In order to create or enhance value throughout their value chain through value-adding products and services, companies should collect data according to their business needs and incorporate clear data strategies and targets to develop new business models or make adjustments to existing ones. Moreover, Big Data objectives should align with the overall business ones to ensure an effective firm performance. The top management can facilitate this procedure by establishing a data-driven mindset inside the organization and by continuously providing clear guidelines about Big Data implementation to every department of the organization. Further value-adding actions of corporate managers can be hiring highly educated and skilled experts who are savvy around Big Data or training employees who cannot understand how to utilize Big

Data, its theories and its potential value in order for them to use it effectively, and regularly showing to them through solid business cases the vital role of data in retaining competitiveness in a highly fluctuated business environment. All the above actions can lead to successfully solving not only the technical challenges, but also the managerial dimensions of Big Data by securing and using effectively the necessary human and financial resources for the transformation into a data-driven organization.

Overall, the combination of the drawing conclusions from both the empirical studies and the theory pinpoints that the integrated corporate culture, governance and strategies around Big Data can influence the role of the latter within the NPD and NSD processes and contribute to improved results in the general firm performance.

6.1 Limitations

The presented topic is aiming to provide a solid basis for the reader to thoroughly understand the relationship and the managerial implications of Big Data on business performance and its utilization in New Product and Service Development of Swedish-based companies. The latter's representatives are trying to explain how their firms leverage their Big Data capabilities and are organized around these. The study is not focusing on the technical parts of Big Data processes that most people think when they hear the term "Big Data", such as explaining IT infrastructures (hardware and software), forecasting or statistical tools and methods (algorithm architecture) appropriate for Big Data or other programming-related issues, but it will be a supplement on the existing literature from a business, managerial and innovative aspect. Furthermore, the examined companies are only a certain sample of companies in Sweden and because this study is a multiple case study, the results may not be generalizable across certain industries or for different kinds of organizations. Besides, this study focuses only on Swedish-based companies, and it is not known if its results can be applicable and generalized to organizations beyond the Swedish context. Another remarkable limitation is the fact that there was found no existing literature on how Big Data can support NSD, and little research respectively on the support of Big Data of the NPD concept. Hence, the author of this paper introduced the concepts of servitization and service innovation and together with the empirical observations from the case companies' practice, was able to support arguments that functioned as assistance to answer the research sub-question about the impact of Big Data on the NPD and NSD processes.

The research has been analyzed using qualitative methods. One limitation that should be taken into consideration is the certain bias that the research imputes when the analysis of data occurs. The study is based on subjectivism; thus, the researchers axiological, epistemological and ontological ideas influence the way these results are interpreted.

6.2 Future Research

Examining and analyzing the empirical findings of the interviews, we observe that the case companies that were examined in this paper coming from different sectors, have one common similarity: they know what tools, methods and technologies to implement and make use of to achieve operational efficiency through Big Data and Big Data analysis, they are aware of the benefits and challenges of them from a technical, process and managerial perspective and of the Key Success Factors that they incorporate, but they seem to struggle to actually establish all this knowledge inside their organizations. Therefore, they have a theoretical knowledge about the phenomenon of Big Data, but they lack the practical application of that knowledge. Future research can focus more, from that managerial and operational point of view, on combining certain factors and theory around Big Data and, through an in-depth examination, find methods or techniques of

how organizations can integrate more successfully and effectively Big Data technologies and analytics to accomplish an improved performance and in turn novel or enhanced New Product or Service Development processes. In addition, since most of the case companies in this paper are involved in the manufacturing industry, it will be also useful to highlight the influence of Big Data practices into the automatization of the internal processes of these kinds of companies and what effective and faster solutions can provide to various departments inside organizations. This research concept can also be expanded in other kind of industries as well.

Further findings from the empirical studies indicated a close relation of Big Data except with a traditional set of analytics, but also its significant influence of the emerging trends of the Internet of Things, Artificial Intelligence and Machine Learning. These technologies have proved to learn faster and make more accurate assessments, judgments and predictions, functioning sometimes like humans. As the representative of Ericsson claimed, they try to automate their processes more and more decreasing the human interference and produce more "smart" products or provide their customers with "smarter" networks and services, from whom many types of data can be derived. Almost the same situation applies to Volvo Group's self-driving and connected vehicles, which can yield many unstructured data. With these "smart" output, organizations can synthesize valuable information from distinct kinds of data generated from many diverse sources and experimenting how these emerging technologies can affect their entire organization in many aspects from the organizational scheme to several departments, their operations, their people and their output. Therefore, an interesting and challenging topic would be to examine the impact of these technologies to certain internal and external corporate operations, with the only proposed prerequisite, however, to be, when organizations will have established and integrated a high rate of maturity and utilization of Big Data and the Internet of Things or Artificial Intelligence or Machine Learning.

Moreover, the aforementioned technologies combined with Big Data exploitation will lead organizations to innovative products and services customized to user's needs, which may strengthen the position of established, developing or start-up organizations in the business environment. Thus, an interesting research will be investigating the impact of Big Data on small and medium sized companies or start-up companies and whether they have started establishing Big Data as one of their strategic objectives or utilizing any other emerging technology.

