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TRANSFORMATION INTO DIGITALLY ANALYTICAL CONTROLLING: CURRENT STATUS AND FUTURE AGENDA

ABSTRACT

Today's constantly and rapidly changing digital environment enables companies to use large amounts of data but also pressures them to target technologies and methods able to process them for effective and efficient decision-making. Because of the variety of data, the competitive advantage of companies is more than ever dependent on making right decisions upon data and information quality. Controlling, as one of the globally recognized functions which contributes not only to efficient decision-making but to the overall company's performance, is like many other functions facing the challenges that the new digital era is bringing. In order to be able to deliver adequate information related not only to past but predicted future, controllers need to embrace new digital techniques and methods. The purpose of this paper is to indicate the importance of the new digital age on the controllers' role as „business partner". This study is motivated by the so far infancy level of academic work examining the effects among digital technology and controlling. The aim of this paper is to explore relevant recent literature, to emphasise the importance of the impact that new technologies have and will have on controlling, and to shed light on this subject matter. Accordingly, a desk research methodology was used. Hence, this paper first defines the difference between four concepts to whose application researchers in the field of controlling are giving more attention in last years: Big Data, Business Intelligence (BI), Business Analytics (BA) and Business Intelligence and Analytics (BI&A). Further, a critical review on the so far emphasised relationship of the four concepts and controlling is given, along with related research among the field of information science. In the end, suggestions for future research are given through postulated research questions, as well the emphasised call for advanced multivariate methods use.

Key words: C*ontrolling, decision-making, Big Data, BI&A*

1. Introduction

Fast and constant market changes and associated risks have a significant impact on the process of making timely and quality management decisions. It is therefore of crucial importance that businesses, i.e. decision-makers dispose with detailed and transparent information that enable effective management. Although globalization and the fast-growing

digital environment allow businesses to utilize large amounts of data, it simultaneously compels them to find appropriate functions, methods. and technologies that ensure their processing for efficient and effective decision-making. Thus, competitive advantage and survival of companies are more than ever dependent on making the right decisions upon high-quality data and information, whose validity is more and more questionable due to today's variety of data. Controlling, as a globally recognized function that contributes not only to the effectiveness of decision-making but also to overall business success, is responsible for providing adequate information to business decision makers. Hence, it represents an efficient contemporary performance management concept that, by analysing data and information from internal and external environments, gives management the "optimal output" i.e. report of conditions, risks and suggestions. Certainly, the ultimate effect on decision-making depends on various factors. First of all, the quality of data and information that controllers use as input variables within their analyses, their own characteristics and characteristics of managers, organisations, and environment. In conditions of the digital era, it also significantly depends on the level of application and adequacy of new intelligence and analytic technology solutions that secure quality in terms of relevance, analytics, accuracy, timeliness, and transparency. Thus, it can be said that the effectiveness of controlling, which is reflected in the quality of its output and the final impact on management decisions, is influenced by numerous factors. But when viewed from the standpoint of providing adequate information related not only to past but predicted future in today's environment, controllers need to embrace digital techniques and methods in order to overcome the challenges that the new era brings.

Thus, the aim of this paper is to explore relevant recent literature that emphasise the importance of the impact that new technologies have and will have on controlling. Accordingly, a detailed desk research was applied to summarize the difference between four concepts of the digital era and to critically review on their so far emphasised relationship to controlling, along with suggestions for future research in terms of questions and statistical methods.

The paper is structured in five chapters. After the introduction, the second chapter defines the difference between four concepts of the digital era: Big Data, Business Intelligence (BI), Business Analytics (BA) and Business Intelligence and Analytics (BI&A). Third chapter presents the literature review of so far emphasised relationship of the four concepts and controlling, while chapter four forms suggestions for future research. Sixth chapter presents concluding remarks.

2. Big Data, BI, BA, and BI&A

Controlling is like many other functions facing the challenges that the digital era is bringing. In order to understand the impact on the controller's role, a definition distinguishing between the concepts of the digital era associated with controlling, is firstly necessary. Those concepts to whose application researchers in the field of controlling are giving more attention in last years are: Big Data, BI, BA, and BI&A.

