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Kaunas University of Technology

School of Economics and Business

Application of Big Data in Management Accounting:

A Case of Lithuanian Service Companies

Master's Final Degree Project

Airidas Kuzminskas

Project author

Assoc. prof. V. Varaniūtė

Supervisor

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Kaunas University of Technology

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Airidas Kuzminskas
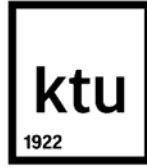
Project author

Assoc. prof. V. Varaniūtė

Supervisor

Assoc. prof. Alfreda Šapkauskienė

Reviewer

Kaunas, 2020

Kaunas University of Technology

School of Economics and Business

Airidas Kuzminskas

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Declaration of Academic Integrity

I confirm that the final project of mine, Airidas Kuzminskas, on the topic „Application of Big Data in Management Accounting: A Case of Lithuanian Service Companies" is written completely by myself; all the provided data and research results are correct and have been obtained honestly. None of the parts of this thesis have been plagiarised from any printed, Internet-based or otherwise recorded sources. All direct and indirect quotations from external resources are indicated in the list of references. No monetary funds (unless required by Law) have been paid to anyone for any contribution to this project.

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Summary

In today's business, competition in the market exponentially increases, management solutions in companies are becoming more complex, and the amount of data to process is continuously increasing, knowing what decision to make in order to minimise the risks is vital part of the company's life. In order to achieve the objectives, every company must make economically justified decisions. Management accounting is a part of accounting that deals with the measures to enhance the organisational benefit. Over the past few year definitions of big data and its variations is being inflected a lot, with many discussions about what it is and what changes it will bring to the accounting field. As a result, the *aim of this Master's thesis* is to understand how services companies in Lithuania are utilising big data information for management accounting functions. The master thesis consists of four parts:

- In the first part research papers on management accounting and big data are analysed. Literature analysis revealed that researchers in management accounting field analyses innovations or topics which are trending. As management accounting searches for new ways to strengthen insights for management, big data could be utilised to improve management accounting techniques.

- The second part of the paper analyses the theoretical framework of management accounting and big data and proposes a conceptual model, which could be used to evaluate how companies are utilising big data information for management accounting. Proposed conceptual big data application on management accounting model is an instrument, which could help companies to identify big data technological level and link it with management accounting processes.

- The third part of the paper provides the methodology used for research. Developed empirical research methodology for big data application on management accounting functions focus on mix methods by using survey and interview methods.

- The fourth part of the paper analyses the empirical results of the research. Service companies in Lithuania are utilising big data information for all levels of management accounting functions. The biggest part of companies utilise big data technologies for several management accounting functions. Despite the fact that companies currently value big data importance to decision making and problem solving (advanced management accounting functions), most companies use basic big data technologies such data storage and data visualisation for basic management accounting functions such as budgeting, planning, forecasting. Additionally, the conceptual model revealed that part of companies are not utilising big data information full potential.

Santrauka

Šiandieniniame versle konkurencija rinkoje eksponentiškai didėja, valdymo sprendimai įmonėse tampa vis sudėtingesni, o apdorojamų duomenų kiekis nuolat auga. Sugebėjimas, priimti sprendimą, kuris sumažintų riziką, yra gyvybiškai svarbus įmonėms. Siekdama tikslų, kiekviena įmonė turi priimti ekonomiškai pagrįstus sprendimus. Valdymo apskaita yra apskaitos dalis, nagrinėjanti organizacinės naudos padidinimo priemones. Per pastaruosius kelerius metus buvo sugalvota didelių duomenų ir jų variacijų apibrėžtis, daug diskutuojama, kas tai yra ir kokius pokyčius tai atneš į apskaitos sritį. Dėl šios priežasties, šio darbo tikslas yra išanalizuoti, kaip paslaugų įmonės Lietuvoje naudoja didelių duomenų informaciją valdymo apskaitos funkcijoms atlikti. Baigiamąjį magistro darbą sudaro keturios dalys:

- Pirmoje dalyje analizuojami valdymo apskaitos ir didžiųjų duomenų tyrimai. Literatūros analizė atskleidė, jog valdymo apskaitos srities tyrėjai analizuoja naujoves ar temas, kurios yra tendencingos. Valdymo apskaitai ieškant naujų būdų, kaip sustiprinti valdymo apskaitos įžvalgas skirtas vadovybei, didieji duomenys galėtų būti panaudoti valdymo apskaitos metodams tobulinti.
- Antroje darbo dalyje analizuojama valdymo apskaitos ir didžiųjų duomenų teorinė pusė ir pateikiamas koncepcinis modelis, kuris galėtų būti naudojamas vertinant, kaip įmonės naudoja didelių duomenų informaciją valdymo apskaitai. Siūlomas konceptualus modelis, galėtų padėti įmonėms nustatyti didžiųjų duomenų technologinį lygį ir susieti jį su valdymo apskaitos procesais.
- Trečiojoje darbo dalyje pateikiama tyrimams naudojama metodika. Sukurta empirinė tyrimo metodika, sutelkta į mišrų metodą, naudojant apklausos ir interviu metodus.
- Ketvirtojoje darbo dalyje analizuojami empiriniai tyrimo rezultatai. Paslaugų įmonės Lietuvoje naudoja didžiųjų duomenų informaciją visoms valdymo apskaitos funkcijoms. Didžioji dalis įmonių naudoja didžiųjų duomenų technologijas kelioms valdymo apskaitos funkcijoms atlikti. Nepaisant to, kad įmonės šiuo metu labiausiai vertina didžiųjų duomenų svarbą priimant sprendimus ir sprendžiant problemas (pažangias valdymo apskaitos funkcijas), įmonės daugiausiai naudoja didžiuosius duomenis pagrindinėms valdymo apskaitos funkcijoms, tokioms kaip biudžeto sudarymas, planavimas, prognozavimas.

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INTRODUCTION

The relevance of the topic. Decision making is a crucial component of business success. Decisions based on a foundation of knowledge and sound reasoning can lead the company into long-term prosperity; conversely, decisions made based on flawed logic, emotionalism, or incomplete information can quickly put a business out of commission. All business' people recognise the painful necessity of choice. Furthermore, making these choices must be done in a timely fashion, for as most people recognise, indecision is a choice in and of itself — a choice to take no action. Ultimately, what drives business success is the quality of decisions and their implementation. Good decisions mean good business.

In nowadays, companies' management decision reflects financial information, i.e., knowledge, obtained by accounting operations, analysing, and evaluating the company's situation. Employees use various information in order to appreciate certain situations, processes, to make management decisions, in that reason, information should always be delivered by time, simply understandable and reliable. Accounting, especially management accounting, is the first source of information (which gathers economic activity results moreover calculates and summarises it) from which management can comprehend the situation of the company.

Lately, when innovations rapidly develop, financial data might be insufficient to accept one or another decision. Management needs more detail information, which would allow to identify the problem, to determine its causes, to model situation, and to forecast. It means that companies need management accounting in order to have superior understanding of company situation. As the business world moves forward and the environment changes, the various processes become dynamic. In the midst of various innovative solutions, as well as dynamically changing the business environment, traditional management accounting does not meet the company's environment, it no longer meets the needs of executives in decision-making. Management accounting provides information according to which responsible persons could make decisions and control decision implementation. Information technologies are being developed globally and innovations are being introduced, new scientific new advanced technologies are being developed. These environmental changes encourage the company to change its strategy. One of the key tools for successful implementation of the strategy is dynamic, timely and informed management accounting.

The problem of the topic. Over the past few year definitions of big data and its variations is being inflected a lot, with many discussions about what it is, what changes it will bring to accounting field and etc. According to Chen, Chiang and Storey (2012) business intelligence and analytics (BI & A) and the related field of big data analytics have become heavily studied in both the academic and the enterprises over the past few decades. Big data, artificial intelligence and business intelligence have been studied extensively in the past years, especially after digitalisation. The importance of data became one of the prioritised emphasis for management today. It can be noticed that big data was analysed by such authors as Boyd and Crawford (2012), McAfee and Brynjolfsson (2012), Nott (2016) and others.

Management accounting is important for decision making. It is noticed that most of the research on this topic is related to management accounting in SME's (Pelz, 2019; Wilkerson and Bassani, 2020; Dearman, Lechner and Shanklin, 2018), to management accounting and environment (Burritt, Herzig,

Schaltegger and Viere, 2019; Mohd Fuzi, Habidin, Janudin, Ong and Ku Bahador 2019) and to researches in the management accounting field and techniques (Andrei, Gâlmeanu and Radu, 2018; Labrador and Olmo, 2019; Hirsch, Seubert and Sohn, 2015).

Management accounting in terms of big data is important for faster, fairer, and more accurate decision making. It is noticed that most of the research on this topic is related to big data information utilisation for decision making (Shamim, Jing, Syed, Shariq and Zaheer, 2019; Warren, Moffitt and Byrnes, 2015), to management control purposes (Warren, Moffitt and Byrnes, 2015; Gray and Alles, 2015). There are many articles about how big data allows achieving competitive advantage and increases effectiveness to companies in various sectors: financial, e-commerce, advertising, telecommunications and etc. Moreover, expectations what could be done with the right usage of big data are vast: from allowing enterprises to take faster and more precise decisions to the reduction of costs, development of new products and faster reaction to market trends. Besides, big data allows companies to minimise manual work and simplify the processes in the company. Integrations of systems and data can support decision making (Kościelniaka and Putoa, 2015). Even though there are many articles about the advantage of using big data, most of the information that could be found is more theoretical rather than a practical level. Due to this, **the problem** is to find out whether the service companies in Lithuania take advantage of big data usage in their business processes and decision-making through management accounting.

Object is big data application in terms of management accounting in service companies.

The **aim of the thesis** is to propose and empirically test the conceptual model of the big data application in terms of management accounting in service companies.

Objectives of the thesis:

1) To reveal currently researched topics in management accounting and big data disciplines and to analyse relations of big data and management accounting in literature.
2) To propose a conceptual model for assessing big data applications on management accounting functions.
3) To develop empirical research methodology for big data application on management accounting functions.
4) To carry out empirical research of the proposed model of evaluation of big data application on management accounting functions solutions and make suggestions for improvement of big data application on management accounting functions.

The methods used. In this thesis the method of scientific literature analysis is used for the analysis of a scientific problem and theoretical justification of the conceptual model. In the exploratory part for practical testing of the model is used the combination of quantitative (survey) and qualitative (interview) research (mixed method).

Limitations. As a master's thesis, this study had some limitations with time and content. This study focuses on service companies in Lithuania as those companies are most likely applying big data tools and generating lots of data in their business environment. Master's thesis in most cases cannot give a full understanding of a topic, due to this reason additional research is needed to ensure the results.

1. THE ANALYSIS OF BIG DATA APPLICATION IN MANAGEMENT ACCOUNTING IN SERVICE COMPANIES

This part of master's thesis consists of three subsections. The first one presents scientific research in the management accounting field. The second subsections review articles that examines big data and its possibilities. The last subsection provides research which examined management accounting topics together in the big data context.

1.1. The relevance of previous research on management accounting

For the literature review, articles related to management accounting were searched, which were written from 2015 until nowadays. After review of couple hundred of articles, selected the first 40 articles which are related to management topic. Selected articles can be grouped according to article themes:

- Management accounting in SME's (6 articles)
- Management accounting and environment (8 articles)
- Management accounting and risk (2 articles)
- Future of management accounting (5 articles)
- Research in the management accounting field and techniques (9 articles)
- Other topics related to management accounting (10 articles)

Management accounting in SME's

Most of the articles with research on management accounting concentrated on large companies. How large companies utilised management accounting, what values were extracted from the field and so on. Several authors such as Pelz (2019), Wilkerson and Bassani (2020) noticed that there is a deficiency of theoretical research on small companies' ability to implement management accounting and management accounting usefulness for small companies. Senftlechner and Hiebl (2015) specifically researched how management accounting and control are implemented in small family business and came to findings that management accounting and control seems to be less relevant to small business or family businesses than to large businesses. Dearman, Lechner and Shanklin (2018) investigated how small companies utilise management accounting information for business plan preparation, and the findings showed that demand for managerial accounting information is based, at least to some extent, on managers' need for key support of optimal decisions. Azudin and Mansor (2018) research focused on how small companies adopt management accounting practices, their study suggested that only small part of practices are adopted and the regression results demonstrate that only operational technology has a positive impact on management accounting practices.

Management accounting and environment

While doing the literature research, noticed that many articles released from 2015 are related to environmental management accounting. CGMA (2020) describes environmental management accounting (EMA) as *"identification, collection, analysis and use of two types of information for internal decision making. The first is physical information on the use, flows and rates of energy, water, and materials (including wastes). The second is financial information on environment-related costs, earnings, and savings. "*

Authors analysed EMA from different perspectives. Burritt, Herzig, Schaltegger, Viere (2019) investigated how environmental management accounting could support management to make decisions about cleaner production. Amir and Chaudhry (2019), Mohd Fuzi, Habidin, Janudin, Ong and Ku Bahador (2019) researched the linkage between environmental strategy and company performance. Both kinds of research showed that positive environmental companies' strategy positively influences companies' performance.

Management accounting and risk

As the business environment is constantly changing and is being reshaped by initiatives such as digitalisation and industry 4.0 authors Köse and Ağdeniz (2019) analysed how management accounting can support risk management. Analysis showed that new management accountants' competences in strategic management, control and business operation are closely related to risk management, and by using management accountants' competences risk management could gain additional insights. Nielsen and Pontoppidan (2020) in their paper analysed how risk management could be more visible and effective and constructs a framework that helps to implement risk management in management accounting and control systems more effectively.

Future of management accounting

Ratnatunga (2015) in his article, discussed new technologies coming to a broader consumer circle. According to the author, technologies such as 3D printing, fuel cells, robotic vehicles and other high tech technologies will furthermore have an impact on the management accounting field, and author recommends to be prepared for these dramatic business changes, but does not provide any explanations which areas might be impacted. Rikhardsson and Yigitbasioglu (2018) also discussed evolving technologies and stated that organisations need to invest in business intelligence & analytics in order to provide for decision-makers relevant information. However, author's research indicated, that the link between management accounting and business intelligence is not reviewed a lot. Осипов, Горина (2019) as well suggested to invest in systems and start developing regulatory applications. Macchia (2019) stated that research on management accounting practices had increased a lot, theoretical approaches are discussed in many articles. However, as the business environment is changing a lot, the author suggests that management accounting change topic should be studied in the nearest future.

Research in the management accounting field and techniques

Many researchers investigated deeper into the management accounting field and techniques, tried to prove the positive impact of management accounting for various subjects. Andrei, Gâlmeanu, Radu (2018) in their work, discussed that management accounting is a crucial part of the company that clarifies past events and helps to deal with present events and plan future events. Authors reviewed available literature from traditional techniques till new guidelines. Hirsch, Seubert, Sohn (2015) suggested that decision-makers are being overloaded with information, which leads to growing pressure as they need to make efficient decision making. Their research proved that good and clear data visualisation improves decision quality. Data visualisation also adds confidence to the decision. Findings showed that graphs improve decision quality and that tables impact managers' performance negatively. Labrador, Olmo (2019) analysed management accounting from cost accounting perspective. Their research focused on government companies and proved that if companies reported

according to full-service costs, rather than based on budgetary, such reporting would increase the usefulness of accrual accounting. Hoozée, Falconer (2019), in their explanatory study, tried to understand who influences the design of management accounting systems. The results showed that management makes the strongest impact on management accounting system design, but as the results differ across the companies, authors suggest that management's accountant's influence is greater. Yousif (2019) also stated that management accounting helps to develop the business and did the research in emerging economy service sector in order to prove that management accounting helps to improve the business. Findings suggested, that strategic management accounting influences services sector performance and could help to make better decisions.

Other topics related to management accounting

Other authors examined various aspects of management accounting. Saukkonen, Teemu, Petri (2018) explanatory case study analysed the decision-making process and how management accounting information helps to it. The study identified that analytical and manager-based features might take different forms in decision making. In decision making, even certain managers' viewpoints can be eliminated from the process, without any explanation. Pasch (2019) investigated the relationship between company lifecycles and adoption of strategic management accounting. Authors seek to understand the consequences of the adoption. Study results showed that strategic management accounting adoption is increasing till revival lifecycle stage and companies which have implemented less of SMA, those companies have lower performance rates. Moorthy and others (2015), noted that decisions formerly were based on guessing and now decision can be simulated using data-driven mathematical models. Mathematical models would lay a precise foundation for decision-making. As the entities gain more data, an accurate analysis could generate competitive advantage. Models would unlock the possibility to forecast raw materials demand, long term trends, financial situation, and cash flows.

From the search of the relevant topics in management accounting, it can be noticed that management accounting topic, mainly is discussed in the light of various changes. Articles discuss how to adopt management accounting to new business trends, how to adopt management accounting to new technologies, even to the environmental changes, management accounting has to adapt. Research studies, how the management accounting should be shaped, in order in the modern future it would be able still to provide relevant information for decision-makers.

1.2. The relevance of previous research on the application of big data

For literature review articles related to big data were searched, which were written from 2012 till nowadays. After review of couple hundred of articles, selected the first 20 articles which are related to big data. Selected articles can be grouped according to article themes:

- Big data field (5 articles)
- Big data in marketing (10 articles)
- Big data and healthcare (5 articles)

Research in big data field

As big data is new buzzword and field, part of the researchers are presenting what big data is, how it could be implemented and used. Batistič, der Laken (2019) in their studies gather more than 300 papers and analysed how big data evolved historically. Rajaraman (2016) analysed what is big data and summarises description of big data. Author says that all big data descriptions, emphasises how large data volumes are and that all authors underline the variety of the data. While one researcher analysed the theoretical perspectives of big data, other researchers such as Cabrera, Juan, Villarejo (2019) analysed why some companies fail to adopt big data analytics. Their study shows that companies fail to create appropriate infrastructure for big data analytics. Importance of appropriate infrastructure exceeds the difficulties, which business faces while implementing it.

Research on big data in marketing

A big part of studies focuses on big data usage for marketing and sales. According to researchers, marketing and sales are of the subjects, which can utilise big data widest. Such trend can be noticed from several surveys, for example, IBM (2012) study revealed, that 50 per cent of companies analysed how to target customers with available big data. Davenport (2014) adds that product-oriented companies have a bigger change to utilise big data, as these companies have loyalty programs, they can research available loyalty data, to personalise offerings and user experience. Akbay (2015) notes that entities could benefit from by listening to data streams and aligning them to their best customers in order to understand the behaviour, such analysis would strengthen company marketing. By knowing what motivates customers to acquire one or another goods or services, companies could strengthen marketing campaigns in that area or apply special pricing if needed. Global Economic Forum (2014) report stated the example of a global mass merchant, which was able to increase company profit per customer by 37 %. Merchant applied customer analytics tools tracking the behaviour, to provide personalised offers.

Many organisations carry out surveys, which highlights the importance of business intelligence and analytics and big data:

- Business analytics is one of the main trends in technology, according to IBM Tech Trends Report (2011).
- According to Bloomberg Businessweek (2011) survey, 97 per cent of large companies, which revenues are over 100 million dollars are using various forms of analytics.
- McKinsey Global Institute report predicts that by 2018, the US alone will have a shortage of employees with good analytical skills. Shortage will be from 140,000 to 190,000 employees. Correspondingly, companies will face a shortage of 1,5 million managers, which would know how to utilise big data in management decisions. (Manyika et al. 2011)
- According to the survey results of The State of Big Data Infrastructure: Benchmarking Global Big Data Users to Drive Future Performance global study, enterprises underline big data as digital transformation the most important aspect. Respondents of the report already see benefits of increased revenue (88%), improved competitive positioning (92%), ability to provide new products or services (94%), and more effective targeted marketing campaigns (90%).

Almost 90% of finance professionals think that it allows unleashing the potential of modification the way business is organised today (CGMA, 2013). McKinsey Global Survey results suggested that about 51% of companies rank big data and analytics in the top 10 corporate priority. However, at the same time, more than 44% of entities think that data and analytics generate more value than it requires and 33% per cent of entities believes that data ant analytics generates the same amount of value as it was required to implement it. IBM, as one of the most innovative companies in the world, conducted few surveys on big data. In survey Analytics: the real-world use of big data participated over one thousand of entities from 95 countries. According to the survey results, which were based on the 2012 year data companies were in the premature stages of big data planning and understanding development efforts. While 26% of financial companies are focused on understanding the concepts (compared with 24% of global companies), the majority are either: defining a roadmap related to big data (47%) or already conducting big data pilots and implementations (27%). New Vantage Partners performed executive surveys on big data annually. The newest survey shows that companies are still learning how to extract the value from artificial intelligence and big data projects. Thus, three-fourths of respondents received measured value from these projects. According to the survey, the number of companies which are benefitting from these projects rose by half from the last survey in 2017, which shows that companies are utilising big data better. Furthermore, 97.2% of executives are investing in, launching, or building AI initiatives.

