Data Driven Decision Support: The Role of the Controller in Decision-Making Processes

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Abstract: During the past two decades the implementation and adoption of information technology has rapidly increased. As a consequence the way businesses operate has changed dramatically. For example, the amount of data has grown exponentially. Companies are looking for ways to use this data to add value to their business. This has implications for the manner in which (financial) governance needs to be organized. The main purpose of this study is to obtain insight in the changing role of controllers in order to add value to the business by means of data analytics. To answer the research question a literature study was performed to establish a theoretical foundation concerning data analytics and its potential use. Second, nineteen interviews were conducted with controllers, data scientists and academics in the financial domain. Thirdly, a focus group with experts was organized in which additional data were gathered. Based on the literature study and the participants responses it is clear that the challenge of the data explosion consist of converting data into information, knowledge and meaningful insights to support decision-making processes. Performing data analyses enables the controller to support rational decision making to complement the intuitive decision making by (senior) management. In this way, the controller has the opportunity to be in the lead of the information provision within an organization. However, controllers need to have more advanced data science and statistic competences to be able to provide management with effective analysis. Specifically, we found that an important skill regarding statistics is the visualization and communication of statistical analysis. This is needed for controllers in order to grow in their role as business partner.

Keywords: big data, data analytics, governance, decision support, business controller

1. Introduction

In the current business environment, digitalization is reshaping the way companies are managed. Over the years the increasing amount of data has significantly changed the role of the controller. As companies are changing in line with technology development, the scope of the controller has expanded from solely score keeping to supporting management in decision making: decision support (Johnson & Kaplan 1987; Verstegen et al, 2007). The volume of data increases with its collection and use. Not all data is valuable, but the potential of it is an increasingly critical resource for businesses. The challenge is to convert these large amounts of data into valuable information which can be used to proactively support decision-making processes.

In this study we describe how the controller can use data analytics to support decision-making processes and become a value adding business partner. In this role the controller acts as an interface between management and IT(-related) departments within an organization. Furthermore, this research increases our understanding of data analytics and its purpose and role in an organization. Data analytics is used to support managerial and strategic decision-making processes. Managers can use their rationality and intuition to make decisions (Kahneman & Tversky 1984; Stanovich & West 2000; Kahneman 2003). Data analytics adds more rationality to this process.

To gain knowledge on how a controller can utilize data analytics, we performed an exploratory research. We conducted interviews with controllers, other financial professionals, academics and a focus group. This was complemented by a literature review which helped to understand the role of the controller and get a better understanding of various definitions of data analytics. Our results contribute to research that aims to understand the changing role of the controller as a result of technological advancements.

The remainder of this paper is structured as follows: the next section summarizes the theoretical foundation of our study, section 3 discusses the research approach which is followed by the results in section 4. Finally the paper ends with the conclusions.

2. Theoretical foundation

2.1 The controller

From an historical perspective, the controlling function has had a sole responsibility of processing company transactions (Morgan 2001; Tulimieri & Banai 2010). Evolving from its traditional emphasis on financially-oriented decision analysis and budgetary control (financial controlling), modern controlling encompasses a more strategic approach that emphasizes the identification, measurement, and management of the key financial and operational drivers of shareholder and company value (Ittner and Lacker 2001). The introduction of Enterprise Resource Planning (ERP) systems meant that controllers could refocus their activities more towards business controlling and providing decision support (Morgan 2001; Verstegen and De Loo 2007).

Controllers today participate in planning, decision making, designing information systems, implementing control, and preparing financial statements (Maher, Stickney & Weil 2006; Brands 2015). According to Cokins (2013) the main obligations of controllers can be classified into preparing financial statements, measuring the company's performance and providing decision support. Vosselman (1999) and Weber & Nevries (2010) provided a more general definition of controlling and stated that the controller has the sole responsibility of securing the rationality of management which leads to data analytics.

2.2 Knowledge management

In order to understand how a controller can utilize data analytics, we need to understand what its purpose within an organization is. Concepts such as data, information, knowledge and wisdom are often used interchangeably, but are substantially different (Rowley 2007).