Big Data can be described as a large pool of data (Manyika et al., 2011) that consists of volumes of differently unstructured, structured and semi-structured data (Giri & Lone, 2014). According to Gärtner and Hiebl (2018, p. 3) "big data refers to the generation, storage, processing, verification and analysis of large, highly versatile and quickly growing volumes of data with the objective of creating valuable information". Warren, Moffitt, and Byrnes

(2015) define Big Data as a set of data so large and unstructured that no system or software program is able to easily process and analyse them. On the other, Hansen and Porter (2017) describes it as a tool that brings together separate flows of data from all over the world, while Appelbaum, Kogan, Vasarhelyi, and Yan (2017) see it as a combination of internal and external data gathering through the enterprise system for the purpose of decision-making. Although there is no unique definition of Big Data, it is mostly characterized using three or five Vs: volume, velocity, and variety (Brynjolfsson & McAfee, 2012), i.e. veracity and value (Ishwarappa & Anuradha, 2015). Some authors even highlight additional Vs like validity, variability, venue or vocabulary (in Gärtner & Hiebl, 2018).

BI was first described by Howard Dresner in 1989, as a set of methodologies and concepts designed to improve decision-making through the use of facts and fact-based systems (Chou, Tripuramallu, & Chou, 2005). Today, it is considered as an important Big Data technology. It represents an application software foremost designed to analyse, report and present data that have previously been stored in a data warehouse (Manyika et al., 2011). According to Williams and Williams (2007), BI is a combination of products, methods, and technologies that ensure key information for managing and improving companies profit and overall performance. As such, BI transforms raw data into meaningful and useful information for effective strategic, tactical and operational insights and decision-making (Evelson, 2008), information into knowledge, and knowledge into plans (Loshin, 2002). In the late 2000s, BA was introduced as the analytical component in BI (Chen, Chiang, & Storey, 2012). Davenport and Harris (2007) defined BA as "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" (Appelbaum et al., 2017).

Because of the little diversity, it is important to distinguish and understand the difference between the BI and BA concept. Maisel and Cokins (2014) emphasis that BA simplifies data to amplify its value, while BI mainly summarizes historical data through tables, graphs, and reports. More precisely, BI consumes stored information and answers basic questions, while BA produces new information, creates questions and has the power to answer them. Additionally, as stated by Richards, Yeoh, Chong, and Popovič (2017), while BI systems can serve as a method to reduce uncertainty by delivering large amounts of information, BA methods, such as data-mining, can discover meaningful patterns among large volumes of data and thus reduce ambiguity. Galetto (2016) describes the difference between BI and BA as following: BI can be treated as the first step in decision-making i.e. the process of data collecting, while BA represents the analysis of the answers that have been provided by BI. Hence, while BI answers only to the question of what happened, BA has the ability to answer why it happened and to predict if it will happen again. In sense of techniques BI "includes reporting, automated monitoring and alerting, dashboards, scorecards, and ad hoc query, BA, in contrast, includes statistical and quantitative analysis, data mining, predictive modelling, and multivariate testing" (Galetto, 2016). If combining this understanding of the two concepts with the classification of business analytics on descriptive, predictive and prescriptive (Appelbaum et al., 2017; Nielsen, 2018), and questions given by Maisel and Cokins (2014), BI and BA would understand following:

- BI - Descriptive analytics = what happened, how many times, how often, where is the problem, and what actions are needed?
- BA - Predictive + Prescriptive analytics = why is this happening, what if these trends continue + what will happen next?

However, according to Côrte-real, Ruivo and Oliveira (2014) today the terms BI and BA are unified into one concept due to their complementary. That concept is BI&A and represents all the positive attributes of both BI and BA. It is defined as "the techniques, technologies, systems, practices, methodologies, and applications that analyse critical business data to help an enterprise better understand its business and market and make timely business decisions" (Chen et al., 2012). Due to today's environment, it is no doubt that efficient and effective decisions can only be made upon the use of descriptive, predictive and prescriptive analytics. Therefore, it is important to analyse the application and implication of these concepts in and on the department of controlling.

3. The impact of digitization on controlling – literature review

Globally, there is numerous research regarding the controlling function i.e. their connection to firm performance, decision-making, change in tasks and instruments, enterprise resource planning and management accounting information systems applications, etc. However, the connection, benefits, and challenges of controlling to the concepts of digitalization, are still unclear and empirically in an infant stage.

The latest research on the level of BI implementation in Croatian firms was conducted by Bilandžić and Lucić (2018). According to their finding, the application of BI is very low. Precisely, only 24% (of 74 participants) confirmed the use of BI tools. Although the author's criticized the level of application, considering that the survey was addressed to the company in general, not to a specific department, the question is if this result can be directly pointed to the controlling department. From a practical point, controllers can use BI i.e. BI&A techniques on their own hand. For example, they can use the free Power BI function of Excel. Therefore, it cannot be generally emphasised that the use of BI systems is low in controlling departments across Croatia companies. Hence, this matter should be investigated for each company function separately.