Big data and healthcare

Big data is also analysed not only from a business perspective but as well from healthcare. Kamble, Gunasekaran, Goswami, Manda (2019) notices that data collection in the health sector is furthermore increasing as electronic health records and registries are introduced. Their study proves that big data analysis increases the performance of healthcare organisations and improves quality of life, diseases diagnosis, service delivery system. Nevertheless, the authors underline a few problems, such as data privacy, security, and traceability. Wu, Li, Lin, Goh (2017) states that wearable devices can be a useful link between healthcare and big data analytics and proves that companies which are introducing big data analysis from wearables data have a positive increase in market share prices, performance and profit comparing to other companies which have not introduced big data analytics in wearables. Clim, Zota, Tinica (2019) similarly proposes to use wearables data to improve patient quality of life and healthcare systems. Wearable sensing devices could suggest personalised medicine. Authors also sees a risk of data privacy and security.

According to the literature review, big data field is fresh. Many authors' tries to explain what big data is, how it is structured and how it could be used. Other authors try to find out how to utilise big data in the business environment to gain a competitive advantage.

1.3. The problem of application of big data in management accounting

Big data usability in management accounting is not studied widely. Some researchers touch only particular parts of management accounting. Shamim, Jing, Syed, Shariq, Zaheer (2019) discusses how big data influences the quality of decision making. Study suggested that companies are having challenges to utilise big data for decision making, due to the lack of employees with the right skills, which could reap the benefits of big data information for decision making. Warren, Moffitt, Byrnes (2015) suggested that other types of data, such as video, audio and text data could help to improve

managerial accounting, financial accounting, and financial reporting. Gray and Alles (2015) also added that by analysing social media, companies could react to indicators of possible issues. For example, companies could analyse comments or complaints. Authors moreover believed that big data will lead to change of management accounting and big data will influence management control systems and correspondingly budgeting process. Warren, Moffitt, Byrnes (2015) and Gray and Alles (2015) stated that big data could be used for controls purposes by creating a balanced scorecard. Moreover, authors think that the most valuable data is the one, from which companies can predict the future or identify potential opportunities. Warren, Moffitt, Byrnes (2015) had similar ideas, that big data together with ERP information could be used in budgeting. Organisations, such as ACCA & IMA (2013) tried to answer the question what future implications of big data companies could expect. Research showed that companies could see better company performance, while using big data and utilising specific real-time information. Furthermore, companies could utilise big data for new product creation, evaluation of risk, providing information for decision making, entering new markets. Moorthy (2015) discusses, that if the companies would collect consumer and market data, by analysing this information, companies would be able to create new products according to the patterns. CGMA (2013) states that by gathering large amounts of data, companies can capture behavioural trends and use the information in creating products that are more appealing or revise pricing models in order to increase sales.

During the literature analysis studies about service companies were searched. After review of several hundreds of articles, only a few were selected. Quantity of studies shows that service companies are not studied in scientific papers widely. Few authors study the management accounting topics in service companies. Alabdullah (2019) concluded research to understand the effect of strategic management accounting to service companies. The research explained that strategic management accounting dies a positive influence on service sector performance. Author suggested to help service companies' managers to understand the importance of available accounting information for decision making. Wnuk-Pel (2016) focused on management accounting systems and lean management in service companies. His study identified that management accounting systems in organisations are loosely coupled.

Appliance of big data to management accounting field in scientific literature is not studied comprehensively. Studies are wide, abstract and are not adapted to companies in specific sectors, especially the service sector. However, studies reveal that companies, which are using big data for decision making, according to management accounting information, can propose more personalised products to customers, can achieve better performance and utilise the existing data. As companies seek to maximise the benefits of big data, it creates a demand for scientists to study particular companies or sectors possibilities to adopt big data to their management accounting functions. Scientific literature review revealed that there is a lack of knowledge for companies (especially service companies), how to build the infrastructure, analyse, manage and later to use data for support of management decision, marketing, forecasting. On the other hand, companies are as well lacking tools in the order they would be able to evaluate their big data application condition and improve company performance. Due to these reasons, there is a need to deeper analyse the applications of big data application to management accounting in service companies.

Further chapters aim to offer a conceptual model of the big data application in terms of management accounting in service companies.

2. THE THEORETICAL ASPECTS OF BIG DATA APPLICATION IN MANAGEMENT ACCOUNTING IN SERVICE COMPANIES

This part of master's thesis contains theoretical literature review of the selected topic. In the first part of chapter management accounting concepts, differences between financial accounting, application areas are presented. The second part of chapter presents the concept of big data, technologies used. The third part of the chapter presents conceptual big data application on management accounting model, which could help companies to identify big data development level and link it with management accounting processes.

2.1. The concept and role of management accounting

In contemporary business, competition in the market exponentially increases, management solutions in companies are becoming more complex, and the amount of data to process is continuously increasing, knowing what decision to make in order to minimise the risks is vital part of the company's life. In order to achieve the objectives, every company must make economically justified decisions.

Management accounting is a part of accounting that deals with the measures to enhance the organisational benefit by devising policies. Management accountants help the management of any business organisation to devise better policies and plan to overcome the hurdles and take the business to the new heights of success. The analysis of the ongoing business activities, the evaluation, and interpretation of performances by an expert team will help to pinpoint the small holes that hamper the success rate of the running business. This branch of accounting is relatively new, which emerged during the late eighties and has been redefined several times since then. Institute of Management Accountants presented one reviewed definition on Management Accounting "*Management accounting is a profession that involves partnering in management decision making, devising planning and performance management systems, and providing expertise in financial reporting and control to assist management in the formulation and implementation of an organisation's strategy*" (IMA, 2008). However, other researchers defined management accounting in different ways by stressing a variety of aspects in management accounting (see Table 1).

Table 1 Management accounting definitions

Author, name of the work	Management accounting definition
Caplan (2006): Management Accounting Concepts and Techniques	Management accounting is the information that managers use for decision-making.
Kaplan and Atkinson (2015): Advanced management accounting	Management accounting information enhances decision making, guides strategy development and evaluates exiting strategies, and focuses efforts related to improving organisational performance and to evaluating the contribution and performance of organisational units and members.
Drury (2006): Management accounting for business	Management accounting is the process of identifying, measuring, and communicating economic information to permit informed judgments and decisions by users of the information.

Table 1 Management accounting definitions (continue)

Author, name of the work	Management accounting definition
Bhattacharyya (2011): Management accounting	Management accounting is that branch of accounting that deals with presenting and providing accounting information to the management in such systematic way so that it can perform its managerial functions of planning, controlling, and decision-making in an effective and efficient manner.
Cillis, Holt, Hussey (2017): Business accounting. An introduction to financial and management accounting.	Management accounting is the branch of accounting concerned with collecting and analysing financial and other quantitative information. It is primarily concerned with communicating information to management to help effective performance measurement, planning, controlling, and decision making.

The essence of management accounting lies in the fact that a perfectly executed planning, control, analysis, decision making, and evaluation would ensure profitable growth and business optimisation (Mihăilă, 2014). With an immaculate managerial accounting team, the organisation can be more productive and have a competitive advantage as it serves to study and understand the changing trends of the market and can alter the company's ultimate goals accordingly.

With the changing trends, notions and ideas, these strategies are changed to attain sustainable profitability for the respective organisation. *Management accounting can change when the work organisation transforms into a more network-oriented direction, informed by holistic, integrated learning* (Schiller, 2010).

One of the most important advantages of management accounting is that with the changing trends, the patterns of management accounting have been accordingly adapted, reviewed, and reformed. *Improved processes are resulting in improved flexibility of the organisation, lower costs, innovation processes and products* (Gornjak, 2014). These modified changes in the management accounting help in better innovation and hence better performance of the organisation. It also helps in gearing up the performance of the employees within the organisation by pinpointing the necessary changes required for a better outcome.

The Law on Accounting of the Republic of Lithuania specifies two types of accounting:

- financial accounting – is defined as a system for recording, grouping, and summarising transactions and transactions in monetary terms to obtain information for making economic decisions and/or preparing financial statements.
- management accounting - includes the collection, systematisation, evaluation, and presentation of information necessary for the management of an entity.

Main differences between financial and management accounting are presented in Table 2. It can be noticed that financial accounting is more regulated area, while management accounting orients more into information generation for internal purposes of decision making, strategy.

Table 2 Differences between financial accounting and management accounting (prepared by the author based on Walther and Skousen, 2009; Luft and Shields, 2003)

	Financial accounting	Management accounting
Regulation	Country laws International accounting standards	Management accounting policies are regulated by companies internally

Table 2 Differences between financial accounting and management accounting (prepared by author based on Walther and Skousen, 2009; Luft and Shields, 2003) (continue)

	Financial accounting	Management accounting
Scope	All activities	Part of activities (products, departments)
Time	Information about past activities. Results are being compared with previous period results.	Information about possible future activities. Results are being compared with planned results.
Users	Managers Employees External users (Tax authorities, supervisors, financial institutions, customers, suppliers, et cetera.).	Managers Employees
Format	Financial information is reported in a defined format so that different organisations can be easily compared.	Informal. Could be formed according to every department/company need.

Management accounting is a component of financial accounting; meanwhile, financial and management accounting are self-contained but are tied by the same study field – cost accounting (Lakis, Mackevičius, Gaižauskas, 2010)

Table 3 Difference between financial accounting, cost accounting and management accounting

	Financial accounting	Cost accounting	Management accounting
Objective	Provides information about financial performance of the company	Ascertain the cost and control	Broadest scope as it provides all types of information to management
Nature	Past data	Past and present data	Past data, but projection to future

Carpenter, Bauer and Erdogan. (2010) underlined the purpose of management accounting in the organisation as a support for management, by collecting the information, structuring it, and providing for decision making, however, management accounting could also be used for other purposes such as communication, planning, controlling, and evaluating business process and company strategy. However, other researchers stress also additional purposes of management accounting, for example, Cillis, Holt and Hussey (2017) as well add performance measurement, Kaplan and Atkinson (2015) add contributions identification. In order to achieve the organisational goals, the management needs to manage its resources, staff, and activities. These requirements are fulfilled by the management accounting team, which then helps the central management in controlling activities, decision making and future planning. The advice and recommendations of this team will strengthen the organisational goals more effectively (Kidane, 2012).

Current role of the management accountant. Many researchers' current years refer as information age, due to the reason that companies are creating lots of data, which is a source of competitive advantage for companies. In this information age, information changes the nature of competition among companies and shifts the traditional industries boundaries by creating whole new sectors. These new drivers are also leading to changes in management accounting. Professional management

accountant now has to have new skills and knowledge in order to be able to adapt to the changing environment.

It is interesting that in most of the cases, companies do not have employees who are called a "management accountant". Most often, functions of management accounting are distributed to many departments in the company, i.e. accounting, reporting, audit. However, for companies, it is crucial to develop and use management accounting. In nowadays, the role of management accountant is changing, because of intense competition between businesses and new information age. According to Brands (2015), management accounting works from four aspects:

- participate in strategic cost management in order to achieve long term goals
- implement management and operation control for performance measure
- plan internal cost activity
- prepare financial statements

Summarising the changes in the role of management accounting specialists in the context of big data, it can be stated that the role of modern management accounting specialists in company processes has expanded from manual data collection to adapting ERP systems in order management accountant could participate and provide information for company management.

The process of management accounting and its application areas. Management accounting helps to make decisions in the company by using cost, quality, and time-based information for decisions. Many employees are involved in their roles in this process. Audit department controls the processes, makes sure that operations are efficient. Accounting unit provides information to external users and has to provide meaningful information to financial reports for decision-makers. Employees responsible for systems developments have to gather requirements for system changes in order management would receive the information in the needed way. Tax unit experts utilise their knowledge in order companies would not overpay legally obligated taxes, also these experts may help in planning and controlling activities. Cost accounting plays a crucial role in tracking and reporting revenues, expenses, and relevant information about the products. Finally, companies have the controllers, which ties these department together and utilises the information from other departments in processes of planning, controlling, evaluating, and decision-making.

Association of International Certified Professional Accountants (AICPA) states that management accounting contributes to the following areas:

- Strategic management – strategic advisor to company management
- Performance management - business and performance-related decision making
- Risk management - identification, measurement, prevention of risks

Hugh Coombs, Ellis Jenkins, David Hobbs (2005) provides a broader application area of management accounting:

- Budgeting, planning, and forecasting
- Cost accounting
- Performance analysis
- Decision making

- Cause and effect

Budgeting, planning, and forecasting. Almost all management accounting techniques are used in the budgeting process. In order to develop a reliable budget, other management accounting techniques must be used, such as cost accounting, performance accounting. Budgeting is also used for planning and coordinating an organisation's activities, allocating resources. Due to these reasons, budgeting is extensively researched topics in management accounting (Covaleski, Evans, Luft and Shields, 2003). Bourmistrova and Kaarboe (2013) state that budgeting is the one key traditional management control tools, which currently is being modernised by introducing new sources of data and methods into it. Traditional budgeting activities are getting old and are too deeply focused inside the entity, suppressing creativity and interfere competitive edge in an information economy. Authors also notice that traditional budgeting process is linked to many limitations, entities are trying to introduce new beyond budgeting methods. Companies are trying to add additional sources of information also to other processes – in operational planning, performance measurement, goal communication, and strategy creation. According to IBM planning, budgeting, and forecasting are three related processes in the company, which helps to create from short to long-term goals:

- **Forecasting** uses available historical data to predict how much revenue company can expect to earn in over the next few months or years. Forecasts are adjusted as new information becomes available.
- **Planning** provides a business' financial objectives for the next 3-5 years.
- **Budgeting** is done to companies' revenue, cash, cash flow and other activities. It shows what the goals for the company for a certain time of period are. In most of the cases, companies created budgets for a fiscal year. Budgets sometimes can be adjusted according to the changed situation in the market or other unprognozed incidents. It also shows how companies are following the goals, exceeding, or meeting the budget.

In management accounting, the planning includes both the financial and non - financial information being highlighted to the organisation's leader for futuristic planning and ultimate decision making. As opposed to a traditional ledger, management accounting crafts, a comprehensive report involving cost examinations and budgetary figures for the beneficiaries. As a result of these immaculate calculations, the competitive performance of the organization is enhanced to a greater degree (Sinaga et al., 2019).

Companies utilise planning, budgeting, and forecasting processes in order to achieve higher revenues. As today's business environment is constantly changing, it is becoming even in more important in company existence. Well-developed budgets' plans and forecasts enhanced decision making.
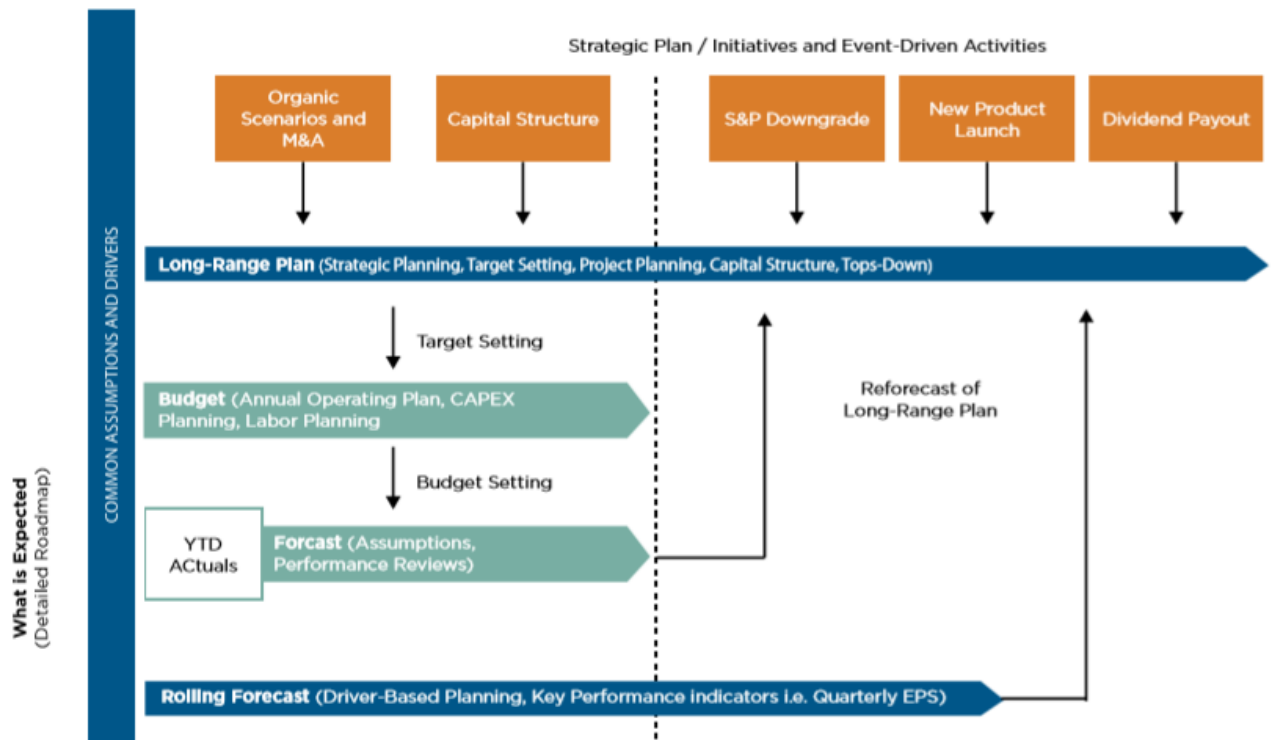
Figure 1 Planning, budgeting, and forecasting process according to Huron Consulting (2016)

Figure 1 illustrates how planning, budgeting, and forecasting processes supplement each other, but also it shows what the difference between them is. Huron consulting proposes to have three-step planning. First of all, the company has to have a Long-range plan (Planning), aspiration to complete it would be in several financial years. According to the plan, the budget has to be prepared for the upcoming period. Forecasts are done from year to date actuals incorporating budget.

Cost accounting.

Many researchers (e.g. Ringelstein, 2018; Narong, 2009) divides costing methods into two groups:
- Traditional
- Contemporary

Ringelstein (2018) provides two traditional cost accounting methods – absorption costing and variable costing.

Table 4 Differences between traditional costing and variable costing

Traditional costing		**Variable costing**
Production costs	Direct materials	Productions costs
	Direct labour	
	Variable manufacturing overhead	
	Fixed manufacturing overhead	Period costs
Period cost	Variable selling and administrative expenses	
	Fixed selling and administrative expenses	

Traditional cost accounting methods use a simple framework (see Table 4). Direct materials and direct labour costs are allocated directly to products costs. Overhead costs are allocated to products based on various company calculated rates. Selling and administrative costs are treated as expenses, which are related to a specific period. Traditional costing may be straightforward to implement and use, but these methods are far from reality, for example, transportation costs and commissions are not allocated to products, even though these expenses are consumed by products. (Garrison, Noreen and Brewer 2018).

According to Narong (2009), traditional cost accounting has been based on allocating a subjective or calculated range of indirect expenses to direct costs. However, due to the modern business environment, traditional cost accounting is not enough to understand the cost behaviour.

Authors Johnson & Kaplan (1987) in their first book "Relevance lost: the rise and fall of management accounting" introduced activity based costing method (ABC), the idea of it, practical calculations, structure advantages and disadvantages of this method (see Figure 2). By using this method, companies were able to receive much useful information, which leads to improvement of strategical company management in a short and long period. In nowadays literature, there are already lots of authors that deepens the knowledge of ABC costing.