2.2.1 The nature of data

Ackoff (1989) proposed a hierarchy with the following levels: data, information, knowledge and wisdom ("DIKW") which forms the foundation of Rowley's work. Following Rowley, we use the DIKW hierarchy as a central model of information and knowledge management (Rowley 2007). The implicit assumption of Rowley is that data can be used to create information, information in its turn can be used to create knowledge and knowledge can be used to create wisdom.

Data are defined as symbols that represent properties of objects, events and their environment (Rowley 2007). Data arises from activities, processes or external environment through which numbers, symbols or images are recorded.

Data must be put into context before they can have meaning. As soon as this happens, information is created (Liew 2007). Information is contained in descriptions and answers to questions that begin with such words as "who", "what", "when" and "how many".

According to Liew (2007) and Ackoff (1989), data and information become knowledge as soon as human experience is applied to information: "Knowledge is the combination of data and information, to which is added expert opinion, skills, and experience, to result in a valuable asset which can be used to aid decision making" (Chaffey and Wood 2005, p.223). The fact that knowledge is placed above information in the hierarchy implies that it has greater 'value' to decision makers than information alone. The key difference is that knowledge makes it possible to construct instructions (Ackoff 1989). This assertion however is also a source of ambiguity since information is also expected to support decision making and thus lead to action. Thus, considerable subjectivity comes into play for an observer to conclude what should be termed information and what should be termed knowledge. What may be knowledge from the point of view of one person (with certain objectives and context in mind) may actually be regarded as data or information by another person with different objectives and context in mind (Batra 2014).

Wisdom is accumulated knowledge, which allows you to understand how to apply concepts from one domain to new situations or problems (Jessup and Valacich 2003). Many philosophers and psychologists, however, do not believe that having knowledge automatically leads to making one wise (Intezari, Pauleen & Taskin 2016). Effective management decisions engage a number of factors other than data, information and knowledge. Qualities such as experience, judgement, intelligence, values and beliefs play a critical role in decision-making and are associated with wisdom (Intezari, Pauleen & Taskin 2016).

2.2.2 Data analytics

Many different terms have been used to describe the process of identifying patterns and gaining insights from raw data to support problem solving (Sircar 2009; Wang 2018). According to Davenport & Harris (2007, p.7), "the extensive use of data, statistical and quantitative analysis, explanatory and predictive models, and fact-based management to drive decisions and actions", is called data analytics. According to Wang (2018) data analytics is a process of increasing understanding of reality, starting from the observations of a phenomenon to reaching the pinnacle of wisdom, empowering informed decisions and practical actions.

Therefore, data analytics is the process of transforming data to information, information to knowledge and knowledge to wisdom to support managerial decision making and problem solving. Within the economic domain of data analytics there are terms such as business intelligence (BI) and business analytics (BA). These terms are used interchangeable but are significantly different (Sircar 2009).

BI may be considered as the management support system for gathering, storing, accessing, and analyzing data for decision making (Chaudhuri et al 2011). Therefore, BI includes the process of data to information.

BA is "the use of data, information technology, statistical analysis, quantitative methods and mathematical or computer-based models to help managers gain improved insight about their operations and make better, fact-based decisions" (Davenport and Harris 2007, p.7). BA can therefore be seen as the process from information to knowledge. Wang (2018, p.12)

2.3 Decision making

Managers make decisions based on the information and knowledge available in the organization (Intezari, Pauleen & Taskin 2016). Stanovich & West (2000) stated in their research that the human brain has two reasoning systems. They called these two systems "System 1" and "System 2". System 1 is described as automatic, associative, heuristic, holistic and a relatively fast system. System 2 can be described as an analytical, controlled, rational, rule-based and relatively slow system. Kahneman (2003) uses the definition of Stanovich & West (2000) and argues that system 1 has an intuitive character while System 2 has a rational character.

Traditional decision-making models, also referred to as rational, assume that the decision-making process involves a certain fixed sequence of steps. These include: definition of both the problem and goal of the decision, identification of decision criteria, search for alternative solutions, comparison and analysis of these alternatives (Malewska 2019). Reality has shown that management does not make decisions in accordance with these rational decision-making models. Simon (1972) introduced the theory of bounded rationality, in which he stated that managers make imperfect decisions due to a number of limiting factors such as limited information, time and cognition. This irrational behavior causes a loss of economic prosperity. After all, due to bounded rationality, solutions that are sought are not always optimal but rather satisfactory. This irrationality is caused by psychological factors such as cognitive bias and limited information processing (Camerer & Loewenstein 2004).