It is well known that the effectiveness of decision-making depends on the reliability of data. According to Baier et al. (2019) survey research on BI trends conducted in the name of Business Application Research Center in 2018 among separate BI organisations and IT, finance and controlling departments, the most important characteristics of BI are data quality, data discovery/visualization, and self-service options. Hence, BI tools are used to visualize analyses for decision-making but on the other hand, they can also be a tool of recognizing the quality of data used in the analyses. As such they represent a powerful and unavoidable tool for controlling. Accordingly, as BI should secure data for efficient decision-making, a direct connection of its use in controlling is clear (Haufe, 2018). Therefore, Appelbaum et al. (2017) give an overview of BI functionalities for the support of controlling.

Table 1: *BI functions to support controlling*

Categories	Function
Data consolidation	• *Integration of internal and external data* • *Simplified extraction, transformation, and loading of data* • *Deletion of unwanted and unrelated data*
Data quality reporting	• *Sanitize and prepare data to improve overall accuracy* • *User defined and standard reports generated at any level* • *Personalized reports for any level of management*
Forecasting and modelling	• *Supports analytics used in predictive and prescriptive analytics which use historical and real-time data, qualitative or quantitative*
Tracking of real-time data	• *Monitor current progress with defined project objectives/KPIs* • *Prioritize scarce system resources*
Data visualization	• *Interactive reports and graphics, possibly with real time updates* • *Scorecards and dashboards*
Data analysis	• *What-if analysis* • *Sensitivity/optimization analysis* • *Goal seeking/goal supporting analysis* • *Descriptive analysis*
Mobility Rapid insight	• *Portability to multiple devices and formats* • *Drill down features that enable many layers of analysis* • *Dashboards that are interactive and that can monitor trends and outcomes*
Report delivery and Share-ability	• *Deliver reports in common formats such as Microsoft Office* • *E-mail reports in different formats*
Ready to use applications	• *Pre-built meta-data with mappings defined considering performance and security needs* • *Pre-built reports, dashboards to support management*
Language support	• *Multiple language support*

Source: Appelbaum *et al.* (2017)

Daryabari (2018, p. 85) also supports the relationship between BI and controlling. Moreover, he calls it "clear" and "important", and attributes it to the fact that BI "is seen in many organisation plans, and better data analysis and decision making can create value for organisations." Although, there is not lot empirical research on the relationship between controlling and BI, nor BA and BI&A, the one of Gullkvist (2013) stands out. Even though BI was used as a control variable to the final dependent variable i.e. changes in controlling practices, and as an antecedent to three independent variables (data quality, information quality, and tasks), the significant impact on controller practice change has been confirmed. Hence, data quality and information quality were positively correlated to business effectiveness and consequently to the change of controlling practice, under the assumption that BI influences the data quality and controller's tasks, but not information quality. This can be interpreted through the fact that it is the controller's task to transform data into usable information by using BI&A tools. Or as Gärtner and Hiebl (2018, p. 11) interpreted Quattrone (2016), „there is still a need for human 'wisdom' to critically question the relevance of the gathered data and information".

There is no doubt that BI is a crucial tool for efficient decision support. But in today's increasingly changing environment, advanced analytical methods and models are necessarily required for the prediction of future events and risk reduction. Hence, the descriptive view of performance measuring is shifting to predictive and prescriptive. Along with that, controlling needs to accept those charges and adapt. In other words, controllers need to improve their skills and competencies in accordance with the BA techniques (Cokins, 2013; Nielsen, 2018; Seufert & Treitz, 2017). As classified by Appelbaum et al. (2017), controllers should use the combination of five categories of analytical techniques: 1) basic accounting analysis, 2) unsupervised, 3) supervised, 4) regressions and 5) other statistics like structural models, Monte Carlo simulations, Analytical Hierarchy Processes, etc. Hence, while the first and second categories include techniques that cover the descriptive orientation of controllers, the rest can also be used for predictive and prescriptive oriented analytics. Therefore, it can be emphasised that for the future role of controllers, BA might be more important that BI due to its ability to overcome more complex and ambiguous decision-making conditions (Richards et al., 2017). Or more correctly, controllers need to use BI&A as the combination of all the BI and BA techniques.

The newest and least investigated concept in general and in connection to controlling is Big Data. As stated by Gärtner and Hiebl (2018, p. 2): "Big Data currently poses one of the greatest challenges for management accounting" i.e. controlling. Also, they emphasise that Big Data can no longer be understood as a completely new trend. It is a topic that affects controlling now. Therefore, controllers need to take advantage of the benefits that it created but also be aware of the additional demands that it sets in front of them. Accordingly, they gave an overview of reference selected, most important opportunities and challenges of Big Data for controlling through three broad phases selected due to the existing definitions of both, controlling and Big Data (Gärtner & Hiebl, 2018).