Chartered Institute of Management Accountants (CIMA) defines ABC as *a method, which involves tracing resource consumption and monitoring final outputs. Used resources are assigned to activities, and activities to cost objects based on consumption estimates. The latter utilises cost drivers to attach activity costs to outputs.*
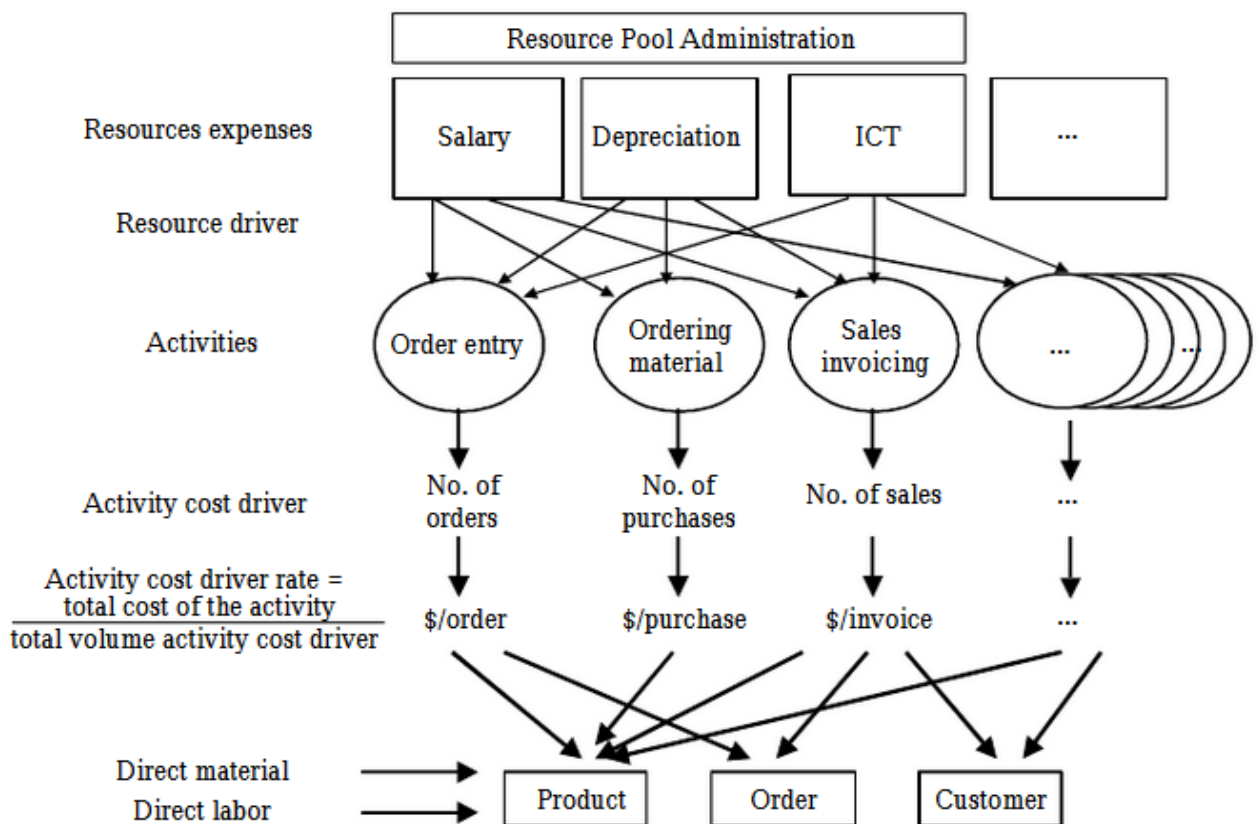
Figure 2 Activity-based costing explanation by Kaplan and Cooper (1998)

ABC method brought many insights to the companies, but many companies criticised this method after application. ABC costing implementation costs were too high. Due to this reason, there appeared a modification of the ABC method, based on the indicators of time, which was called the Time-Driven Activity-Based Costing (T-D ABC) (Pawłyszyn, 2017) (see Table 5). For the calculation of production or service costs with the T-D ABC methodology, the two key parameters are required: 1) the practical capacity of committed resources and their cost, and 2) the time which is needed to perform a transaction or an activity.

Table 5 ABC versus Time driven ABC (Demeerec, Stouthuysena and Roodhooft, 2009)

	ABC	Time driven ABC
Step 1	Identify the different overhead activities	Identify the various resource groups (departments)
Step 2	Assign the overhead expenses to the different activities using a resource driver	Estimate the total costs of each resource group
Step 3	Identify the activity driver for each activity	Estimate the capacity of each resource group (e.g. available working hours, excluding vacation, meeting, and training hours)
Step 4	Determine the activity driver rate by dividing the total activity costs by the practical volume of the activity driver	Calculate the unit cost of each resource group by dividing the total cost of the resource group by the practical capacity
Step 5	Multiply the activity driver rate by the activity driver consumption to trace costs to orders, products, or customers	Determine the time estimation for each event, based upon the time equation for the activity and the characteristics of the event
Step 6	-	Multiply the unit cost of each resource group by the time estimate for the event

Performance analysis

In order to enhance the company performance, companies need to implement management accounting control system. Due to this reason strategy, management accounting and control systems have a strong relationship and in the current business environment receives increased attention from management (Christopher 2012). Robert Simons (1995) describes the management control system (MCS) as a *package of formal, information-based routines and procedures that managers use to maintain or alter patterns in organisational activities.*
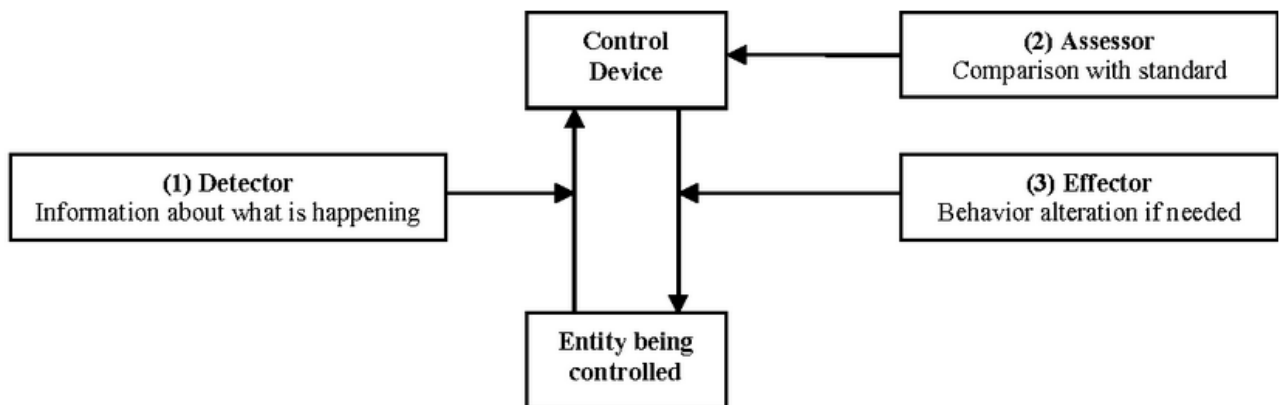
Figure 3 Management Control Systems (Anthony and Govindarajan, 2000)

According to Anthony and Govindarajan (2000), MCS should have these components (see Figure 3):

- Detector – a process which is measuring a process which is in control.
- Assessor – a process to which detector results are being compared
- Effector – a process which changes the process if assessor is identified.
- Communication network – network in which information between detector and assessor and between assessor and effector is shared in order to reach the desired goal.

MCS allows managers to receive analysed data on companies' main abilities and identify problematic areas from a process perspective and furthermore system allows to evaluate financial impacts of a strategic plan. To create a functional and accurate management control system, it is necessary that management accountants would understand the operational business activities, and convert this understanding into the design of control system also incorporating control with business strategy.

Decision making

Decision making is an inseparable part of management and generally the primary function of company management. Decisions in modern businesses play a key role as it affects organisational, operational, and managerial activities. In a business environment, the decision can be defined as a selection of the best alternative which would help to achieve strategic goals.

Nita and Solomon describe decision making as a selection of the most successive problem - solving alternative, which would help to achieve certain group goals. Problem-solving alternatives should be selected by searching and standardising the criteria's and special measures.

According to Edwards and Fasolo (2001), decision theory consists of three instruments:

a) Outcome evaluation – the values of contribution and decision making are directly proportional to each other. All these values have to be measured on a similar scale. Except for special cases, when the best alternative can be selected from the less information, while the scale is an interval. It means that all quantities have to be measured until positive linear transformation.

b) Probabilities evaluation – when we are stating that heads will fall out three times from three tosses of a coin, the probability is one from eight. While stating that, we have made two assumptions: 1) probability that heads will fall out on any coin is one of two 2) all coin flips does not belong on each other. This situation is simple and clear, but in reality, most of the decisions are made without clear conditions, due to this reason it means that some of the actions will have more than one possible result and decision-maker cannot fully control which result will occur.

c) Value and probability evaluation – if decision-maker knows appropriate benefits and if needed appropriate probabilities, then decision-maker has quantitative decision-making basis. To answer the questions which alternative to choose, decision-maker will have to connect the dots.

Cause and effect

In general, management accounting includes planning which seeks to identify possible alternatives and then to select the best suited alternative that goes with the objective of the organisation. Then

comes the analysis of day-to-day activities and scrutinising the overall process to ensure that the plan is being followed. Feedback is likewise crucial in management accounting for it helps in keeping track of operations being conducted so that an effective controlling strategy is well-taken. Monitoring is also vital so that any deviation can be readily identified and proper steps are taken to avoid any harmful results (Mihăilă, 2014).

In 1950's Japanese organisational theorist Kaoru Ishikawa created cause and effect diagrams (see Figure 4 and Figure 5). Cause and effect diagrams help company managers to identify variations, defects and imperfections. Diagram reveals the relationship between effect and its causes.
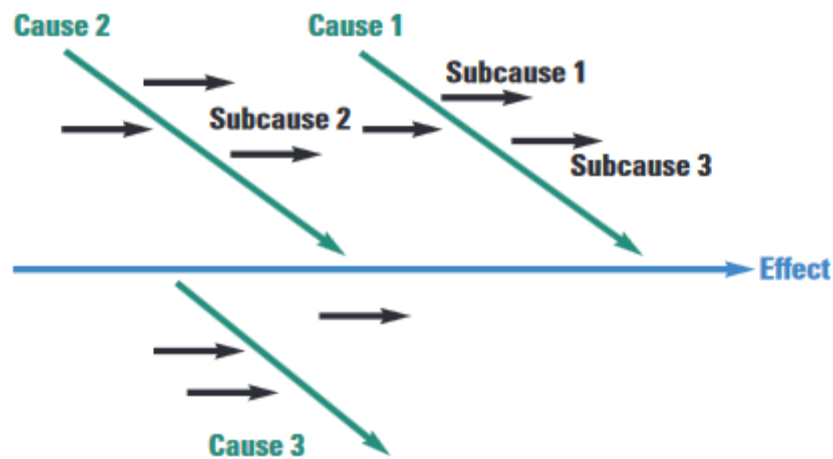
Figure 4 Cause effect diagram by Chen and Chung (2002).

Figure 4 shows how generally the diagram should look like. The effect is written on the head of an arrow. Arrows going into the main effect arrow shows the causes which influence the effect. The diagram might as detailed as desired, the cause can have their own sub causes.
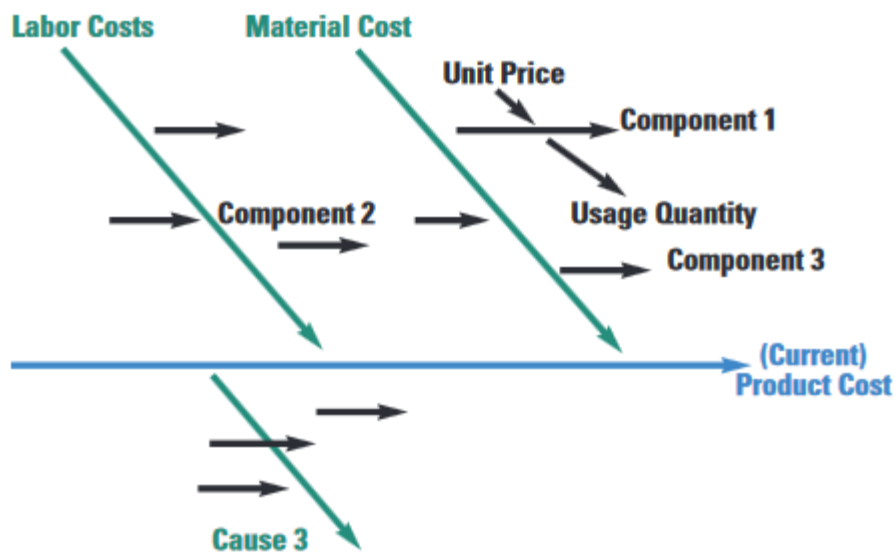
Figure 5 Cause effect diagram for cost analysis by Chen and Chung (2002).

Chen and Chung (2002), in their article, presents how cause and effect analysis can be introduced into managerial accounting. Authors propose to implement cause and effect analysis for target costing in order to strengthen the competitive business strategy.

Cause and effect analysis also could be used not only for cost analysis but also for product quality controls, planning or creating the strategy.

As a result of many different functions, management accounting is a vital part of companies' life. Management accounting information provides necessary information for management, which improves the decision-making process. Big data information could be used in management accounting to improve the quality of information and speed-up decision-making process.

2.2. The theoretical aspects and role of Big Data

The concept of Big Data. Big Data is, in many ways, is a poor term. As Lev Manovich (2011) notes, it has been used in the sciences to refer to data sets large enough to require supercomputers, although now vast sets of data can be analysed on desktop computers with standard software. Big data is called so due to the relationship with other data, rather than of its size. Big data is networked, as companies are trying to mine and aggregate it, and the main value of it comes from connections between different types of data.

Laney, LeHong and Lapkin (2013) describe big data as huge volumes of structured and unstructured data it will collect, processed, and analysed in real-time to reveal unexpected linkages, provide unique insights, and perhaps even to help predict the future.

Data is being created anywhere and at any time. It is called big when it cannot be processed using comprehensive technology, such as relational databases or spreadsheet applications (Bharadwaj et al., 2013; Chen and Zhang, 2014).
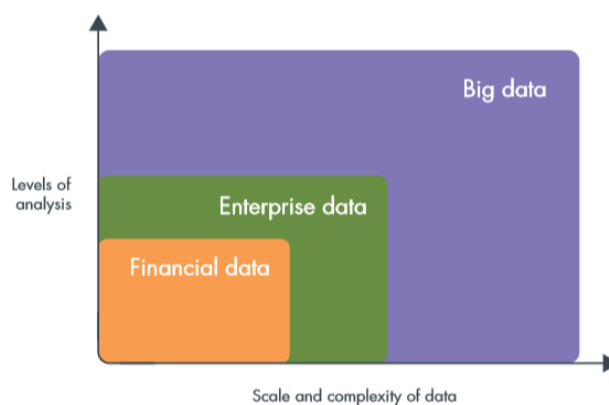
Figure 6 Big data definition according to CGMA (2013)

CGMA provides visual definition (see Figure 6). Financial data: Standard financial information, well-structured and understood. Enterprise data: financial data plus broader operational and transactional data that may be used to bolster analysis and forecasting. Big data: financial and enterprise data with the addition of new types of internal and external data, which is unstructured, but could provide new insights to companies performance, risks and opportunities if structured well.

Gartner (2016) provides a more official definition of Big Data as, ''*high volume, high-velocity and/or high-variety information assets that demand cost-effective, innovative forms of information processing that enable enhanced insight, decision making, and process automation*.''

Many other authors term big data describes likewise Gartner did and distinguished the same 3v's:

- **High volume.** In 2012, everyone created 2.5 exabyte's of data daily. This number is doubled every forty months. Due to developed internet technologies, on the internet, we exchange every second more data than were stored in the whole internet 20 years ago. Because companies can now generate and work with many petabytes of data in a single data set. For example, it is estimated that the US biggest retail chain collects more than 2.5 petabytes of data every hour from customer transactions. A petabyte is equal to one quadrillion bytes, or the equivalent of about 20 million filing cabinets worth of text. An exabyte is 1,000 times that amount or one billion gigabytes. (McAfee and Brynjolfsson, 2012)

- **High velocity.** The speed of data creation for many businesses is more important than the volume. Real-time or nearly real-time information makes it possible for a company to be much more agile than its competitors. The more real-time data decision-makers will have, the more quickly they could make a decision, or spend more time to investigate the best option for business.

- **High variety.** Management accountants while collecting the data, first heed on the veracity and value/cost-benefit of data collection (Rockart, 1988). Nevertheless, nowadays, management accountants collect not only financial and internal or external business information but also can collect various other information. The data variety is enormous, from GPS coordinates to google searches, clicks on websites, social media posts, likes, shares, comments.

Cheng, Zhang and Qin (2016) add two more V's to 3V's model:

- Veracity - as models have approximations and data inconsistency, it is important to guarantee the veracity of data.
- Value. The value of the insights and benefits.

Nott (2016) also provides 3 C's for big data. In order to have value from various data collected, it should be valuable structured and usable.

- The first C of big data is **confidence.** Decision-makers should be confident that the data provided in order to make a decision is correct.
- The second C of big data is **context**. In order to understand it, it is needed to understand who is asking the question and for which purpose. It is also needed to understand from what role perspective these questions are raised and how this information will be used.
- The third C of big data is a **choice.** One of the big data systems is Apache Hadoop. As this application has a cost-effective infrastructure, many companies have implemented it. Such implementations require to consider information governance in the early stages of implementation. If companies do not consider the governance in the early stages, it might lead to the situation that business could be reliant on such a system. Regular analytic runs are starting to compete for the resources with exploratory analytics, whereas the system can exceed capacity limits.

Business analytics. Appelbaum, Kogan, Vasarhelyi and Yan (2015), classifies business analytics into three categories:

- Descriptive analytics.
- Predictive analytics.
- Prescriptive analytics.

Tschakert, Kokina, Kozlowski and Vasarhelyi (2016) also adds one more category and explains each type of it (see Table 6):

Table 6 Types of analytics

Type of analytics	Explanation	Examples
Descriptive analytics	Provides insight based on past information. What is happening?	Used in standard report generation and in basic spreadsheet functions such as counts, sums, averages, and percent changes and in vertical and horizontal analyses of financial statements.
Diagnostic analytics	Examines the cause of past results. Why did it happen?	Used in variance analyses and interactive dashboards to examine the causes of past outcomes
Predictive analytics	According to the patterns from historical data, predictive analytics provides foresight. What will happen? When and why?	Can be used to predict an accounts receivable balance and collection period for each customer and to develop models with indicators that prevent control failures.
Prescriptive analytics	Helps to identify the best option for desired outcomes. What should we do?	Used in identifying actions to reduce the collection period of accounts receivable and to optimise the use of payables discounts

Types of analytics have a close relationship with each other with direct impact one to each other.
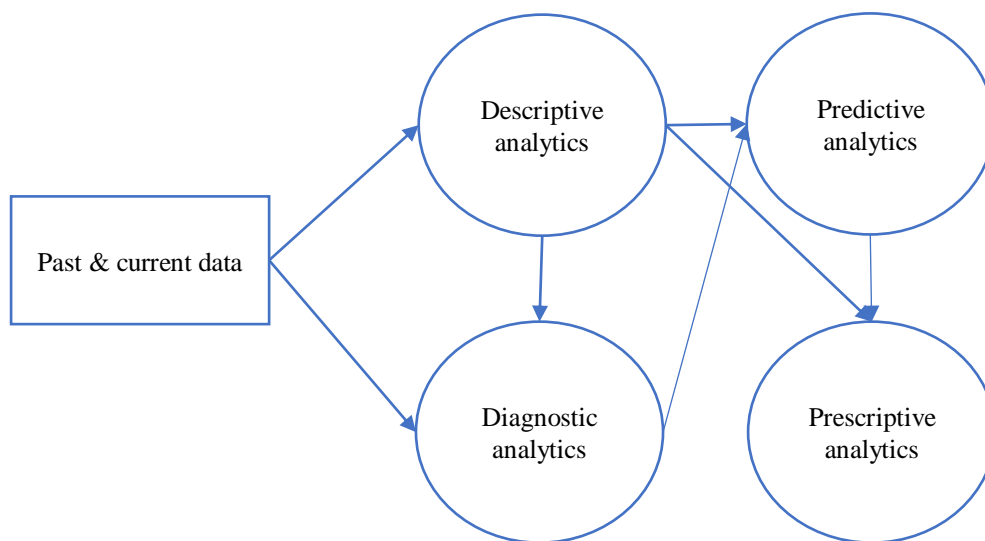
Figure 7 Relationships between analytic types

As it is shown in Figure 7, descriptive analytics gathers data from current and past events and answer a question of what happens/happened. Diagnostic analytics uses the same data and descriptive analytics in order to clarify why descriptive analytics did happen. Predictive analytics is the next step taken with the knowledge acquisition from descriptive analytics (Bertsimas and Kallus, 2014) and answers the question of what could happen (IBM, 2013). Prescriptive analytics (Bertsimas and Kallus, 2014; IBM, 2013) answers the question of what should be done given the descriptive and predictive analytics results. Prescriptive analytics may be described as an optimisation approach. Prescriptive analytics go beyond descriptive and predictive by recommending one or more solutions and showing the likely outcome of each.

Big data technologies. Jaseena and David (2014), study revealed that over 4 million searches are being done thru Google every minute, 200 million e-mails are sent, 72 hours of videos are uploaded to YouTube, 2 million posts are created and shared on Facebook, and 277,000 Tweets are generated every minute on Twitter, Instagram users post 2,16,000 new photos every minute. To process such high-volume data, new technologies were needed. Current technologies, such as low-price storage capabilities, allows organisations to produce and collect large sets of data. More is not certainly mean better as large sets of data pools make it difficult to convert data into information in a timely and structured fashion. This is particularly vital in nowadays, as product and service life cycles have become shorter. The ability to analyse meaningful and relevant data and convert data to information, knowledge, and ultimately action in time to favourably influence an organisation is a key competitive differentiator (Bumblauskas, Nold, Bumblauskas and Igou, 2017).