Applying both rational and non-rational decision-making techniques is a quality that is associated with effective decision making (Intezari, Pauleen and Taskin 2016). Rationality actively engages data, information, and knowledge into the decision-making process, while non-rationality engages creativity, intuition and empathy, in addition to knowledge (Rooney, Mandeville and Kastelle 2012). Such an integration is more likely to happen at the pinnacle of the DIKW hierarchy (Intezari, Pauleen and Taskin 2016).

3. Research approach

This study aims to better understand why data analytics is important and how the controller can use data analytics to add value to the business. An exploratory study was conducted consisting of a literature review and

field research. The literature review provided insight into the profession of the controller and the essence of data analytics. The field research consisted of a focus group session to validate and further enhance the outcomes of the literature study which was followed by interviews, for this a different population of controllers, data experts and academics was used.

Merchant (2008) and Williams, Jenkins & Ingraham (2006) warn against the excessive use of statistics as a research method to study individual behavior, such as controllers in our study. The consequence of such studies is that controllers might not be able to use the research results in practice. In order to safeguard practical relevance, this research has a qualitative approach. Furthermore, the initial focus was broad and as the study progressed it converged towards those findings that are relevant for practice.

3.1 Method of data collection

After the literature study was concluded a focus group was organized, in the form of a round table meeting. The main aim of this meeting was to test and confirm our findings and analysis of the literature review, and discover new perspectives and directions for our research. The focus group had great contributions in the setup of the research, the research direction and future interviews. The focus group started with a presentation of the preliminary literature results. A group interview followed. During the group interview, questions and statements were presented to the participants. Some examples of these are: The role of the controller is not clearly defined; What will be the role of the controller in the future?; How can the controller utilize data analytics?; What are important competences regarding data analytics?

An overview of participants of this focus group is shown in table 1. At the request of the participants their anonymity is safeguarded.

Table 1: Focus group sample

Type of organization	Profession	Expertise	Experience
Consulting	Managing Consultant	Dynamic Control	38 years
University of Applied Sciences	Lecturer	Corporate Finance	27 years
University of Applied Sciences	Lecturer	Process mining	28 years
University of Applied Sciences	Lecturer	Accounting	47 years
University of Applied Sciences	Lecturer	Assurance	28 years
University of Applied Sciences	Senior Lecturer, Research Fellow	Governance and IT	35 years
University of Applied Sciences	Lecturer	Controlling	Unknown
Publisher	Publisher	Literature	19 years

For the second phase of our research semi-structured interviews were conducted with nineteen controllers, financial professionals, data scientists, data analysts and academics from different types of organizations. Having first identified several persons to interview based on the researcher's personal networks, the next interviewees were recruited by snowball sampling in which interviewees recommended potential new interviewees for specific subjects and future interviews. Subsequently, the researchers checked whether these potential interviewees matched the criteria used and would add value to the research.

The interviewees can roughly be categorized in two samples. The first sample contains experts in the field of controlling. These are controllers, financial professionals and academics in the field of controlling. These interviewees have an advanced knowledge of the profession of controlling. The second sample consists of experts of data and analytics. These interviewees have an advanced knowledge of data analytics and its application. By using two samples the researchers were able to continuously validate findings from each sample. The findings from interviews of one sample was continuously validated during an interview with an interviewee from the another sample. By doing so, the researchers applied a judgement sample in which interviewees (table 2) were purposefully selected based on the following criteria: expertise, experience in profession, experience with research, knowledge of technology and level of technological implementation in the organization. Each interviewee was asked questions based on his expertise/experience and the specific subject in the research. However each interviewee was also asked some standard questions based on the topic list as stated before. An overview of the interviewees is shown in table 2. The sample of controlling experts is marked white while data experts are marked in grey. To safeguard the anonymity of the interviewees, their names will not be shown.