Table 2: *Opportunities and challenges of Big Data for controlling*

Phase	Opportunities	Challenges
1) Data generation and storage	• *integration of new data channels, unstructured data* • *automatic generation of data* • *cost savings* • *increasing value of data*	• *large volumes of data* • *information overload and data veracity* • *lack of resources*
2) Data processing, verification, and analysis	• *time savings* • *availability of data in real-time* • *automatization of data analysis and processing*	• *necessity of new technologies* • *loss of data sovereignty* • *automatization of data analysis and processing*
3) Reporting and decision support	• *improved decision support for top management* • *improved operational planning* • *improved strategic planning*	• *changing cost structures* • *making false decisions faster*

Source: Gärtner and Hiebl (2018)

In addition to the mentioned opportunities and challenges, the automatization and information system expert i.e. data scientist can be seen as a direct threat to controlling (Al-Htaybat & Alberti-Alhtaybat, 2017; Gärtner & Hiebl, 2018; Ossimitz, Wieder, Chapman, & Thirathon, 2017). But, as noted by Brynjolfsson and McAfee (2012), although the best data scientists are comfortable speakers of the business language, people with all the skills are difficult to find. Therefore, controllers need to keep up with the demands set by the digital age - proactive

learn and adopt new techniques and methods. They need to be able to predict further outcomes and to give the decision-makers the best output of risks. In order to do that, they need to be engaged in analytics. According to Peppard, professor of European School of Management and Technology in Berlin, controllers across many sectors are already engaged in analytics (CGMA, 2016). But, for the efficient use of analytical tools which enable easy spotting of statistical patterns, trends, and relationships, and whose application consequently leads to actions that generate value, controllers need to be able to understand the causes behind those patterns (Lycett, 2013). Accordingly, Sharma, Mithas, and Kankanhalli (2014), emphasis that the first-order effects of BA are likely to be on decision-making processes and that the outcome, enabled by BA, is the improvement of organisational performance. Nevertheless, as stated by Côrte-real et al., (2014, p. 172) "in the era of Big Data, BI&A can help to improve organisational performance as a result of improvement on business decision making". Simply said, we can see Big Data as a data source and BI&A as tools for advanced analysing and reporting of data and information. All combined used for the purpose of efficient data collection, analysis and consequently effective business decisions.

Certainly, most research upon the influence of the four digital concepts is made in the field of information science. As such, they need to be taken into account when investigating the current and future role of controlling in decision-making and its transformation into a digitally oriented analytical function. Richards et al. (2017) argued that BI and BA system effectiveness influences planning and measurement which in turn has an impact on organisational process effectiveness. Although a strong relationship between BI system implementation effectiveness and BA effectiveness has been proven, the impact of BA on process effectiveness has not been shown as significant as the impact of BI. Hence, the authors suggest the use of the competence of staff using BI tools as an additional variable for better linkage exploration. Further, the study of Cao, Duan, and Li (2015) confirmed that the frequent use of BA mediated through a data-driven environment leads to the development of information processing capability, which in turn has a major impact on organisational decision-making. Thereby, they define information processing capability as the organisations capacity to "capture, integrate, and analyse data and information, and use the insights gained from data and information in the context of organisational decision making" (Cao et al., 2015 p. 385). Accordingly, by comparing this definition with the main task of controlling, it can be assumed that controlling can significantly influence the decision-making process through the use of BA. Thirathon, Wieder, Matolcsy, and Ossimitz (2017) confirmed that Big Data Analytics sophistication leads to more analytic-based decisions of managers i.e. that better interaction skills of analysts and managers'quantitative skills have a positive effect on analytic-based decision-making (Thirathon, Wieder, & Ossimitz, 2018).

We need to be aware that Big Data and BI&A bring a lot of advantages for many functions, but also risks if not responsibly and adequately handled. According to the thinking of Quattrone (2016, p. 120) Big Data will have a negative influence on decision-making i.e. "it will make people take wrong decisions much more quickly than before". Therefore, despite all the advantages that digital intelligence and analytics bring, controllers need to be sure that they make their analysis upon quality data, no matter where they collected them. Additionally, they need to have adequate techniques that will ensure them a quality analysis and decision suggestions towards the management. In line with the statements from previous researchers that would be the BI&A and Big Data (Appelbaum et al., 2017; Baier et al., 2019; Gullkvist, 2013; Rikhardsson & Yigitbasioglu, 2018). Hence, they contribute to controlling tasks through an efficient generation and analysis of appropriate and usable data and information to support their primary task – creating outputs i.e. reports for decision-making purposes.