Big data analytics application unlocks the possibility of using data in a preferred way together with appropriate visualisation. Visualisation is crucial, as it links large datasets to context and shows correlated variables. It also helps to identify patterns over time. Big data is so large that the need for technologies to evolve rose in order to process it. Hadoop and Hbase or other similar big data programs are used for data processing, which also supports data mining techniques. Evolving techniques and systems brought a positive impact on the cost of data storing, collecting, and processing, due to this reason, available data was widened and created the demand for such programs. (Fisher et al., 2012, IBM, 2012)

Term business analytics commonly associates with the support of data for decision making. In the entities, an analytic team often uses their experience to report for company management by analysing the available data sets. Analytics are becoming more critical process in companies as management part of duties are reliant on the decision making according to the provided information. (Fisher et al., 2012)

Fisher, DeLine, Czerwinski and Drucker (2012) illustrates (Figure 8) that big data applications attempt to unlock the potential of data using business analytics and visualisation trends. To provide a clear picture - visualisation is critical. Clearly visualised data provides context by showing data as a subset of a larger part of data, showing correlated variables. Generally, authors provide a process of data reflection clustered into five steps.

Figure 8 Five step cluster

Data collection – analysis from which systems and what kind of data is available from big data systems.

Architecture selection – "*Whatever platform the big data analysis is performed on, the platform organises the computation around a set of programming abstractions substantially different from those of the normal desktop environment. Analysts trained on the desktop environment must learn these new abstractions and plan their computation around them, often facing a new set of engineering trade-offs and failure modes*" (Fisher, DeLine, Czerwinski and Drucker, 2012).

Data shaping - Once the analyst has found a dataset and a computing platform, then the data uploading into the platform is being performed. Data analysts have to ensure that data is structured following computation structure and appropriately distributed and partitioned.

Code - With an architecture selected and the data in place, the analyst begins to select their analysis. Data analysts have to design the code and split the code into smaller parallelizable parts.

Big data programs process massive amounts of data in order to find useful correlations between different data sets. Increased processing power allows to power up analyzation tools, which can create for decision maker's timely and accurate information. (ACCA & IMA, 2013; Davenport, 2014). Connection to the network allows to gather distributed systems, datasets from completely different locations and analyse accurately. (IBM 2015). Vasarhelyi et al. (2015) suggest that in order business would be able to benefit more from data – companies need to map internally generated and automatically-collected information with external information, for example, information about the person, credit information, criminal records or any other records.

As entities generate a lot of data transactions, often part of it remains unused. This part of transactions which is recorded in their daily business process but not used for value generation is called dark data. (Gray and Alles, 2015).

Ohlhorst (2012) mentions that Big Data applications can include such analytics concepts and technologies as:

Traditional business intelligence (BI). Traditional BI technologies are used for gathering, storing, analysing, processing, and providing data to users. Companies implement BI programs in order to have support for better decision making based on facts. Programs deeply analyses of extensive company data, databases, application information and other data sources. Depends on how companies

have implemented BI programs, but companies use BI to provide structured historical, current and predictions for future operations.

Data mining. It is a process which analyses data from different angles and generates summary into useful information. This process typically is used with archival data. Mining techniques concentrate on modelling and knowledge discovery for predictive, rather than descriptive. Main aim to detect new useful data patterns in large data sets.

Statistical applications. Such applications analyses data sets from polls, census, and other statistical data sets. Statistical applications concentrate on predictive analysis and are accurate in delivering sample observations. Empirical data is the main source for information analysis.

Predictive analysis. It is a division of statistical applications. The predictive analysis examines data to generate predictions based on data trends and insights. Companies are using predictive analysis widely in order to create budgets, plans, forecasts. Predictive analysis insights help to identify possible risks and opportunities in the business process, various markets or manufacturing.

Data modelling. Data modelling allows to generate and test "what if" by using algorithms and various data sets. If the model is created appropriately, it reacts to changed information which is available for algorithms and provides insights on changed data sets. Data visualization is a crucial part of data modelling.

Every technology needs to have an application in order to process the data. Kiran (2019) categorizes big data technologies into four fields:

- Applications for data storage
- Applications for data mining
- Applications for data analytics
- Applications for data visualisation

Data storage applications

The most popular data storage applications are these:

- Apache Hadoop – The Apache Hadoop software library, which uses simple computing models to access and process large data sets in the network. Clients - Microsoft, Amazon, Pineapple fund.
- Mongo DB - MongoDB is a document database with the scalability and flexibility that is dedicated to querying and indexing. Clients - Facebook, eBay, Adobe.
- RainStor - RainStor is an analytical archiving application for structured data, which runs natively on Hadoop. RainStor stores its archived data directly on HDFS in a highly compressed form, using its own file format. The platform supports direct access to the data via SQL. Clients - Barclays, Credit Suisse.
- Hunk - Hunk lets to access data in remote Hadoop Clusters through virtual indexes and lets to use the Splunk Search Processing Language to analyse the data. Clients – Intel, Lenovo.

Data mining applications

The most popular data mining applications are these:

- Presto – application which allows to run SQL queries on large amounts of data. Clients - Facebook, Airbnb, Dropbox.
- Rapid miner – solution which allows to create, maintain predictive analytics. Clients - Domino's, In Focus
- Elasticsearch – search engine which allows to search in large amounts of data, which could be both, structured and unstructured. Clients - Sky, Oxford University, Volvo group.

Data analytics applications

The most popular data mining applications are these:

- *Kafka* - A streaming platform has three key capabilities: Publish store and process. (Clients – Netflix, LinkedIn)
- Splunk - captures, indexes, and correlates real-time data in a searchable repository from which it can generate graphs, reports, alerts, dashboards, and visualizations. Clients - Trustwave, Radar.
- Knime - KNIME Analytics Platform is the open-source software for creating data science. Intuitive, open, and continuously integrating new developments, KNIME makes understanding data and designing data science workflows and reusable components accessible to everyone. (Clients - Harnham, Paloalto)
- Spark - is a unified analytics engine for large-scale data processing. Clients - Amazon, Oracle, Cisco.
- R-Language - free software which could be used for statistical computing and graphics. Clients - Bank of America, Barclays.
- Blockchain - BlockChain is used in essential functions such as payment, escrow, and title can also reduce fraud, increase financial privacy, speed up transactions, and internationalize markets. Clients - Facebook, Oracle.

Data visualisation applications

The most popular data visualisation applications are these:

- Tableau - Tableau is a Powerful and Fastest growing Data Visualization tool used in the Business Intelligence Industry. Clients - Oracle, Qlik, Cognos.
- Plotly - Mainly used to make creating Graphs faster and more efficient. Clients - Paladins, bitBank.

2.3. Big data in business processes and decision-making through management accounting

Decision making is a very crucial difficult process containing activities, which unveils the specific problem to the management and leads to the formulation of goal. The goal is to come to the best solution possible for the business Decision-making process is one of the most crucial processes for

managers of the company. Activities of managers in companies, therefore it is the core of management. (Litvaja and Stancekovaa, 2014).
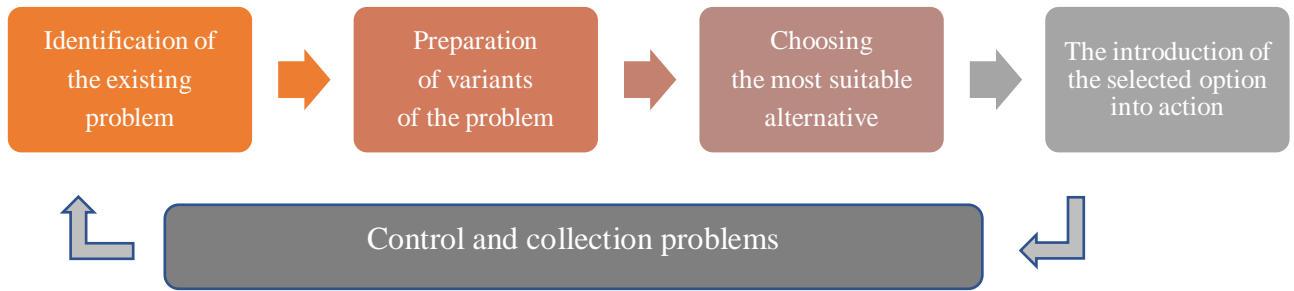
Figure 9 Decision-making process (Riplová, et al, 2008).

Literature analysis revealed that management accounting is a discipline which analyses various sources of information in order to provide insights to management which would support effective decision making. The collected information could be used on several management accounting application areas such as budgeting, planning, forecasting, cost accounting, cause and effect, performance analysis, problem solving, decision making. In order to provide insightful information to management, management accountants need to find new sources of data and understand how to utilise it. Besides, scientific and practical literature analyses revealed that big data is a vast amount of data which could be structured and unstructured. Big data includes not only financial information or company-generated data but also external data. As the amounts of data are huge, specific applications are needed in order, companies could process it and utilise the advantage of it. As management accounting is a constantly changing field, which adapts to new technologies, companies started to analyse and implement big data processes which would help to provide information for management accounting application areas.

In order to understand at what level companies utilise big data and to what management accounting extent, the conceptual model was created (Figure 10). The model divides big data technologies into two levels:

- Basic big data technologies
- Advanced big data technologies

As data storage and visualisation are technologies used to already existing information, these techniques were assigned to the level of basic big data technologies, as these technologies do not require a lot of skills and knowledge to implement it. Data mining and data analytics are more difficult processes which are requiring deeper knowledge, as a result of these techniques were assigned to the level of advanced big data technologies. From literature analysis, it can be seen that those researchers similarly groups big data technologies. Simon (2015), in his works, mentions that data storage is a basic function, while data modelling and mining are advanced techniques. Boyd and Crawford (2011) suggest that big data analytics is an advanced technique. This shows that organizations can be at a different level of big data technologies, one company could be using basic big data technologies and those companies have a possibility to implement more sophisticated big data technologies, while other company already use advanced techniques

Management accounting functions were correspondingly split into levels:

- Basic management accounting functions
- Middle management accounting functions
- Advanced management accounting functions

To the level of basic management accounting functions such as budgeting, planning and forecasting were assigned as these activities mostly relies on past events to project the future events or creates the future events and projects back to the current day. To the level of middle management accounting functions as cost accounting, cause and effect and performance analysis were assigned as these techniques requires more knowledge to create the processes and to understand the business performance. To the level of advanced management accounting functions as problem solving and decision making were assigned as these management accounting functions are the most difficult ones and require information from basic and middle management accounting functions in order companies could take decisions.

The proposed model (see Figure 10) could show in which management accounting functions big data is utilised and how it is utilised. Model moreover would suggest which places of big data usage need to be improved or which are utilised correctly. For example:

- If companies are using basic big data technologies for basic management accounting functions, then it means the company correctly utilises basic big data technologies for basic management accounting functions.
- If a company is using advanced big data techniques, but only for basic management accounting functions, which would mean that company is not fully utilizing big data possibilities, and it shows that company have possibilities to improve the technology used for more difficult management accounting functions.
- If companies are using basic big data technologies for advanced management accounting functions, this option could have positive and negative sides. From the positive side, companies are able to utilise big data for advanced management techniques with basic big data techniques. Negative aspects could be that those basic technologies have a higher risk to have the wrong infrastructure, and in the future, while implementing new processes, it might bring the risk that it will be harder to adapt to existing infrastructure these processes.

Conceptual big data application on management accounting model is an instrument, which could help companies to identify big data technological level and link it with management accounting processes. The model can also be used to identify the areas which need to improve and also used for comparison between companies. Model results help to indicate important information for management - how big data is utilised in the company and to which level. Based on conceptual big data application on management accounting model, empirical research is performed, to evaluate practical model adaption possibilities in organizations. Further, methodological provisions and research findings are provided.

	Budgeting	Planning	Forecasting	Cost accounting	Cause and effect	Performance analysis	Problem solving	Decision making
Data analytics	Orientation to budgeting through data analytics	Orientation to planning through data analytics	Orientation to forecasting through data analytics	Orientation to cost accounting through data analytics	Orientation to cause and effect through data analytics	Orientation to performance analysis through data analytics	Orientation to problem solving through data analytics	Orientation to decision making through data analytics
Data mining	Orientation to budgeting through data mining	Orientation to planning through data mining	Orientation to forecasting through data mining	Orientation to cost accounting through data mining	Orientation to cause and effect through data mining	Orientation to performance analysis through data mining	Orientation to problem solving through data mining	Orientation to decision making through data mining
Data visualization	Orientation to budgeting through data visualization	Orientation to planning through data visualization	Orientation to forecasting through data visualization	Orientation to cost accounting through data visualization	Orientation to cause and effect through data visualization	Orientation to performance analysis through data visualization	Orientation to problem solving through data visualization	Orientation to decision making through data visualization
Data storage	Orientation to budgeting through data storage	Orientation to planning through data storage	Orientation to forecasting through data storage	Orientation to cost accounting through data storage	Orientation to cause and effect through data storage	Orientation to performance analysis through data storage	Orientation to problem solving through data storage	Orientation to decision making through data storage

Big data — Advanced big data, Basic big data

Basic management accounting | Middle management accounting | Andvanced management accounting
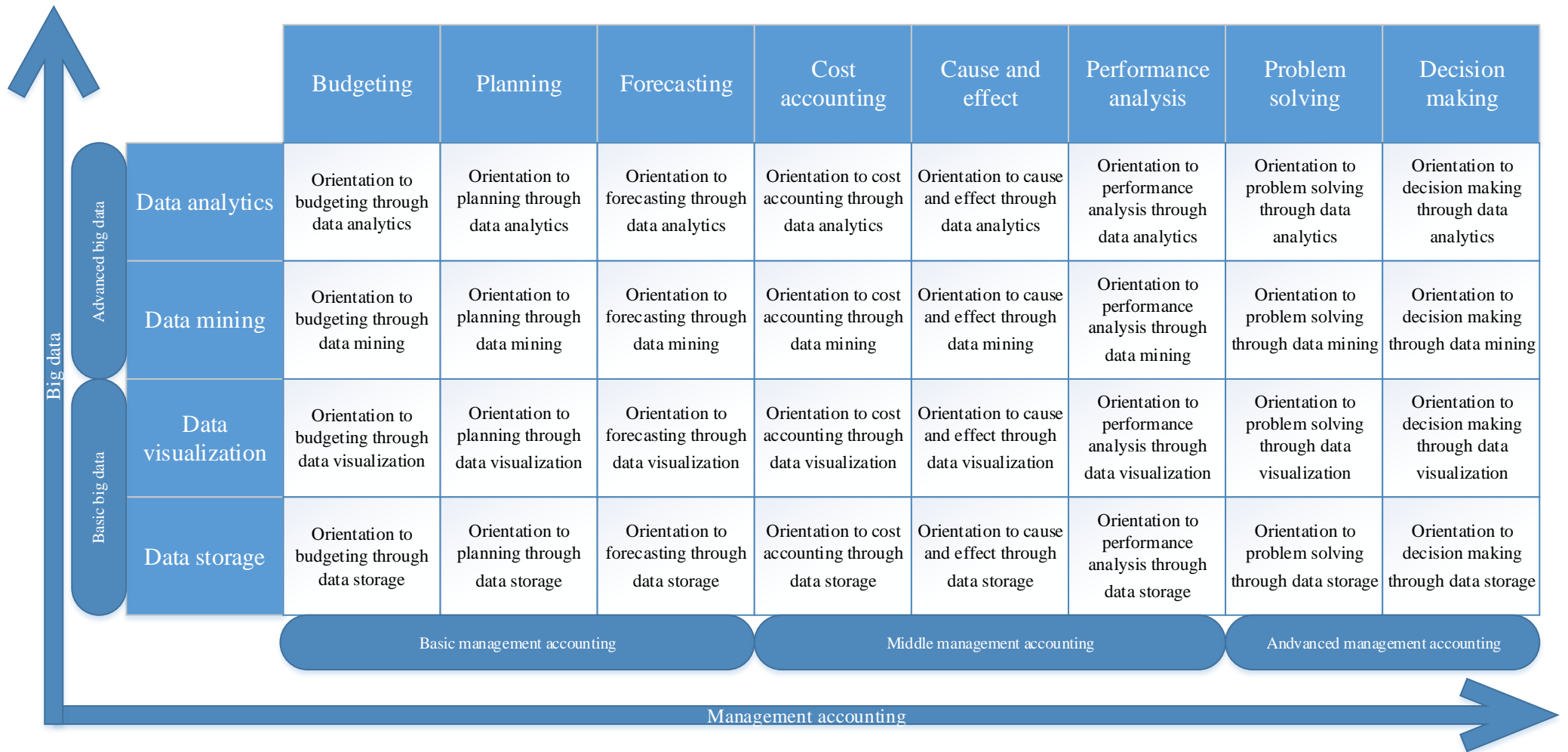
Management accounting

Figure 10 Conceptual big data application on management accounting model

3. THE METHODOLOGY OF BIG DATA APPLICATION IN MANAGEMENT ACCOUNTING IN SERVICE COMPANIES

In this thesis, the method of exploratory part for practical testing of the model is used the combination of quantitative (survey) and qualitative (interview) research. This means that it is used mix-method research methodology. Wisdom and Creswell (2013) defines mix-method research as a methodology which integrates qualitative and quantitative information in a single research, to answer the research question. Shorten and Smith (2017) divides mixed-method research into types:

- Explanatory sequential – Mixed-method research type, which firstly analyses quantitative information and then uses qualitative information to clarify quantitative data (Qualitative → Quantitative).
- Exploratory sequential – Mixed-method research type, which firstly analyses qualitative information and then uses quantitative information to prove findings (Quantitative → Qualitative).
- Parallel – Mixed-method research type which analysis qualitative and quantitative data concurrently (Quantitative + Qualitative).
- Nested – Mixed-method research type in which as the main design could be used qualitative or quantitative information with alternative paradigm (QUANTITATIVE + qualitative or QUALITATIVE + quantitative).

Explanatory sequential, mix-method research helps to achieve research questions:

1. How and to what extent Lithuanian enterprises utilise management accounting?
2. How and to what extent Lithuanian enterprises utilise big data?
3. What are the applications of big data on management accounting?

3.1. Quantitative research method

The chosen method to gather the data for the quantitative part is a survey. Due to the quantitative nature of the survey method, it aims to provide some insight into the subject. A survey is useful in answering questions such as who, what, how much or how many (Yin, 2014). A survey aims to describe and chart phenomenon rather than explain reasons and consequences (Buckingham and Saunders, 2004).

Research instrument. This chapter gives an overview of the construct of the survey and its contents. The survey was carried out as an internet survey where the respondents received an invitation to take part in the survey via e-mail or LinkedIn wherein a link to the survey was provided. The survey form consisted of 3 sections:

- Questions related to big data and management accounting, possible application areas, current and future usage possibilities.
- Big data and management accounting current usage in companies.
- Background information.

The research instrument is provided in appendix 1.

Research participants. For the research service companies were selected due to several reasons. Firstly, according to Lithuanian Statistics department service companies have made the biggest positive influence during 2014-2018 to GDP. The second reason Survey was sent out to service companies of various sizes that service companies have the potential to utilise big data information. The recipients of the survey invitation were executives and high-level managers in various size companies. Respondents were from different functions of the enterprise, including, e.g. top management, finance and IT. Enterprises spanned over several different industries ranging from manufacturing to financial and insurance services. As a quantitative study, a comprehensive sample would have been preferred (>400 observations) in order to be able to conduct statistical analyses of the data. However, as is often the case with internet surveys, the response rate remained low and resulted in only 25 observations which are utilizing big data. The important aspect to consider is that while the statistics may indicate significances, they need to be considered as initial results at best.

Data collection. The survey was carried from 2020 January 02, till 2020 April 19.

3.2. Qualitative research method

In this thesis, the quantitative part lacks the general qualities of a quantitative study because it does not aim to generalize. Considering a small sample size and low response rate, a second part was conducted in order to expand the amount of data. The data in the second phase of this study is gathered with interviews. Interviews are chosen in order to gain more in-depth insight into the subject of how and why companies in Lithuanian apply big data in their business processes and utilise it in decision-making. It aims to acquire information more extensive information and create a somewhat explicit picture. The aim is to get personal experiences from companies. Weaknesses of an interview to gather data are for instance bias due to poorly constructed questions and prompting the interviewee to tell what the interviewer wants to hear (Yin, 2014).

Research instrument. This chapter gives an overview of the construct of the interview (Research instrument is provided in appendix 2) and its contents. The interview was carried out as an internet open question interview where the respondents received an invitation to take part in the interview via e-mail or LinkedIn, wherein a link to the interview was provided. The interview form consisted of 2 sections:
- Questions related to big data and management accounting, possible application areas, current and future usage possibilities.
- Big data and management accounting current usage in companies.

Research participants. Several researchers such as Maxfield (2015), Ghosh (2014) underlines that financial service companies have an advantage in utilisation of big data, as these companies have customer behaver data in their business. As the financial sector has an advantage, and as in the survey, most of the companies were from the financial sector, the interview was also carried with financial service companies. Interview participants were executives and high-level managers in financial sector companies. Respondents were from different functions of the enterprise, including, e.g. top management, finance, and IT. As a qualitative study, a sample of three companies was selected.

Data collection. Interviews were gathered from 2020 April 20, till 2020 April 25.