Table 2: Interviewees

Type of organization	Function	Expertise	Experience
Trade organization	Group Financial Controller	ERP	26 years
Conglomerate	Director Corporate Controlling	Data Science	30 years
Marketing organization	Head of Business Analytics	IT-audit	12 years
Consulting	Chief Data Officer	Data Science	27 years
University of Applied Sciences	Lecturer / Researcher	Data mining	28 years
Accounting & Consulting	Partner	Auditing	37 years
Accounting & Consulting	Senior Manager	Risk management	15 years
Accounting & Consulting	Director	Risk management	32 years
Software supplier	Manager Controlling	ERP	25 years
Accounting & Consulting	Associate Partner	Data analytics	21 years
University	Researcher	Information technology	35 years
University	Professor	Business analytics	32 years
Consulting	Managing Consultant	Dynamic control	38 years
University	Program Director	Accounting	15 years
Production organization	Finance Manager	Managerial Finance	23 years
Consulting	Head Financial Administration	Bookkeeping	25 years
Accounting & Consulting	Senior Consultant	Organization culture	3 years
Accounting & Consulting	IT Consultant	Business intelligence	2 years
Engineering and consulting	Director Corporate Finance & Control	Data analytics	21 years

The interview questions were initially formulated based on the literature study and were used as a guideline that could be adapted during the interview to the expertise of the interviewee. As the interviews progressed, questions were adjusted in accordance with the empirical findings and the list of possible topics was expanded. Examples of such topics are: the added value of the controller, impact and use of data analytics and the competences needed to work with data analytics. By using a topic list the researchers did not use a fixed structure for the interviews and were able to anticipate on the answers of interviewees.

The interviews were recorded as an audio file then written out in transcripts and finally presented to the interviewee to verify and comment. Eighteen interviews were conducted via direct contact and one interview by phone. All interviews with experts were conducted in the Netherlands.

3.2 Data analysis

To ensure the quality of the collected data an iterative process was followed. The researchers collected the data, examined data and then draw the first conclusions. Subsequently, the found data, insights and discoveries from the focus group and interviews were validated and complemented in subsequent interviews. It was then determined what type of additional information was required and based on these requirements further interview questions were formulated. If necessary, the data from field research was complemented with literature to form the theory.

4. Results and discussion

4.1 Information provision

The increasing availability of data makes it possible to extract more value from the data. As a result, the controller has the possibility to become the director of information provision. The controller has the overall knowledge of the organization and is involved in managerial decision making. In order to derive value from the data, the controller must create insights.

According to the interviewees, the creation of insights from data consists of three phases: (1) data extraction, (2) data visualization and (3) the analysis. It must be possible to visualize the collected data in a dashboard so that it is information for the end user. Management wants to be able to steer the organization and take actions by means of the information provided. However, business intelligence ends after the information is provided.

This means that analyses and forecasts must be added to the information provided. The added value of data analytics is therefore in the so-called business analytics, where action-oriented information (knowledge) must be provided to support management's intuition (wisdom) in decision-making processes.

The literature review has shown that business analytics consists of the process from information to knowledge. By applying business analytics the controller would be able to separate facts from fiction. Based on the interviews it was found that an instrument used in business analytics that is increasingly becoming important for the controller is statistics. Statistics is an enrichment to the instruments of the controller and contributes to fact-based decision making. Using statistical analysis, the controller is able to test and refine the assumptions made by management and others in an organization. One interviewee emphasizes the importance of statistics as follows:

> *"In the last century we said goodbye to the homo economicus. You saw that behavioral finance became more important. Today it can be seen that fact-based is becoming more important. The controllers play a role in providing information to management because of its irrationality. Analytics plays an important role in counterbalancing this irrationality. Analytics supports management's intuition."*

The essence of statistics is therefore: the rationalization of insights via statistical analysis and to challenge and complement the intuition of management as well as other stakeholders within an organization.

When utilizing statistics, the interviewees stated that the visualization and communication of the analysis to the end user is an important factor. If the controller does not have this capability, management and the organization will ignore the analyses provided. Regarding this issue, the controller should provide standard reports in drill-down format. When organizations use drill-down, this means that information is first presented at a global level, and then gives the opportunity to present certain data in more detail. Based on the interviews we found that the controller needs several important competences in order to apply data analytics: creating data awareness, making data accessible and ensuring quality and relevance of the data.