4. Future research

Managers are those who set goals, make decisions and consequently direct the future of an organisation. Controlling on the other provides information about the future and as a co-responsive function i.e. "business partner" (Weber & Schäffer, 2014) helps managers in achieving best results. Accordingly, the decision-making function can be seen as the most important of controlling, especially in today's rapidly changing environment where decisions are expected to be made quality and ad-hoc upon available structured and unstructured data. Thus, controllers need to be aware and embrace their business analyst role of prediction and prescription through the application of appropriate digital technologies. Furthermore, research upon the controllers' influence on decision-making through skills and knowledge upgrade and degree of BI&A and Big Data application, are of crucial importance. Given the theoretical background and previous research finding, a set of research questions are postulated for future research in the field of controlling.

Table 3: *Postulated research questions for future research in the field controlling*

Themes	Postulated research questions
Data gathering.	• *What techniques are currently used and which should be used in terms of internal and external data gathering? Which enable best data quality and integrity for particular controller's analysis?* • *Which sources of Big Data secure the best outputs i.e. analysis and reports in controlling?* • *What new skills and competencies do controllers need to acquire in order to be able to gather quality data?*
Data analysis, reporting and decision-making support.	• *Does the use of BI&A influence data quality and integrity, as well as output quality of controlling? If yes, on what BI&A maturity level?* • *Does the long-time use of BI&A change the controlling practice?* • *What level of education and work life experience enables controllers to efficiently use BI&A, and does it affect the quality of their outputs?* • *What descriptive, predictive and prescriptive techniques controllers currently use and which do they need to apply in the future? How will their use impact the quality of the controller's outputs i.e. decision-making?* • *What is the optimal combination of controllers operational and strategic instruments (i.e. Balanced Scorecard, ABC costing, Target costing, Benchmarking, etc.) and business analytical techniques (i.e. statistical and econometrics)?* • *What other futures influence the quality of controllers outputs i.e. lead to more analytics-based decisions?*
Controller's tasks and cooperation.	• *With whom controllers need to cooperate in order to secure appropriate and quality input data?* • *To whom should the external data gathering be assigned to and in what extent?* • *Should controllers be afraid of the data scientist? Should they adopt their specific knowledge and to what extent?* • *What other organisational functions could have a significant impact on the controller's role in the future?*

In order to give answers to these questions and those posted recently by other researchers (Gärtner & Hiebl, 2018; Rikhardsson & Yigitbasioglu, 2018, etc.), different statistical models can be used. But, in line with recent literature, the use of Partial Least Squares Structural Equation Modelling (PLS-SEM) is suggested. PLS-SEM is a multivariate statistical modeling technique whose application has grown exponentially in the past few years, especially in marketing, strategic management, and management information systems (Hair, Hult, Ringle, & Sarstedt, 2017). However, its application in the field of controlling, despite all advantages, lags behind (Smith & Langfield-Smith, 2004), but is also recently significantly encouraged (Nitzl, 2018). Nitzl (2018) points following advantages of its use in controlling research: 1) suitable for fields where the theoretical bases are often weak and relied upon other theories, 2) allows to estimate not only reflective but also formative constructs, 3) allows easy integration of archival data, 4) allows the use of small sample sizes, and 5) allows estimation of very complex model with many constructs and indicators by maximize the explanation of one or more dependent variables. Accordingly, it is just the matter of time before the academic and scientific community, as well as controllers become aware of the potential that this method can bring in practice and theory (Nitzl, 2018). Therefore, it is important to further shed light on the use of this method, both in controlling and other similar disciplines.

5. Conclusion

The primary task of the controllers as co-holders of responsibility has and will always be to provide quality outputs i.e. analysis and reports, to managers for timely and accurate decision-making. However, today's dynamic environmental changes, and thus fast-growing technical and digital evolution call into question the future efficiency of the controllers' task fulfillment. Hence, it puts an ultimatum on its further development and survival as a function and profession. Therefore, controllers need to embrace the new concepts of digitalization in order to further deliver adequate information to decision-makers related not only to past but predicted future. They need to embrace the opportunities given by Big Data and BI&A, and accordingly upgrade their skills in term of predictiveness and prescriptiveness. Only by embracing solutions of new technologies controlling can overcome the challenges that the digital era has brought upon many organisational functions. Thus, controllers today need to be more than just analysts. They need to be able to recognize and generate key input data from "enormous piles of data", analyse them, interpret and propose solutions through real-time vitalization outputs, in ways that support strategic – future-oriented decisions. Concludingly, controlling needs to accept its transformation into a digitally analytical, prescriptive oriented decision-making function.

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