4. EMPIRICAL FINDINGS AND ANALYSIS OF BIG DATA APPLICATION IN MANAGEMENT ACCOUNTING IN SERVICE COMPANIES

In the first subsection of this chapter, the quantitative results of the survey are analysed. The second subsection provides an analysis of qualitative interviews. The third subsection combines both quantitative and qualitative results and compares the results.

4.1. Results of quantitative research

To carry out the quantitative research, survey method was chosen. 46 companies have participated in the survey. Participants of the survey were from different service industries (see Figure 11).
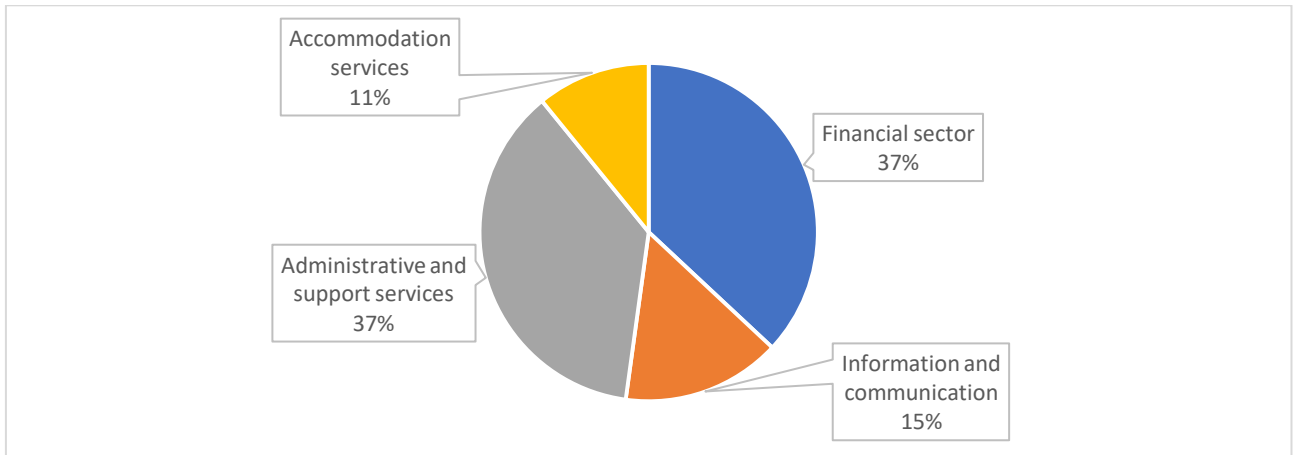
Figure 11 Industries in which respondents operate

The major part of respondents were from administrative and support services (37%, 17) and from the financial sector (37%, 17), 7 respondents (15%) were from information and communication sector and the least participants were from accommodation services – 5 (11%).

Respondents work in different size of companies. 24% (11) of respondents companies had the revenue from 0 to 0,7 million euro, 35% (16) from 0,7 to 8 million euro, 17% (8) from 8 to 40 million and 24% (11) had more than 40 million euro revenue. Most of the respondents (33%, 15) were from companies which employed more than 250 employees, 26% (12) have from 50 to 250 employees, the same amount of respondents have from 10 to 50 employees and 15% (7) have up to 10 employees.

Occupations of the respondents are various (see Figure 11). The biggest part of respondents (35%, 16) are CFO's or works in the finance area, CEO's (20%, 9) and 18% (8) of respondents are from business developments. However, other respondents are working in various occupancies such as the head of big data and artificial intelligence unit, head of data analytics, data scientist, and IT area.
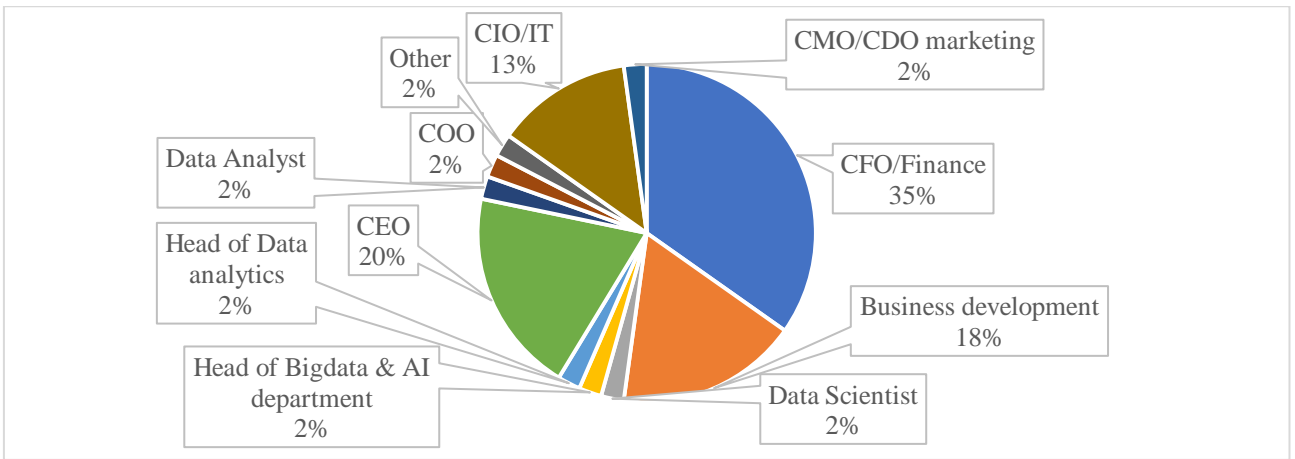
Figure 12 Occupation of survey participants

Big data usage in service companies. The first part of the survey tried to find out if companies are using big data in their business.

According to the survey's results, 25 (54%) companies out of 46 utilise big data to support their management accounting techniques and processes. 44% (11) of those companies had revenue more than 40 million euro 24% (6) of companies had revenue from 8 million to 40 million. 28% (7) of companies had revenue from 0,7 million to 8 million. 4% (1) of companies had revenue from 0 million to 0,7 million.
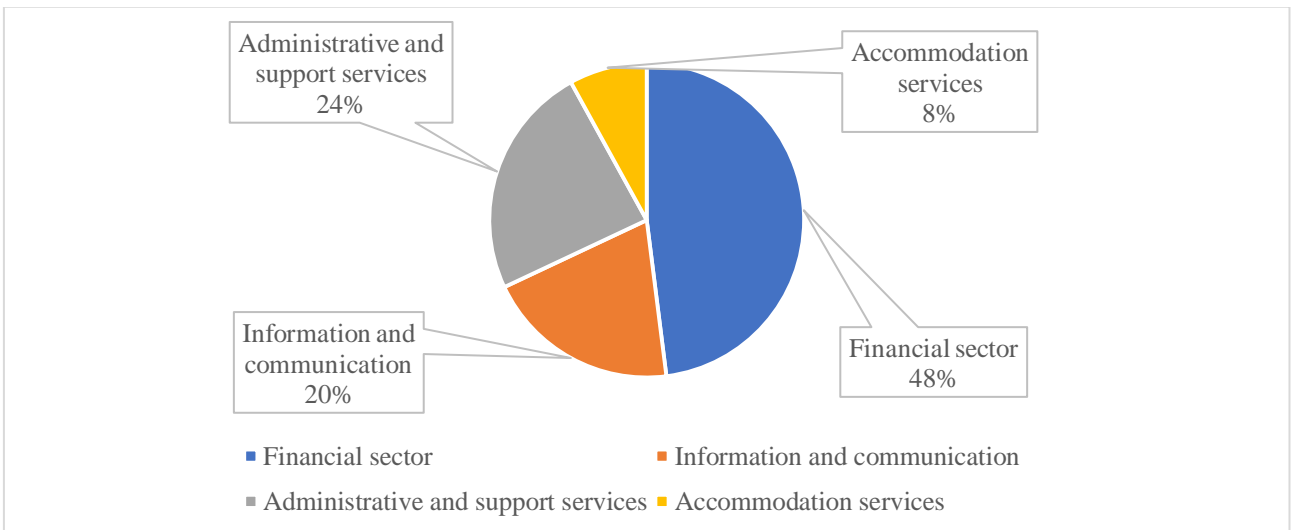
Figure 13 Big data usage by service sectors

The biggest percentage of companies which have participated in the survey and utilises big data is from the financial sector - 48% (12). 24% (6) are working in administration and support services area. 20% (5) of companies are working in the information and communication sector. 8% (2) are working in the accommodation sector.

Three companies (12%) out of 25 which are utilizing big data, outsource this function. Management accounting functions are outsourced in 9 companies (20%) out of 45. The bigger percentage of management accounting outsource might impact the fact that management accounting is more used by companies than big data.
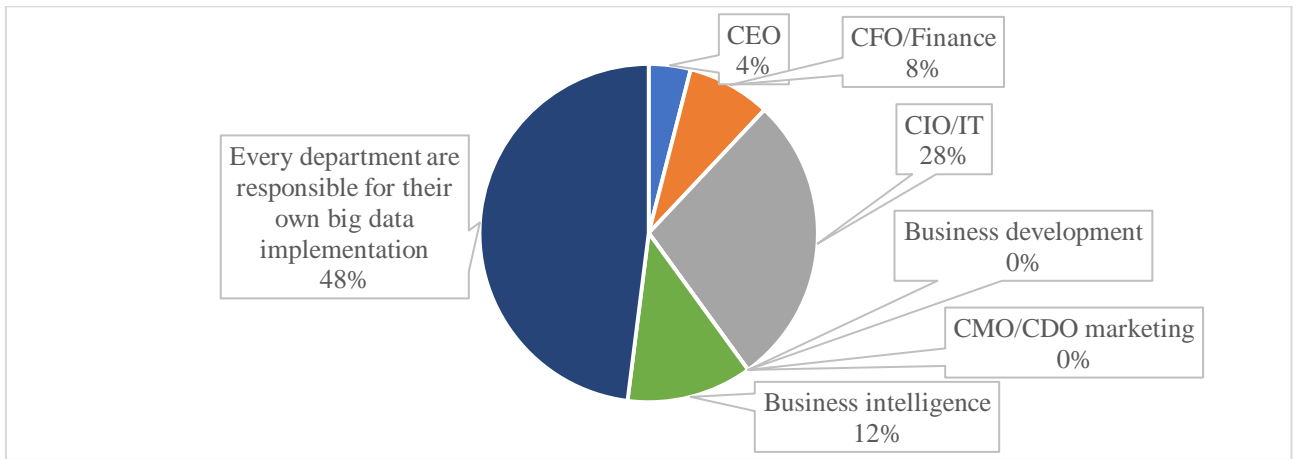
Figure 14 Big data ownership in companies

Survey shows that big data ownership in companies is various. In 48% (12) of companies, every department is responsible for their own big data implementation. In 28% (7) of companies, the IT department owns big data processes. In 12% (3) of companies, business intelligence is responsible for big data. In 8% (2) of big data is owned by finance. Furthermore, only in one company, big data is owned by the CEO.
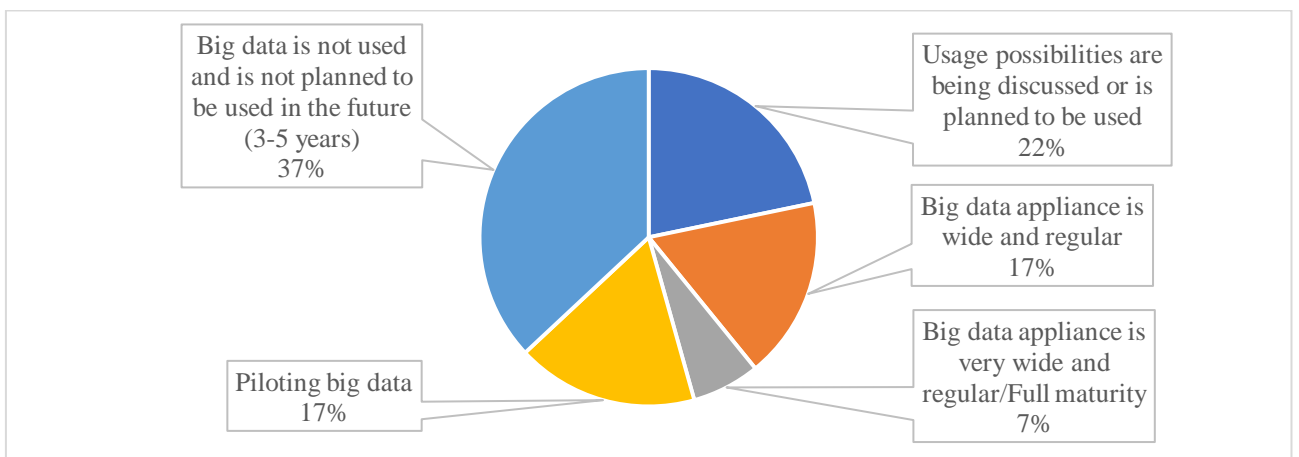
Figure 15 Big data usage in companies

37% (17) of companies are not using big data and are not planning to start to use it during the period of 3-5 years. 22% (10) of companies discuss the possibilities to implement big data, or it is planned to use. 17% (8) of the companies have implemented the first steps in the usage of big data and now are piloting it. The same amount of respondents (17% (8)) states that their big data usage is wide and regular. 7% (3) of companies have applied big data usage very widely and regular. Results suggest that not many companies utilise big data, however part of the companies are discussing the possibilities to implement it, therefore in the future bigger part of companies will be using big data.

Management accounting usage in service companies. Survey tried to find out if companies are using management accounting in their business.

Survey results show that only 4% (2) of companies are not using management accounting and are not planning to implement it during the period of 3-5 years. 11% (5) of respondents discuss the possibilities to use management accounting or are planning to use it. 18% (8) are stepping the first

steps and piloting management accounting. More than half of companies (54% (25)) are applying management accounting widely and regularly. 13% (6) are using management accounting at full maturity.
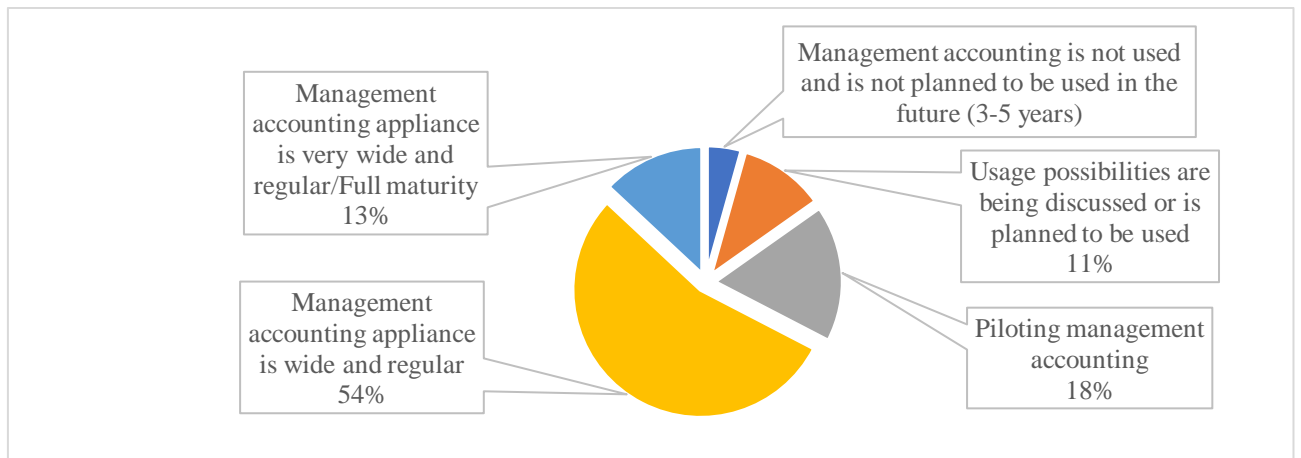
Figure 16 Management accounting usage in companies

Results show that companies which are already using management accounting widely or very widely (67% (31) of total companies, which participated in the survey) are piloting, or have already implemented big data. Results suggest that management accounting is used in the more significant part of the companies, it might be due to the reason that management accounting field comparing to big data field is older, and so more companies have adopted it. As companies have been using management accounting extensively, new ways to gain insights are needed to support their management accounting field.

Management accounting ownability differs from big data. In 77% (34) of companies, it is owned by finance. In 14% (6) it is owned by the CEO. Moreover, only in 4 (9%) companies, every department is responsible for their own management accounting data.

Big data in business processes and decision-making through management accounting. Further, respondents answered how important big data, business intelligence and management accounting information is important to company management (see figure 17).
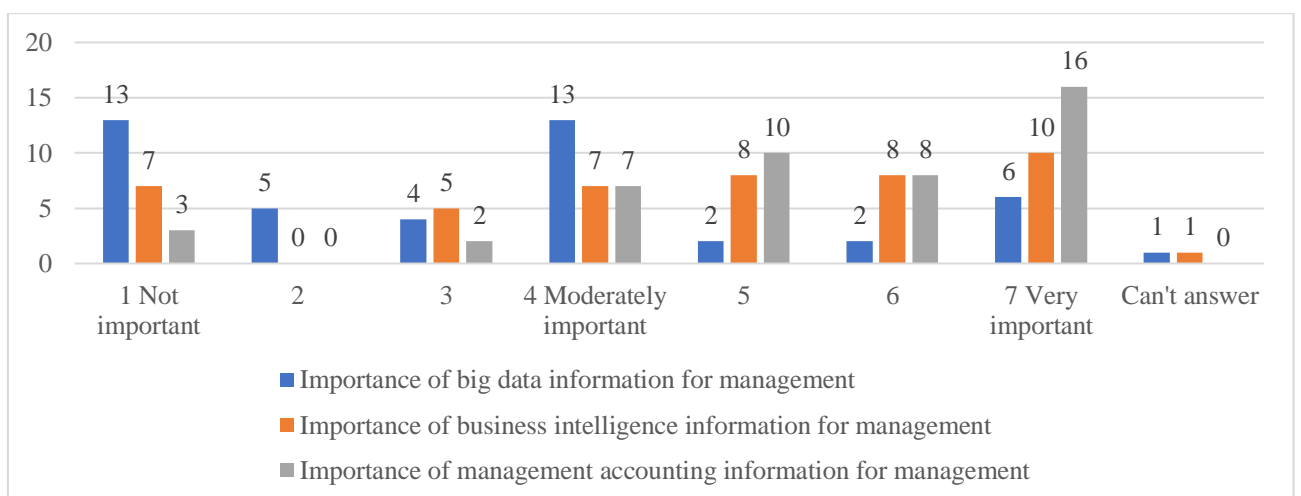
Figure 17 Current importance of big data, BI, and MA information to management

For 76% (35) of respondents, big data information considers from not important to moderately important. Only 13% (6) of companies currently thinks that big data information for management is very important. Survey shows that importance of business intelligence information for management have been valued more favourably compared to big data information. 72% (33) of respondents value business intelligence from moderately important to very important. 15% (7) says that business intelligence information is not important to management. Management accounting currently is being valued as the most important for management. 89% (41) of respondents value management information to management from moderately important to very important.

Figure 18 presents how respondents see future importance (3-5 years) of big data, business intelligence and management accounting information to company management in the future.
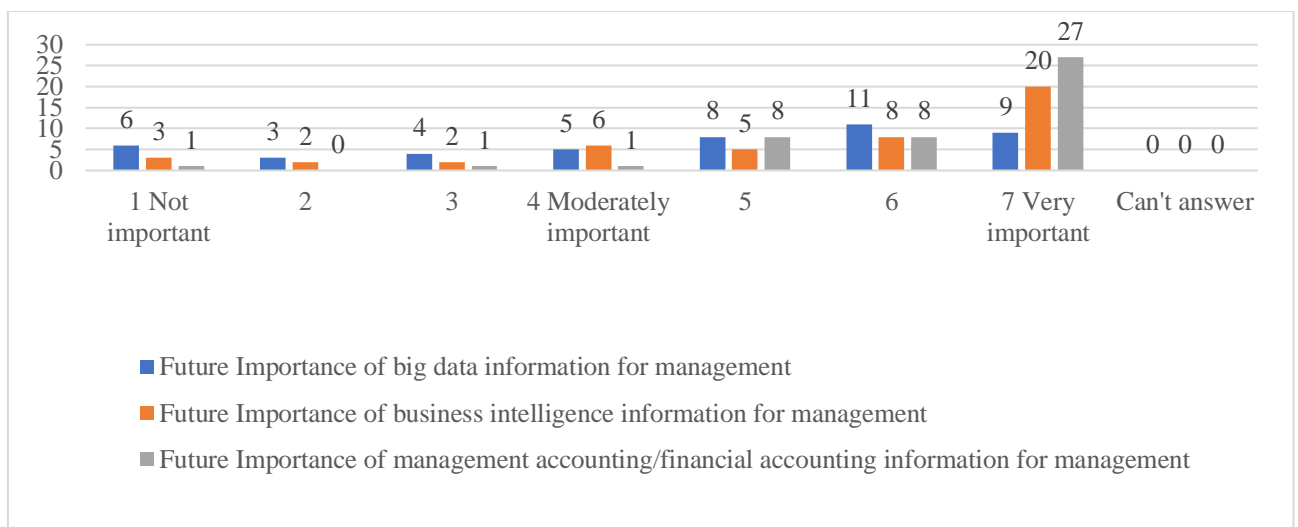
Figure 18 Future importance of big data, BI, and MA information to management

Respondents' answers suggest that all types of information will be much more important in the future. Despite the fact that currently, big data information for management is less important compared to business intelligence or management accounting information, big data importance prediction for the future rose heavily. 72% (33) of respondents value that in the future, big data importance will be from moderately to very important. Respondents who suggest that big data information will not be important to management in the future, have also answered that those companies are not planning to utilise big data and mainly, these respondents represent small businesses. 85% (39) of respondents believe that in the future, business intelligence information for management will be from moderately important to very important. 96% (44) of respondents believe that management accounting information will be from moderately important to very important. Answers to survey suggest that big data currently is not very important for companies, but companies understand the value of utilizing it, so respondents expect that big data will be more important in the future, this expectation can also be supported by the previous answers, as more companies are planning to start utilizing big data.