An author's speculation is the challenge of actually implementing BD perhaps rises from the fact that the field of Big Data is highly complex for organizations. The latter want to see quick and clear results in their established strategies and targets, quick returns of their investments, so most of them are impatient and the procedures of collecting various types of data from diverse sources, storing, cataloguing, and analyzing it, extracting insights, creating graphs and patterns to understand it better, employing the appropriate software, tools and technologies, and applying this information of analytics in every spectrum of their business, are perplexing and time-consuming. Therefore, they try to meet their objectives by other business and strategic means. However, the assistance of the emerging technologies that were mentioned before, can definitely play a major role by automizing these procedures leading the organizations to explore Big Data with much more efficient and effective methods that will make their lives easier in the short-term future. Moreover, there is a risk that may see in investing in Big Data resources (human, financial, technological) and in developing business models based on market, customer and social media insights and trends for creating new products or services that may change in the near future, reasons that may affect its implementation, might be mitigated by utilizing these technologies.

Finally, the author speculates that there are problems in the organizational structure and ineffective communication among managers and among employees from different departments inside an organization, so a research that focuses on examining the organizational structure, what communication channels, frameworks and protocols are used and how these have effect on the Big Data implementation would be stimulating.

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Appendices

Appendix A: Interview Guide

* My master thesis project is about the impact of Big Data on business performance of Swedish-based firms.

* The results will be used for a better understanding of the related topic.

* The data after the end of the course will be used only for academic purposes.

* Do you want to be anonymous?

* Is it ok if we record this interview?

Background information

(*This part is designed to get some addition information about the role and the position of the person in the company. According to the answers taken from the interviewee, we can see if this specific person is the appropriate one to answer the research question.)*

a. What is your full name and the name of the organization that you work?
b. What is your position inside the company?
c. How long have you worked at the organization? How long have you had this position?
d. How is your role related to Big Data and/or Business Development? (Business Intelligence, Big Data Analytics, Machine Learning, Innovation Management, Project Management)

Big Data Understanding

-How would you define Big Data?

-How does your company collect data?

-How does your company manage the data and verify its quality?

-What is your company data mining/data gathering objective(s)?

-What types of data are considered useful and how are they used in the company's daily operations?

-How do you select and assess the potential value of data?

-Have you established a data-driven culture inside your company?

-Have you noticed any data-driven influence on your daily business operations?

Big Data and Business Performance

-How do you measure business performance at your company?

-Do big data help you to create new business opportunities and how?

-Do/Have Big Data improve your business performance (achieving selected goals) and in which ways?

-In which parts/departments of your company do you apply insights from Big Data Analytics?

-Does data-driven decision-making can result in business change and how?

-Big data analytics provides companies with many insights and information about their business performance, but a lot of companies face difficulties in utilizing it. Machine Learning is proved to be a solution to big data analytics challenges. Have you considered using it or are you using it already?

New Product and Service Development

-What is your company's process for New Product or Service Development?

-How do you structure/manage this process?

-What tools do you use to evaluate your projects during development?

Big Data and New Product Development (NPD)

-Have big data helped you to improve the value of your offerings?

-Does your company make use/implement Big Data in the NPD process?

-If your company does not make use of Big Data, how possibly could make use of them regarding the NPD process, in your opinion?

-What benefits/challenges have you noticed of using Big data in NPD process?

-How would you rate your company's utilization of Big Data in NPD process?

-Successful: Can you quantify results?

-Unsuccessful: What are the reasons?

-Do you use any Big Data Analytics tools in NPD process to get insights? If not, which ones would you use?

-Do you have/Have you had any actions planned to improve the management support towards big data implementation in the NPD process?

-Are there any Key Success Factors (KSF) of using big data in the NPD process?

Big Data and New Service Development (NSD)

-Does your company make use/implement Big Data in the NSD process and how do they improve the NSD process?

-If your company does not make use of Big Data, how possibly would make use of them regarding the NSD process, in your opinion?

-What benefits/challenges have you noticed of using Big data in NSD process?

-How would you rate your company's utilization of Big Data in NSD process?

-Successful: Can you quantify results?

-Unsuccessful: What are the reasons?

-Do you use any Big Data Analytics tools in NSD process to get insights?

-Do you have/Have you had any actions planned to improve the management support towards big data implementation in the NSD process?

-Are there any Key Success Factors (KSF) of using big data in the NSD process?

Appendix B: Communication e-mail to the companies

Hello,

My name is Alexandros Kouseras and I am a master student enrolled in the program of Innovation and Industrial Management at the School of Business, Economics and Law at the University of Gothenburg. This semester I am conducting my master thesis and I write this e-mail wishing to build with you an initial communication channel seeking to explore the possibility of a joint research cooperation.

The topic of my master research will be: "The impact of Big Data on business performance for Swedish-based firms". Your participation to the project through an interview can be contributive as I will have the opportunity to exploit your accumulated knowledge and experience on the related topic. The interview will take 15-20 minutes and can be conducted face-to-face or through a skype call or a phone call. We can fix an appointment whenever it suits you better always dependent on your already respected and burdened agenda.

I hope in a more direct communication and in a more extensive dialogue with you on the subject. You can contact me on the details that appear below. Thank you in advance for your time and interest.

Best Regards,

Alexandros Kouseras