4.1.1 Data awareness

The interviewees stressed that organizations must be open for the analyses performed and must be willing to use them. This relates to the organizational culture. Data analytics requires an organizational culture in which the organization is open to challenges and employees are encouraged to innovate. Management has an important role in achieving such an organizational culture and must understand the usefulness of data. Without this, all the provided information and analyses have no value for the organization. The goal is to create awareness among employees. This is a continuous process in which employee behavior must be influenced.

4.1.2 Accessibility of data

When extracting value of data, the question remaining is how data should be made accessible. The possibilities and full potential of data are still unknown. Regarding this uncertainty, some interviewees mentioned that it is important to make the raw source data accessible to employees so that they can start extracting the value of data themselves. Employees can select, clean and analyse data based on their wishes. If the controller is going to clean up data, there is a risk that potential value is being destroyed.

In order to make this possible, the controller needs to work together with other departments such as information technology (IT) and, if available, data scientists. Such teamwork can be established by creating a multidisciplinary team consisting of financial professionals, IT specialists and data experts. Controllers could lead this multidisciplinary team given their expertise of the organization. However, controllers then need to know more about other disciplines, such as IT and data science, in order to work together and effectively communicate with team members.

In order for employees to work with data themselves, it is important to create knowledge about theuse of data and the systems in the organization.

4.1.3 Recording, quality and relevance

The quality of the data determines the quality of the information, analysis and decision making. Safeguarding the quality of the data is something that should be established with data awareness. The employees within an organization must recognize the importance of data quality and the risk of drawing wrong conclusions. Furthermore, data ownership must be established. With data ownership the producer of the data is determined. It is possible that the controller needs specific data for certain issues or analyses. By determining data owners, it can be clearly determined who is responsible for creating certain data in a specific data domain. Data ownership makes it possible to determine where the controller can retrieve data from owners. The controller can also use this to determine to what extent the data is of good quality and whether the data owner adequately performs the quality assurance.

The controller needs a proactive way of managing the relevance of the provided information. Traditionally, the controller first identifies management's information needs and then collects information based on that need to ensure the relevance of information. However, this is a defensive way of managing information.

The controller knows the business and will first be able to determine from the business model what more information management might need in order to make a selection of relevant information himself. This selection can then be validated with management to see to what extent his selection is relevant. Management can indicate what is important and on this basis the controller will adjust its information provision again. The controller will make its own proposals based on the business model and validate these proposals with management.

5. Conclusion

Literature suggests that, due to technological developments, the role of the controller will increasingly focus on decision support. However, this change has not occurred to the same extent in practice as the literature indicates. Data analytics provides the controller with the opportunity to elevate its role within an organization providing more added value to the business. More specifically, by using data analytics to support management's irrationality, the controller can become the director of information provision and a valued member in the decision-making processes.

Our research provides insight in why data analytics is important for controllers, how controllers can use data to add value and how they can grow in their role as business partner. Data analytics have an impact on the way in which the original accountability function of information has increasingly evolved into action-oriented management information. Action-oriented information clearly leads to a higher added value for a company: providing the right information, analyses and forecasts to the business in order to make good decisions. The controller can use data analytics for decision support. However, the research shows that the nature and scope of controlling has not yet fully developed to take advantage of such techniques. The challenge with data analytics is to determine how a business can extract value of its data and connect data with its business, strategy and goals. In accordance the following critical success factors for applying data analytics were found: creating data awareness, making data accessible and ensuring the quality and relevance of data. Controllers are ideally suited to facilitate and manage this because they are the stewards of companies' internal accounting information and financial analyses and can combine this with expertise about the business. However, this does mean that controllers need to be upskilled. In order to effectively support decision-making, statistics becomes an increasingly important instrument for the controller. By using advanced statistics the controller will be able to challenge and test assumptions and contribute to fact-based decision-making. This requires profound knowledge of statistics and data science as well as a critical and open attitude. Finally, we found that an important skill regarding statistics is the visualization and communication of statistical analyses.

To conclude, it should be stressed that besides supporting the rationality in decision-making, data analytics should complement intuitive decision-making and not replace it. The combination of both rationality and intuitiveness results to effective decision making.

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