Companies understand the value of information from business intelligence and management accounting, due to this reason, currently, business intelligence and management accounting information are valued more important than big data. However, companies currently utilise more business intelligence and management accounting information than the big data, so the current importance is higher due to this reason.

As companies want to utilise big data or implement management accounting functions, during the survey, respondents were asked how they are currently evaluating importance of business intelligence experts, data scientists and management accountant and how they see those roles importance in the future (3-5 years) (see Figure 19).
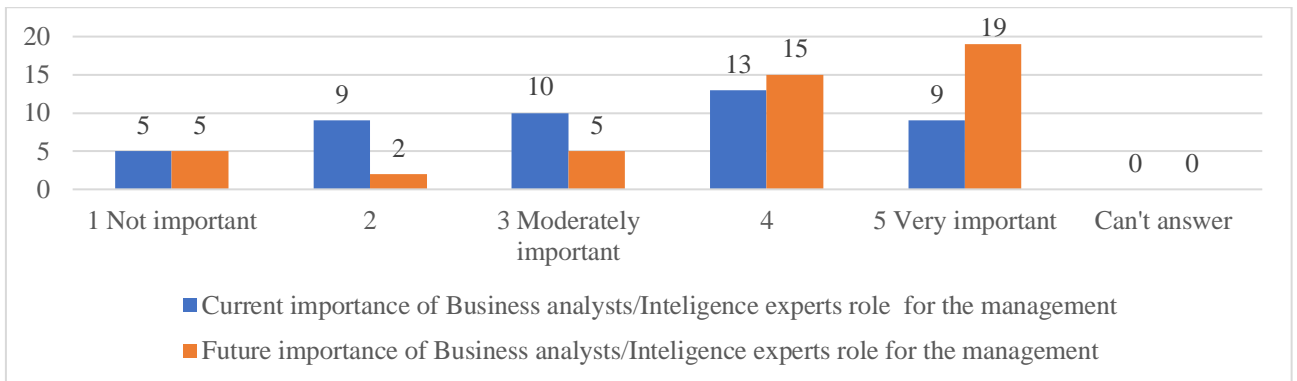
Figure 19 Current versus future business intelligence experts' importance to management

Currently, 30% (14) of companies value business intelligence experts from not important to less than moderately important. Respondents see the change in the future, and 85% (39) of companies thinks that business intelligence experts will be valued from moderately important to very important.

Figure 20 presents how respondents see current and future importance (3-5 years) of data scientists' role for management.
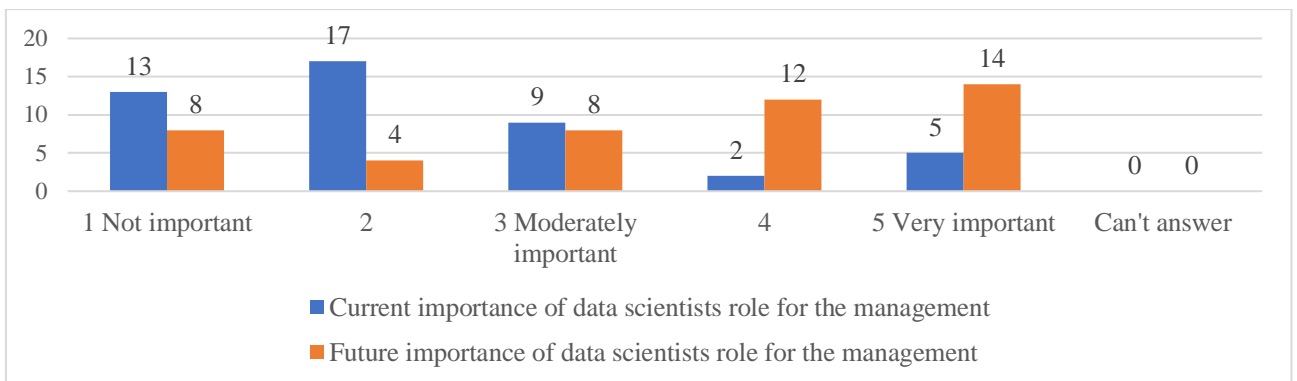
Figure 20 Current versus future data scientists' importance to management

Data scientists, according to the survey, are currently valued as the least important of those three positions. Currently, 65% (30) of companies values data scientists from not important to less than moderately important. However, in the future, the importance of this position will grow the most. 74% (34) of companies think that data scientists will be valued from moderately important to very important.

Figure 21 presents how respondents see current and future importance (3-5 years) of the management accountant role for management.
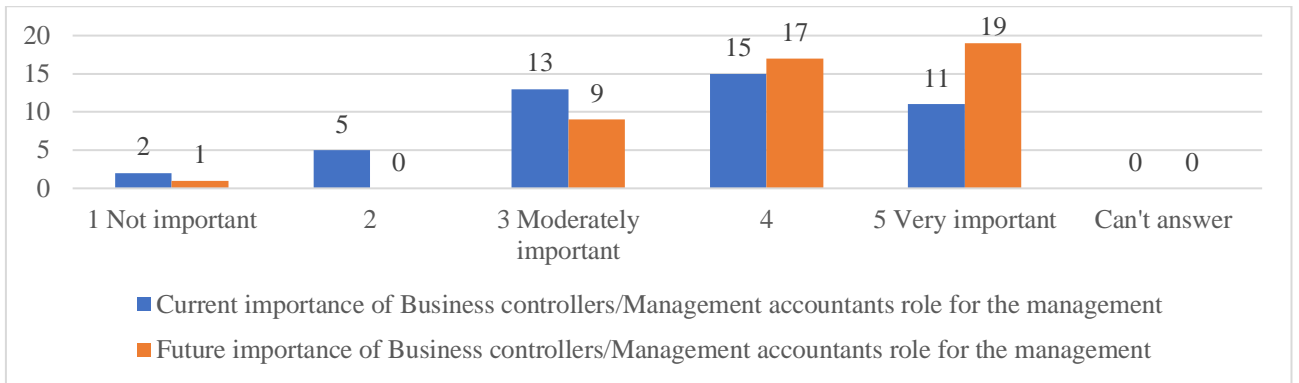
Figure 21 Current versus future business controllers/management accountants' importance to management

Companies currently value management accountants' importance the highest. Currently, 85% (39) of companies value management accountants from moderately important to very important. In the future companies predicts that importance will also grow and 98% (45) of companies thinks that management accountants will be valued from moderately important to very important.

Role importance support answers support the previous question. Data scientist role currently is valued as not very important for companies, but companies expect that big data will be more important in the future and that more companies are planning to start utilizing big data, data scientist importance to management will also rose.

As companies currently utilise more business intelligence and management accounting information, the importance of business analysts and management accountants' role is higher, however, in the future, the importance will also rise. The rise could be explained that there will be a need for skilful and knowledgeable employees which would help companies to build big data infrastructure and utilise it.

Big data application importance to management accounting functions. Further, respondents answered how they see current and future big data importance to management accounting functions (see Figures 21-28).
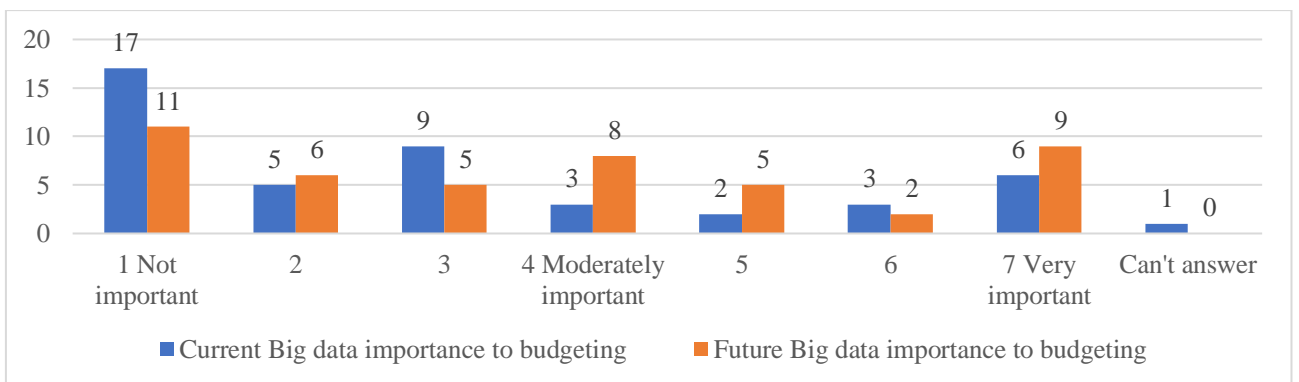
Figure 22 Current versus future big data importance to budgeting

74% (34) of respondents state that currently, big data importance to budgeting varies from not important to moderately important. In the future companies thinks that big data importance to

budgeting will slightly increase. In the future, 35% of respondents think that big data will from more than moderately till very important.
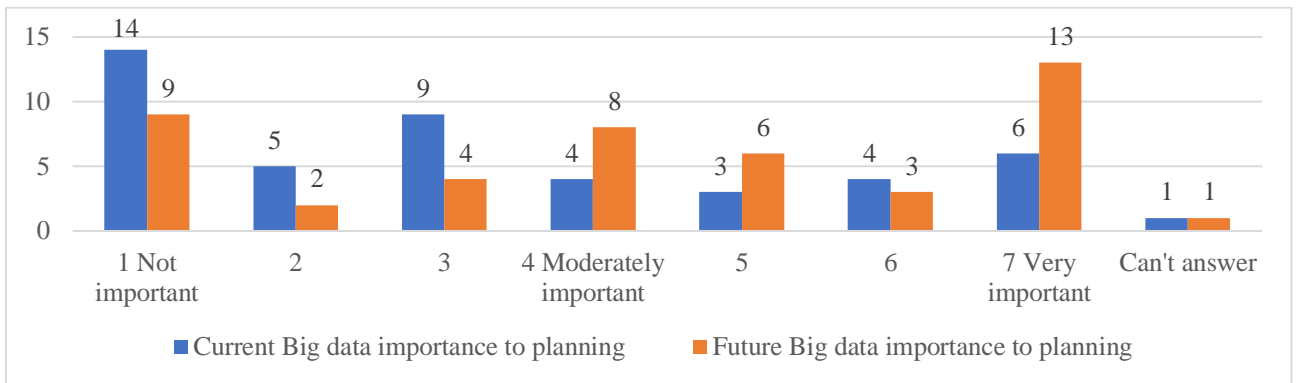
Figure 23 Current versus future big data importance to planning

Importance of big data to planning compared to budgeting is slightly higher. 70% (32) of companies value big data information from not important to moderately important to planning. In the future companies believes that importance will increase, and 48% (22) of respondents says that it will be from more than moderately important to very important.
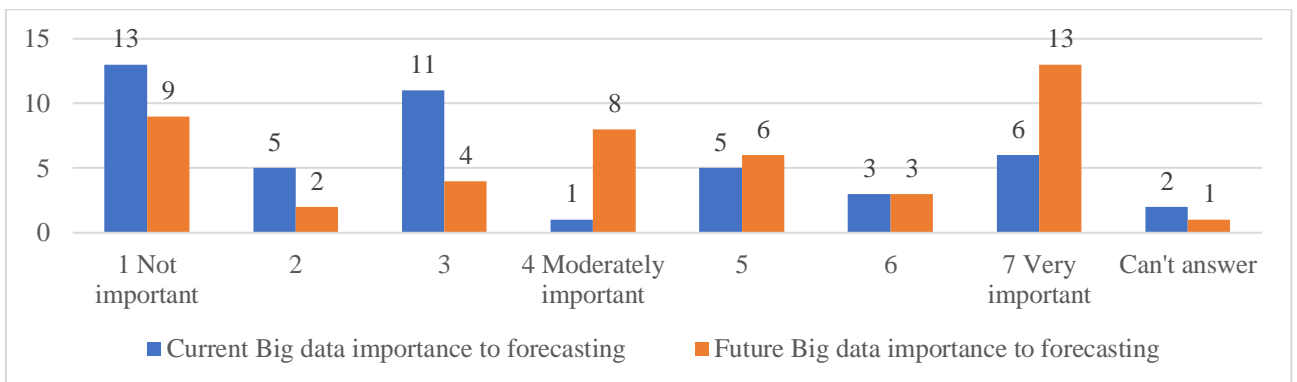
Figure 24 Current versus future big data importance to forecasting

Importance of big data to forecasting compared to planning is similar. 65% (30) of companies value big data information from not important to moderately important to forecasting. In the future companies believes that importance will increase, and 48% (22) of respondents says that it will be from more than moderately important to very important.
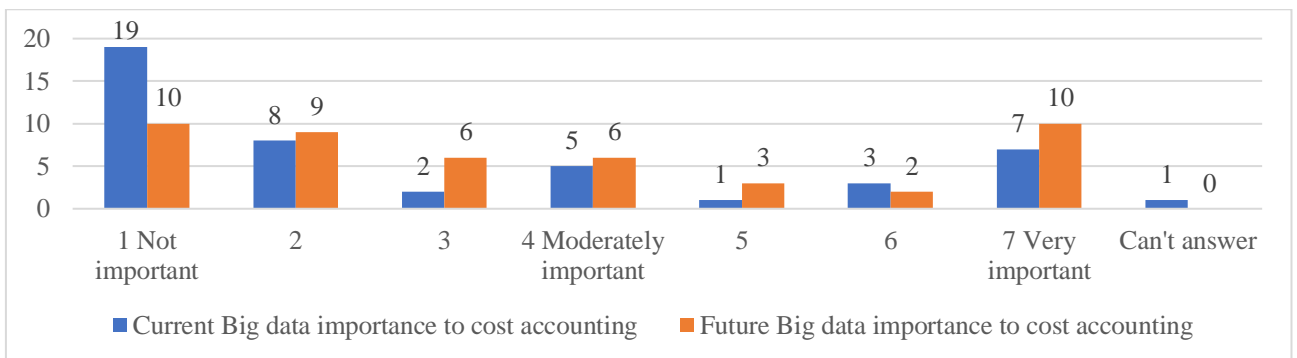
Figure 25 Current versus future big data importance to cost accounting

Big data importance to cost accounting is one of the lowest. Currently, 74% (34) of companies values big data information from not important to moderately important to cost accounting. In the future companies still states that importance will not increase a lot. 33% (15) of respondents say that it will be from more than moderately important to very important in the future.
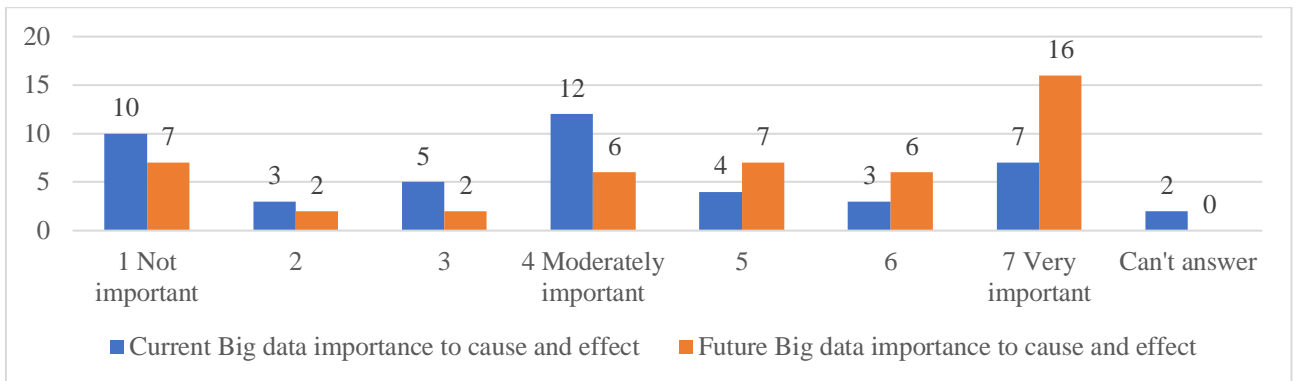
Figure 26 Current versus future big data importance to cause and effect

65% (30) of companies value big data information from not important to moderately important to decision making. In the future companies believes that importance will increase, and 63% (29) of respondents says that it will be from more than moderately important to very important.

Figure 27 Current versus future big data importance to performance analysis

Currently, 72% (33) of companies value big data information from not important to moderately important to performance analysis. 43% (20) of respondents say that it will be from more than moderately important to very important in the future.
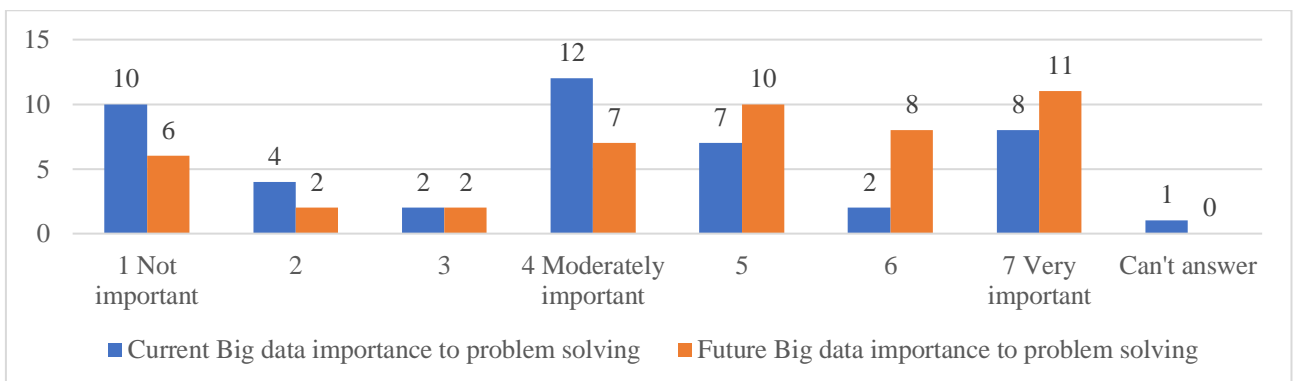
Figure 28 Current versus future big data importance to problem solving

Importance of big data to problem solving companies see more important than planning, budgeting, or forecasting. 61% (28) of companies value big data information from not important to moderately important to problem solving. In the future companies believes that importance will increase, and 63% (29) of respondents says that it will be from more than moderately important to very important.
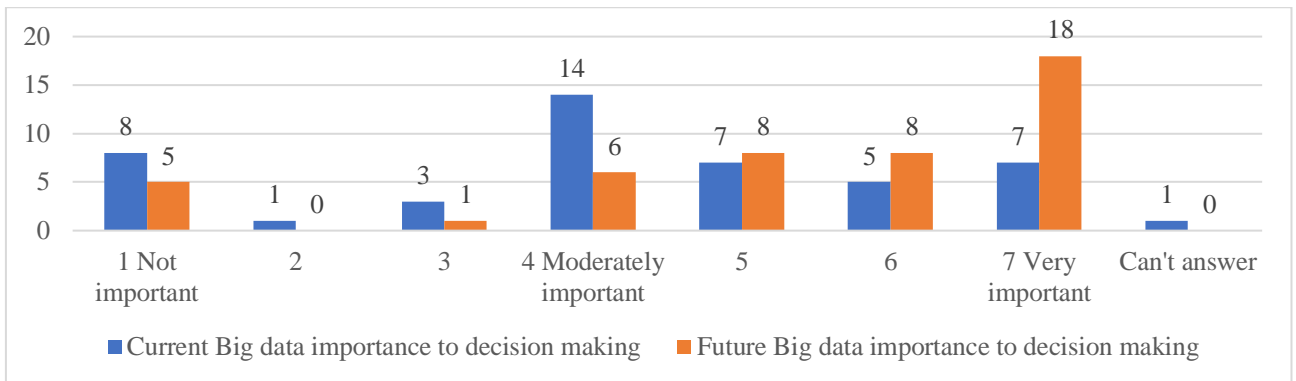
Figure 29 Current versus future big data importance to decision making

56% (26) of companies value big data information from not important to moderately important to decision making. In the future companies believes that importance will increase, and 74% (34) of respondents says that it will be from more than moderately important to very important.

According to the results, for companies currently, it is important to utilise big data information for advanced management functions, such as problem solving and decision making. In the future, when big data utilization for advanced management accounting functions will be wide and usual, companies will utilise big data information for basic and middle management accounting functions.

Big data application to management accounting functions. Companies which are utilizing big data also answered the question what kind of big data technology is used for management accounting functions. The analysis shows that only 3 companies out of 25 use one application related to big data. All other companies use several applications which are suited to handle big data. Some of the companies are even using 6 or more application.

Big data			Budgeting	Planning	Forecasting	Cost accounting	Cause and effect	Performance analysis	Problem solving	Decision making
Data analytics	Apache Kafka		1	1	1		3		3	3
	Splunk									
	Knime						1		1	
	Spark		1		1		1		1	1
	BlockChain									
	Other		10	10	10	8	9	7	12	12
Data mining	Presto									
	Elastic search		1	2	1	1	2	2	2	2
	Rapid miner									
	Other		5	5	5	5	8	4	7	7
Data visualisation	Tableau		2	2	1	1	1	1	2	2
	Plotly									
	Other		13	13	13	8	15	10	18	20
Data storage	Hadoop		5	3	3		1	3	4	5
	Mongo DB									
	Rainstor									
	Hunk									
	Other		11	10	13	7	8	6	10	9

Advanced big data — Basic big data

Management accounting: Basic management accounting | Middle management accounting | Advanced management accounting

Figure 30 Big data applications on management accounting functions

Furthermore, analysis shows that companies utilise big data mostly to several or to all management accounting functions. 36% (9) of companies utilise big data to all eight management accounting functions, 24% (6) utilises to six out of eight management accounting functions, 12% (3) utilises to seven out of eight management accounting functions, the same amount of companies utilises to three out of eight management accounting functions, and only 12% (3) utilises big data to two or less management accounting functions. Decision making and problem-solving are the main management accounting techniques to which companies apply big data. Cost accounting is the least function, to which big data is applied.
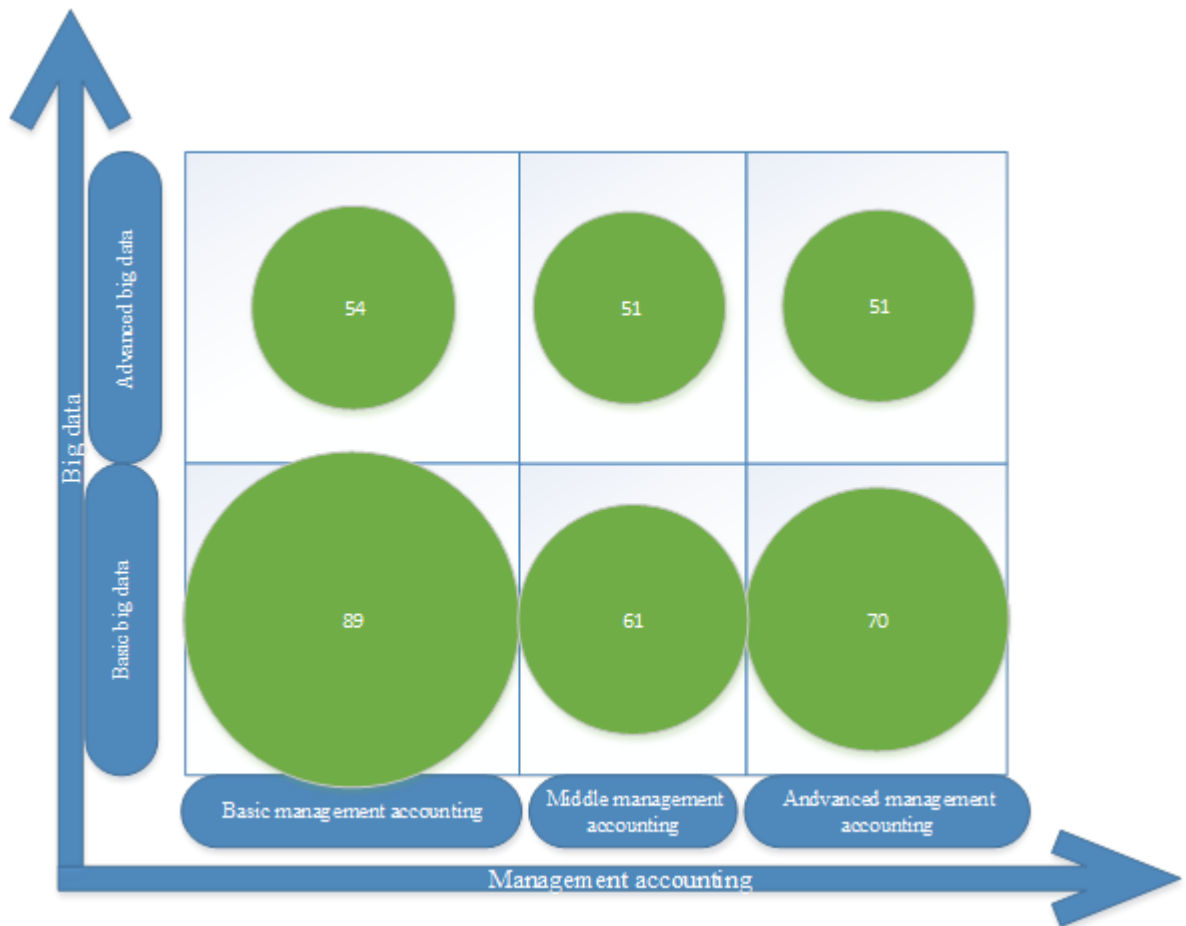
Figure 31 Big data applications on management accounting (summary)

Summarized model version demonstrates mostly companies adapt basic big data techniques for essential management accounting functions, such as planning, forecasting, and budgeting. Advanced big data techniques such as data mining and data analytics are used more or less equally through management accounting levels.
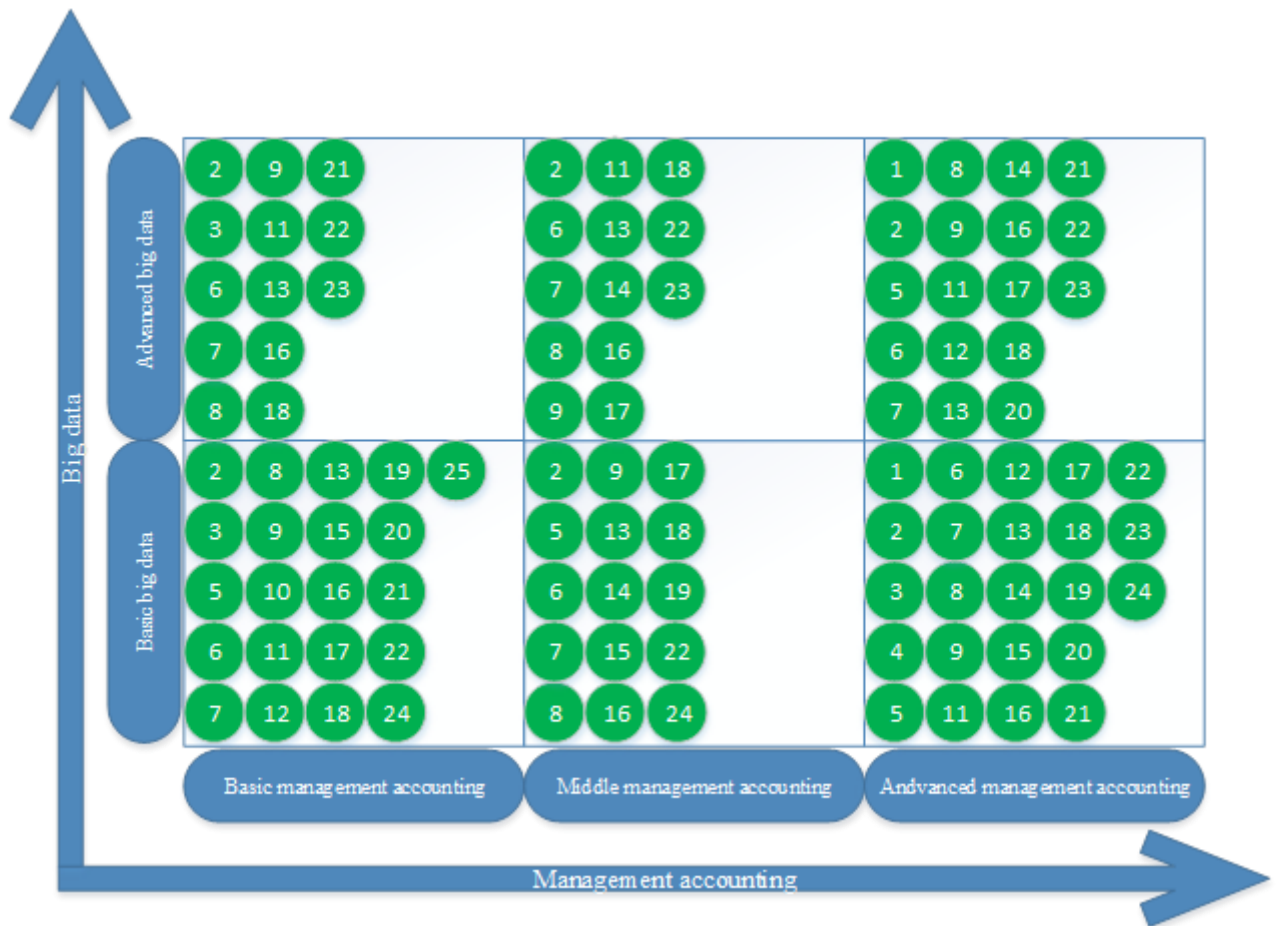
Figure 32 Big data applications on management accounting (by companies)

The model showed in which management accounting functions big data is utilised and how it is utilised. According to if, we can see which companies need to discuss possibilities to change the processes or improve utilization of big data:

- Companies 2, 3, 5, 6, 7, 9, 10, 11, 12, 13, 15, 16, 17, 18, 19, 20, 21, 22, 24, 25 are using basic big data technologies for basic management accounting functions, it means that companies correctly utilise basic big data technologies for basic management accounting functions.
- Companies which are using advanced big data techniques, but only for basic management accounting functions (2, 3, 6, 7, 8, 9, 11, 13, 16, 18, 21, 22, 23) dedicates advanced big data techniques to simple management accounting tasks, it shows that companies have a possibility to release resources which are being used for those management accounting tasks, and use the resources for more advanced management accounting activities,
- Companies which are using basic big data technologies for advanced management accounting functions (1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24), should evaluate if current platform will be capable to hold more functions and implementation of new processes.

Open questions were raised to respondents to understand what kind of management accounting techniques or technologies are used by companies. The answers show that companies which are using big data are also using more advanced management accounting and technologies such as internally developed programs, acquired programs as SAS guide, Access, Cognos, WebFocus, SQL scripts.

While companies which are not utilizing big data in most of the cases are using excel, accounting information, macros'es and ERP.

As new information is being generated at a fast pace and as companies have possibilities and tools to analyse this data, it is important to utilise big data information to management functions. Quantity of survey responses is statistically insignificant, further analysis is needed.

4.2. Results of qualitative research interviews method

As the principal part of respondents who were using big data works in the financial services area, invitations to interview were also sent financial industry companies. 3 companies participated in the interview. As companies did not want to reveal their names, further in the analysis participants will be addressed as "Credit", "Debit" and "Balance".

Big data usage in the financial sector. Companies which participated in interview utilises big data for internal purposes. Interviewees, in their company's context, defines big data similarly:

"Credit": *"I would use the definitions available in the market: extremely large data sets that may be analysed computationally to reveal patterns, trends, and associations, especially relating to human behaviour and interactions."*
"Debit": *"Large amount of data that could be analysed using advanced tools in order to reveal reliable patterns and conclusions".*
"Balance": *"Big data is unstructured, raw data from measurements or other facts to be analysed for our purpose. Many mix big data with just internal accounting, transactions data. In bank case big data could be treated client transactions".*

In the first place, interviewees underline the vast amount of data, which could be analysed and used for internal decisions.

Companies have different levels of big data maturity. "Credit" is using a small part of big data and values the current maturity in 5 points scale as "1" (planning to use), as the transformation project is ongoing, which will allow using. "Debit" values big data maturity in their company as "3". "Balance" values big data maturity as "2".

All participants have different reasons why they decided to utilise big data in their company ("Credit": *"Due to better financial market supervisory purposes, due to better quality of data, statistics and insights. Ultimately we are striving to be leader in advanced data analytics/data management/BigData & AI implementation in the EU."* "Debit": *"Key objective is to gather and process information that can support decision making resulting in better performance of the company".* "Balance": *"To understand client needs, habits.").* Despite the fact that the reasons are different, but the usage area is the same – management accounting. To *gather* data, *analyse* in order to *understand needs,* provide *insights* and *support decision making.* From the answer, we can also understand that companies want to use advanced big data technologies which would support advanced management accounting functions.

Big data as a function also has different owners in the companies. In the "Credit" every department is responsible for their big data. In the "Debit" big data is owned according to its content, financial information is owned by the finance department (CFO), commercial information by Chief

Commercial Officer. "Balance" was the only one, which outsources the big data function, and the outsourced function is owned by the business development department. The results show that big data is a new thing in the companies, and companies still try to figure out who should be responsible for it. The ownership of one department/party would slow down the implementation, but quality and control would be better.

Management accounting usage in the financial sector. Companies which participated in interview utilises management accounting for internal purposes. Two interviewees, in their company context, defines management accounting similarly ("Debit": *"Discipline to use accounting/financial data/information in company management decisions";* "Balance": *"Management accounting is financial data processed to information for decision making."),* but one was not able to describe it ("Credit": *"I am in no position to professionally answer this question.").* Both definitions emphases, that management accounting is a discipline which provides information for company management, which could be used for decision making.

Companies have different levels of management accounting maturity. "Credit" is using management accounting and values the current maturity in 5 points scale as *"2, little mature".* "Debit" values big data maturity in their company as "4 – wide and regular maturity" and provides example *"and a very fresh evidence of it is how quickly company makes informed decisions on the strategic direction in the context of COVID-19 (how to generate new revenue streams to amortize budgeted revenue losses, where to make cost savings etc.)".* "Balance" values big data maturity as "3". Results suggest that management accounting is used more widely in the companies, than big data. As companies have been using management accounting extensively, new ways to gain insights are needed to support their management accounting field.

Companies have different reasons why they decided to utilise big data in their company ("Credit": *"I have no information on that.";* "Debit": *"Informed decision making (supporting decisions with actual data) is key for management of our company.";* "Balance": *"Profitability of products, clients mainly).*" As "Debit" aim is to gather information for decision making, it shows that the company is aiming to utilise advanced management accounting functions. While "Balance" is aiming for middle management accounting functions such as costing and performance analysis.

Management accounting in these three companies has the same in own age structure. In all of the companies' management accounting function is owned either by the finance department or by the chief financial officer. Management accounting as a function in all companies is insourced.

Big data in business processes and decision-making through management accounting.

Table 7 Current importance of information to management

	"Credit"	"Debit"	"Balance"
Current importance of big data information to management	„7. All of company decisions are data - driven. We strive to improves this by better tools and new skills."	„6. In general it is very important (explained in #7-8). However, there are situations when decisions are made without the support of the data using general experience/ knowledge of the industry"	„5, it is quite costly to analyse big data into something valuable for long term"

Table 7 Current importance of information to management (continue)

Current importance of business intelligence information to management	*„7"*	*„7. Business Intelligence data is essentially the main input to management accounting in our company context."*	*„7"*
Current importance of management accounting information to management	*„7 regarding bussiness purposes."*	*„7. Most of company management decisions are being backed up with management accounting data."*	*„6"*

Companies value the current importance of big data information differently. The first company which is currently having a project to improve the utilisation of big data values the big data information the most. The second company gives a very high-value grade but also notices that sometimes in order to have faster decisions. The information for these decisions could be made according to the experience and expected outputs. The third company values big data information, the least and states that it is costly.

Business intelligence information to management companies values the most. As business intelligence is older field than big data, it might be so that companies have developed more business intelligence functions which currently provides more information than big data information.

Management accounting is also valued highly. Might be to the same reason as business intelligence, management accounting discipline is the oldest.

Table 8 Future importance of information to management

	"Credit"	"Debit"	"Balance"
Future importance of big data information to management	*„7"*	*„7. As business is becoming more and more complex as well as our company is growing rapidly, Big data has a big potential to be a key source of information to be used in management."*	*„4, one needs to truly understand what is needed from that data."*
Future importance of business intelligence information to management	*„7"*	*„7. As the business is growing to larger scale as well as technology advances, it's going to be critical source of information to management accounting."*	*„7"*
Future importance of management accounting information to management	*„3 and 7 like before. "*	*„7. As the business is growing to larger scale as well as technology advances, it's going to be critical discipline to keep up with competition in the market."*	*„6"*

The future importance of information compared to current has not changed much. Companies still value the information very highly. Interestingly, one company thinks that big data information to management might be less important in the future, interviewee suggests that maybe companies are nor currently overestimating big data information.

Big data application importance to management accounting functions. Further, companies answered how they see current and future big data importance to management accounting functions (see Table 9-10).

Table 9 Current importance of big data to management accounting functions

	"Credit"	"Debit"	"Balance"
Current importance of big data to budgeting	*„Budgeting to company I would guess that it is little important because the budget little depends on the data we collect. But the income that the company receives, very much depends of the quality of decisions made by using data. so i would say 4-5."*	7. Big data is especially useful when making budgeting decisions as it does indicate trends impacting cost and revenue	*„2"*
Current importance of big data to forecasting	*„3, we have little big data at this moment."*	*„7. Same as previous"*	*„2"*
Current importance of big data to planning	*„3, we have little big data at this moment."*	*„7. Same as previous"*	*„2"*
Current importance of big data to cost accounting	*„3, we have little big data at this moment."*	*„7. Same as previous"*	*„1"*
Current importance of big data to cause and effect	*„3, we have little big data at this moment."*	*„7. Same as previous"*	*„3"*
Current importance of big data to performance analysis	*„3, we have little big data at this moment."*	*„7. Same as previous"*	*„3"*
Current importance of big data to problem solving	*„3, we have little big data at this moment."*	*„7. Same as previous"*	*„1"*
Current importance of big data to decision making	*„3, we have little big data at this moment."*	*„7. Same as previous"*	*„2"*

Companies value the importance of big data to management accounting functions differently. "Credit" valuates big data information importance to budgeting as the highest (4-5), all other functions company values 3 (close to moderately important), lower importance was explained that currently, company does not have implemented big data processes. "Debit" values big data importance to all management accounting functions as very important but also underlines that big data information helps to improve the budgeting process by indicating trends which impacts costs and revenue. "Balance" gave the lowest importance valuations to management accounting, however big data in that company have the most important (valued as 3) impact to middle management accounting functions such as performance analysis and cause and effect.

Table 10 Future importance of big data to management accounting functions

	"Credit"	"Debit"	"Balance"
Future importance of big data to budgeting	„5-6"	„7. Same as #18. Due to increase in business complexity and company size it's going to be more important than ever."	„4"
Future importance of big data to forecasting	„7, we will have vast amounts of it in the future."	„7. Same as previous."	„4"
Future importance of big data to planning	„6-7, we will have significantly more data in the future."	„7. Same as previous."	„4"
Future importance of big data to cost accounting	„6-7, we will have significantly more data in the future."	„7. Same as previous."	„3"
Future importance of big data to cause and effect	„6-7, we will have significantly more data in the future."	„7. Same as previous."	„6"
Future importance of big data to performance analysis	„6-7, we will have significantly more data in the future."	„7. Same as previous."	„6"
Future importance of big data to problem solving	„6-7, we will have significantly more data in the future."	„7. Same as previous."	„4"
Future importance of big data to decision making	„6-7, we will have significantly more data in the future."	„7. Same as previous."	„4"

Companies expect that in the future, the importance of big data to management accounting functions will increase. "Credit" after the project will have a vast amount of available data, so it will be utilised to support management accounting functions, due to this reason company expects that in the future big data information for companies will be very important (6-7). "Debit" has not changed the valuation in the future and believes that big data information importance in the future will be very important. "Balance" also expects that the importance will higher and believes that importance to middle management accounting functions such as cause and effect and performance analysis will be close to very important (6).

According to the results, for companies currently, it is important to utilise big data information to all levels of management accounting functions. In the future, when big data utilization for advanced management accounting functions will be wide and usual, companies will utilise big data information for all of the levels also.

Big data application on management accounting functions. Figure 33 presents what kind of big data technologies are applied to certain management accounting functions. Company "Credit" in the figure is reflected as "C-1", Company "Debit" as "C-2", Company "Balance" as "C-4".

	Budgeting	Planning	Forecasting	Cost accounting	Cause and effect	Performance analysis	Problem solving	Decision making
Data analytics	C-2, C-3	C-2, C-3	C-3, C-2	C-2	C-2	C-2	C-2	C-3, C-2
Data mining		C-1				C-1		
Data visualisation	C-2	C-1, C-2	C-2			C-1		
Data storage	C-2, C-3	C-1, C-2, C-3	C-3, C-2	C-2	C-2	C-1, C-2	C-2	C-3, C-2
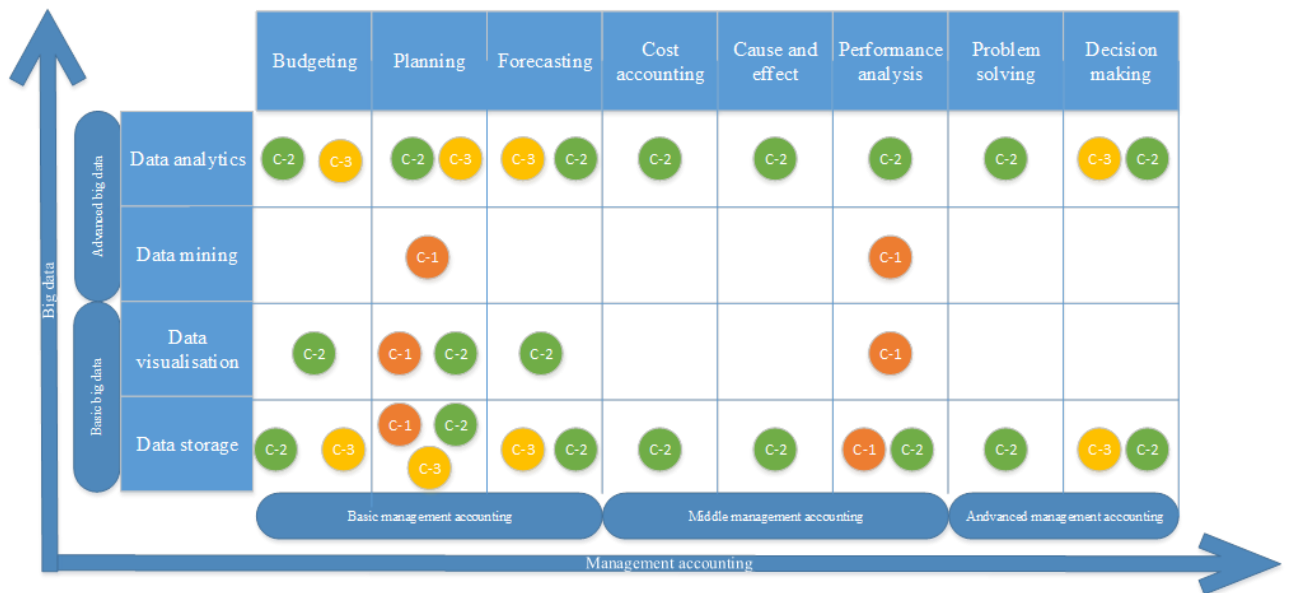
Figure 33 Big data applications on management accounting functions

Answers show that companies utilise big data mostly to several or to all management accounting functions. Planning, budgeting, forecasting and performance analysis are the main management accounting techniques to which companies apply big data, it means that companies are utilising big data information to basic management accounting functions mostly.

Model shows in which management accounting functions big data is utilised and also how it is utilised. According to it, we can see which companies need to discuss possibilities to change the processes or improve utilization of big data:

- "Credit", "Debit", "Balance" are using basic big data technologies for basic management accounting functions, it means that companies correctly utilise basic big data technologies for basic management accounting functions.
- "Credit", "Debit", "Balance" also uses advanced big data techniques, for basic management accounting functions and dedicates advanced big data techniques to simple management accounting tasks, it shows that companies have a possibility to release resources which are being used for those management accounting tasks, and use the resources for more advanced management accounting activities,
- "Debit", "Balance" as they are using basic big data technologies for advanced management accounting functions, should evaluate if the current platform will be capable of holding more functions and implementation of new processes.

Companies also named the factors which will affect the future roles of management accountants/business intelligence experts/data scientists ("Credit": *"Of course. The awareness of value of the data. The technological advancement. The growing business needs and the market needs";* "Debit": *„Yes. Importance of the role will increase due to increasing amounts of data, technology advancing rapidly. This expertise and skills will be hugely valued in business due to it's impact";* "Balance"*: „More data management skills will be needed").* All companies underline that increasing data availability/quantity and technological advancement will be the main factors influencing the changes to the roles.

Interviews revealed that companies are utilizing big data information to management accounting functions and expect to utilise the data even more in the future.

4.3. Comparison of the results

Big data usage in service companies. According to the survey's results, 25 (54%) companies out of 46 utilise big data information in their companies. From those 25 companies, the biggest percentage of companies which have participated in the survey and utilises big data is from the financial sector - 48% (12). Due to this reason for the interview, financial companies were invited. Results may show that financial companies as they have customer transactions, understand the value of big data information and tries to utilise it.

The survey showed that three companies outsource big data processes, however, from interviewed companies, only one is outsourcing the process. Due to small quantity of answers, no statistical insights could be done, however, the outsourcing could show that companies are willing to find skilful companies which would help to implement big data processes, also companies with more experience could help to extract more value from available data. On the other hand, companies which outsource the process are losing the control of data and it might lead to security issues which in nowadays is an essential topic. Also, companies could miss the metadata (information about data), which might lead to missed insights in analytics and reporting.

Interviews also underlined that companies want to utilise advanced big data technologies which would support advanced management accounting functions.

Both survey and interviews show that most of the companies which are utilising big data, are still in early stages of it and tries to find how effectively to utilise it and also "Credit" from interview supports this statement, as "Debit" currently has an ongoing project to implement big data activities. Besides, big data ownage in the companies varies a lot, in most of the companies every department is responsible for their own big data implementation. It shows that companies big data processes are not centralized and very much depends on the specific managers and their knowledge.

Management accounting usage in service companies. According to the survey's results, 2 (4%) companies out of 46 are not utilizing management accounting information and techniques in their companies, besides, results from interviews also show that for companies' management accounting discipline is crucial. The survey showed that eight companies outsource management accounting processes, however, interviewed companies revealed that management accounting processes are insourced. In most of the cases, companies which have outsourced management accounting functions are small and generating up to 0,7 million euro revenues. It might show that small companies are trying to save by outsourcing these functions.

Interviews also underlined that companies want to utilise management accounting information to support advanced management accounting functions, such as decision making. The aim is similar to big data utilisation aim.

Both survey and interviews show that most of the companies, which are utilising management accounting, are in more mature stages of it, comparing to big data maturity. 67% (31) applies management accounting widely and regularly or has full maturity of management accounting

processes. The maturity statement could also be supported by the ownage of the management accounting process. In 77% (34) of companies, it is owned by finance. Results suggest that companies already utilised management accounting functions widely and extensively, due to this reason, new ways to gain insights are needed to support their management accounting field. As big data can provide important insight, companies are starting to implement the processes.

Big data in business processes and decision-making through management accounting. As companies are still at the early stages of the big data implementation, 76% (35) of respondents, big data information considers from not important to moderately important. As companies still need to support management decisions, currently, other disciplines are valued as more important than big data. 72% (33) of respondents value business intelligence from moderately important to very important. 89% (41) of respondents value management information to management from moderately important to very important. Information supports the idea that management accounting and business intelligence processes are valued more highly due to the reason that these processes are more mature. However, companies understand the value of utilizing big data, so respondents expect that big data will be more important in the future, this expectation can also be supported by the previous answers, as more companies are planning to start utilizing big data.

Accordingly, companies value the roles of data scientists/business analytics/management accountant. As companies currently utilise more business intelligence and management accounting information, the importance of business analysts and management accountants' roles are higher compared to data scientists, however, in the future, the importance will rise more. The rise could be explained that there will be a need of skilful and knowledgeable employees which would help companies to build big data infrastructure and utilise it.

Big data application importance to management accounting functions. Survey and interview results reflect how companies value big data importance to certain management accounting functions. Currently, companies believe that big data is the most important to such advanced management accounting techniques as problem solving and decision making. The least important is basic management accounting techniques such as planning, budgeting, forecasting.

Companies suggest that in the future, the importance of big data information to management accounting functions will be even bigger. The importance of big data to advanced management accounting functions remains high, however, companies expect that in the future the importance of big data to basic management functions will be on a similar level as advanced management accounting functions.

Big data application to management accounting functions. Survey and interview results show similar results - companies utilise big data mostly to several or to all management accounting functions. Planning, budgeting, forecasting and performance analysis are the main management accounting techniques to which companies apply big data, it means that companies are utilising big data information to basic management accounting functions mostly.

The model also shows that companies which are utilising advanced big data technologies for basic management accounting techniques should consider using the same techniques for more sophisticated and important management accounting functions such as problem solving and decision making. Also, companies which are using basic big data technologies for advanced management accounting

functions should consider evaluating if the current platform will be capable of holding more functions and implementation of new processes.

CONCLUSIONS

By summarizing the results of the thesis, the following main conclusions can be done:

1) Literature analysis revealed that management accounting discipline is being researched heavily in various contexts. As the field roots dates back in the 1920s in other fields, current research focuses more on management accounting usage with new technologies or on popular subjects (such as environmental topics) which are currently heavily analysed. Big data literature analysis revealed that this new subject originated as a result of the increased volumes of data. As amounts of data are vast, new applications/technologies were created to process the data. As management accounting searches new data to provide better insights for management, big data could be implemented to improve management accounting techniques.

2) Proposed conceptual big data application on management accounting model is an instrument, which could help companies to identify big data technological level and link it with management accounting processes. The model can moreover be used to identify the areas which need to improve and likewise used for comparison between companies. Model results help to indicate important information for management - how big data is utilised in the company and to which level.

3) The developed empirical research methodology for big data application on management accounting functions focus on mix methods by using survey and interview methods. This methodology was chosen to get a deeper insight in the analysed topic and to analyse the trends.

4) Empirical research results revealed:

- Currently, companies mostly value big data information for advanced management accounting functions such as problem solving and decision making. However, big data information for basic management functions such as planning, budgeting, forecasting is the least important.
- In the future, companies still the most values importance of big data to advanced management accounting functions but results furthermore shows that importance to basic and middle management accounting functions will rise and be similar to advanced management accounting functions.
- However, as management accounting field maturity is higher, companies are utilising management accounting information more widely and regularly, so currently the management accounting information for companies is more valuable than big data insights. Companies expect that in the future situation will change, and big data information will be equally important.
- Service companies in Lithuania are utilising big data information for all levels of management accounting functions. The biggest part of companies utilises big data technologies for several management accounting functions. Part of the companies which participated in the research uses worldwide popular big data handling application, but most companies implemented other solutions.
- Despite the fact that companies currently value big data importance to decision making and problem solving (advanced management accounting functions), most companies use basic big data technologies such data storage and data visualisation for basic management accounting functions such as budgeting, planning, forecasting.

- Research besides revealed that companies use advanced big data technologies for basic management accounting functions or basic big data technologies for advanced management accounting functions.

RECOMMENDATIONS

The main recommendations can be given:

1) Companies which uses advanced big data technologies for basic management accounting functions are not utilising full big data potential. These companies should consider improving the appliance of big data to more advanced management techniques in order to utilise the full potential of big data.

2) Companies which uses basic big data techniques for advanced/middle management accounting techniques should consider revising the processes, in order to understand will the architecture of those applications be capable to hold more processes in the future if needed.

3) Companies which uses basic big data technologies for basic/middle management accounting functions - correctly utilise basic big data technologies for basic management accounting functions. These companies should, at some point of times, revise the processes and make sure that new processes are not overloading application.

4) Companies which uses advanced big data technologies for advanced/middle management accounting functions - correctly utilise advanced big data technologies for advanced/middle management accounting functions. These companies should, at some point of times, revise the processes and make sure that still applications are utilised fully.

5) As the survey results are statistically insignificant, further research needs to be performed.

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APPENDIXES

Appendix 1, Survey form

   1) Big data usage in your company:
- ○ Big data is not used and is not planned to be used in the future (3-5 years)
- ○ Usage possibilities are being discussed or is planned to be used
- ○ Piloting big data
- ○ Big data appliance is wide and regular
- ○ Big data appliance is very wide and regular/Full maturity

   2) Management accounting usage in your company:
- ○ Big data is not used and is not planned to be used in the future (3-5 years)
- ○ Usage possibilities are being discussed or is planned to be used
- ○ Piloting big data
- ○ Big data appliance is wide and regular
- ○ Big data appliance is very wide and regular/Full maturity

   3) Current importance of Big data for management

	Not important			Moderately important			Very important	Can't answer
	1	2	3	4	5	6	7	X
Importance of big data information for management								
Importance of business intelligence information for management								
Importance of management accounting/financial accounting information for management								

   4) Future importance of Big data for management

	Not important			Moderately important			Very important	Can't answer
	1	2	3	4	5	6	7	X
Importance of big data information for management								
Importance of business intelligence information for management								
Importance of management accounting/financial accounting information for management								

5) Current importance of big data in certain possible application areas

	Not important			Moderately important			Very important	Can't answer
	1	2	3	4	5	6	7	X
Big data importance budgeting								
Big data importance to forecasting								
Big data importance to planning								
Big data importance to problem solving								
Big data importance to decision making								
Big data importance to cause and effect								
Big data importance to cost accounting								
Big data importance to performance analysis								

6) Current importance of big data in certain possible application areas

	Not important			Moderately important			Very important	Can't answer
	1	2	3	4	5	6	7	X
Big data importance budgeting								
Big data importance to forecasting								
Big data importance to planning								
Big data importance to problem solving								
Big data importance to decision making								
Big data importance to cause and effect								
Big data importance to cost accounting								
Big data importance to performance analysis								

7) Conducting big data

	Yes	No
In our company we conduct big data analysis by ourselves		
If (1) yes: recruited specialists are carrying the duty		

If (1) yes: big data activities are centralized		
If (1) yes: big data activities are decentralized		

8) Conducting management accounting

	Yes	No
In our company we conduct management accounting analysis by ourselves		
If (1) yes: recruited specialists are carrying the duty		
If (1) yes: management accounting activities are centralized		
If (1) yes: management accounting activities are decentralized		

9) If your company conducts big data, then who is the owner of big data process:
   - ○ CEO
   - ○ CFO (Finance)
   - ○ CIO/IT
   - ○ CMO/CDO marketing
   - ○ Business development
   - ○ Business intelligence
   - ○ Every department are responsible for their own big data implementation
   - ○ Other (please specify)

10) If your company conducts management accounting, then who is the owner of management accounting process:
   - ○ CEO
   - ○ CFO (Finance)
   - ○ CIO/IT
   - ○ CMO/CDO marketing
   - ○ Business development
   - ○ Business intelligence
   - ○ Every department are responsible for their own big data implementation
   - ○ Other (please specify)

11) Big data is outsourced

Yes	No

12) Management accounting is outsourced

Yes	No

13) If your company is using big data, what technologies/methods are used?

	Budgeting	Forecasting	Planning	Problem solving	Decision making	Cause and effect	Cost accounting	Performance analysis
Data storage (software - Hadoop)								
Data storage (software - Mongo DB)								
Data storage (software - RainStor)								
Data storage (software - Hunk)								
Data storage (software - other)								
Data mining (software - Presto)								
Data mining (software - Rapid Miner)								
Data mining (software - ElasticSearch)								
Data mining (software - Other)								
Data analytics (software - Apache Kafka)								
Data analytics (software - Splunk)								
Data analytics (software - Knime)								
Data analytics (software - Spark)								
Data analytics (software - BlockChain)								
Data analytics (software - Other)								

	Not important			Moderately important			Very important	Can't answer
Data visualisation (software - Tableau)								
Data visualisation (software - Plotly)								
Data visualisation (software - Other)								

14) If your company is using big data, what technologies/methods are used?

15) How you see the current overall role of the following professionals for the management in your company:

	Not important			Moderately important			Very important	Can't answer
	1	2	3	4	5	6	7	X
Business analysts/Intelligence experts								
Data scientists								
Business controllers/Management accountants								

16) How you see the future (3-5 years) overall role of the following professionals for the management in your company:

	Not important			Moderately important			Very important	Can't answer
	1	2	3	4	5	6	7	X
Business analysts/Intelligence experts								
Data scientists								
Business controllers/Management accountants								

17) If you see changes in the future roles, please name major drivers for the change.

18) Your age:

- ○ 20-29 years
- ○ 30-39 years
- ○ 40-49 years
- ○ 50-59 years
- ○ 60 and more years

19) Experience in your work area:

- ○ 1-5 years

- ○ 5-10 years
- ○ 10-15 years
- ○ 15-20 years
- ○ More than 20 years

20) Your position:
- ○ CEO
- ○ CFO/Finance
- ○ CIO/IT
- ○ CMO/CDO marketing
- ○ Business development
- ○ CRO
- ○ Other

21) Industry in which your company is working:

Industry	
Financial sector	
Information and communication	
Administrative and support services	
Accommodation services	
Other, please specify	

22) Turnover:

0-0,7 m.EUR	
0,7-8 m.EUR	
8-40 m.EUR	
More than 40 m.EUR	

23) Employees

Up to 10	
10-50	
50-250	
More than 250	

24) Additional comments

25) If You would like to receive a copy of this study, please state the email address.

Appendix 2, Interview form

1. How would you define big data? How would You define in big data in your company context?
2. Who is the owner of big data? Who is responsible for it? Is big data, or part of it outsourced?
3. How mature is big data in your company? On scale of 1 to 5? 1- Only planning to use it, 5 full maturity.
4. Why your company decided to utilise big data? What objectives You would like to achieve?
5. How would you define management accounting? How would You define in management accounting in your company context?
6. Who is the owner of management accounting? Who is responsible for it? Is management accounting, or part of it outsourced?
7. How mature is management accounting in your company? On scale of 1 to 5? 1- Only planning to use it, 5 full maturity.
8. Why your company decided to utilise management accounting? What objectives You would like to achieve?
9. How You currently value the importance of big data information to management? On a scale 1- not important, to 7 –very important.
10. How You currently value the importance of business intelligence information to management? On a scale 1- not important, to 7 –very important.
11. How You currently value the importance of management accounting information to management? On a scale 1- not important, to 7 –very important.
12. Future importance of big data information to management? On a scale 1- not important, to 7 –very important.
13. Future importance of business intelligence information to management? On a scale 1- not important, to 7 –very important.
14. Future importance of management accounting information to management? On a scale 1- not important, to 7 –very important.
15. What kind of programs/tools do you use for big data? Have You changed the platform architecture before implementing big data?
16. What kind of programs/tools do you use for management accounting? Have You changed the platform architecture before implementing management accounting?
17. How You currently value the importance of big data to budgeting? On a scale 1- not important, to 7 –very important. Explain the valuation if possible.
18. Future importance of big data to budgeting? On a scale 1- not important, to 7 –very important. Explain the valuation if possible.
19. How You currently value the importance of big data to forecasting? On a scale 1- not important, to 7 –very important. Explain the valuation if possible.
20. Future importance of big data to forecasting? On a scale 1- not important, to 7 –very important. Explain the valuation if possible.
21. How You currently value the importance of big data to planning? On a scale 1- not important, to 7 –very important. Explain the valuation if possible.

22. Future importance of big data to planning? On a scale 1- not important, to 7 –very important. Explain the valuation if possible.

23. How You currently value the importance of big data to problem solving? On a scale 1- not important, to 7 –very important. Explain the valuation if possible.

24. Future importance of big data to problem solving? On a scale 1- not important, to 7 –very important. Explain the valuation if possible.

25. How You currently value the importance of big data to decision making? On a scale 1- not important, to 7 –very important. Explain the valuation if possible.

26. Future importance of big data to decision making? On a scale 1- not important, to 7 –very important. Explain the valuation if possible.

27. How You currently value the importance of big data to cost accounting? On a scale 1- not important, to 7 –very important. Explain the valuation if possible.

28. Future importance of big data to cost accounting? On a scale 1- not important, to 7 –very important. Explain the valuation if possible.

29. How You currently value the importance of big data to performance analysis? On a scale 1- not important, to 7 –very important. Explain the valuation if possible.

30. Future importance of big data to performance analysis? On a scale 1- not important, to 7 –very important. Explain the valuation if possible.

31. How You currently value the importance of big data to cause and effect? On a scale 1- not important, to 7 –very important. Explain the valuation if possible.

32. Future importance of big data to cause and effect? On a scale 1- not important, to 7 –very important. Explain the valuation if possible.

33. What big data technologies do you apply to management accounting functions? Big data technologies – data storing, data visualisation, data mining, data analytics. Management accounting functions - Budgeting, Forecasting, Planning, Problem solving, Decision making, Cause and effect, Cost accounting, Performance analysis.

34. Do you think that there will be changes in the future roles of management accountant/business intelligence expert/data scientist? What would be the factors influencing the changes?

35. Other comments?