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Big Data Analytics and Simulation for Better Strategic Management

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Abstract
Nowadays, technological innovations allow the connection between many devices through intelligent and interoperable nodes. This connection gives an ability to perform analytical processes in a real time for big data and makes enable many devices to work together in order to generate meaningful knowledge for systems. Therefore, the collection and analysis of big data has gained great importance in order to make vital strategic decisions. The emergence of big data has influenced strategic planning processes in both planning and implementation stages. Especially for companies that want to protect their assets for a long time and survive in the competition market, it is vital to use big data analytics tools. Therefore, the most important contribution of this study is that the big data structures and methodologies used in big data analytics have been examined in the context of strategic planning. n addition, the use and effectiveness of modeling and simulation approach in strategic decisions to be realized within the scope of big data are discussed. The study is aimed to provide insight for researchers working on strategic planning and big data

1. Introduction

Strategic management, which contains strategic planning and decision-making processes, is an important instrument to construct sustainable and protective environment for firms in the competitive world of business. It is used as a tool to create competitive advantages and improve firm's performance. Given insights that can be obtained from mining big data, managers increasingly make use of dashboards, numbers, statistical analysis, and computer-based tools such as simulation, in addition to their experiences, perceptions, or intuitions, when making strategic decisions (Silahtaroglu & Alayoglu, 2016). To that end, mining and analyzing big data using data mining techniques and business intelligence

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tools become an essential part of decision-making processes [Silahtaroglu & Alayoglu, 2016; Grover et al., 2018]. Therefore, firms should learn what big data is, how it can be analyzed and, how they can evaluate internal and external factors of firm performance together with the results of their analysis.

Djamaiel et al. (2014) defined the concept of big data as complex data sets to capture, manage, and process within short terms. Big data may be in various formats such as structured data, semi-structured data, or unstructured data. Wamba et al. (2015) provided a definition of the concept of big data using five Vs as the followings: *volume,* representing the data size; *velocity*, representing the speed of data generation; *variety*, representing the variation of data type such as numbers, images, text, and so on; *value*, representing any value that can provide a valued-added to business; and *veracity*, representing the quality of data. Big data can be used to obtain insights into organizational performance in an effort to develop better organizational structures for more accurate evaluation of decision-making processes (Grover et al., 2018).

Another tool to obtain insights into organizational performance is simulation which is modeling of the current system to improve it or a new system to reach the best alternative for business performance using statistical techniques and computer-based tools (Harrington & Tumay, 2000). It helps to analyze existing systems and makes it easier to see the inadequacies in the real systems and to solve the encountered problems.

In this paper, relationship between big data analytics and strategic management, and relationship between simulation and strategic management will be studied in order to show advantages of those tools on developing firm performance and making efficient decisions. We organize the remainder of this paper as follows. Section 2 provides an overview of the strategic management, introducing basic concept, summarizing important features, associating with big data and the explaining of the advantages of simulation methodology as a specific solution tool. Conclusions and discussion is explained in section 3.

2. Strategic Management

Strategic management has three main steps which are *analyze*, *decide*, and *plan*. It concerns with the analysis of objectives of a firm and the evaluation of internal and external environment (Choubey & Mishra, 2016). It consists of three basic stages which are *formulation*, *implementation* and *evaluation* (David, 2013) as it is seen on figure 1, and each of them shows a complementary characteristic for another:

Figure 1: Basic Steps of Strategic Management

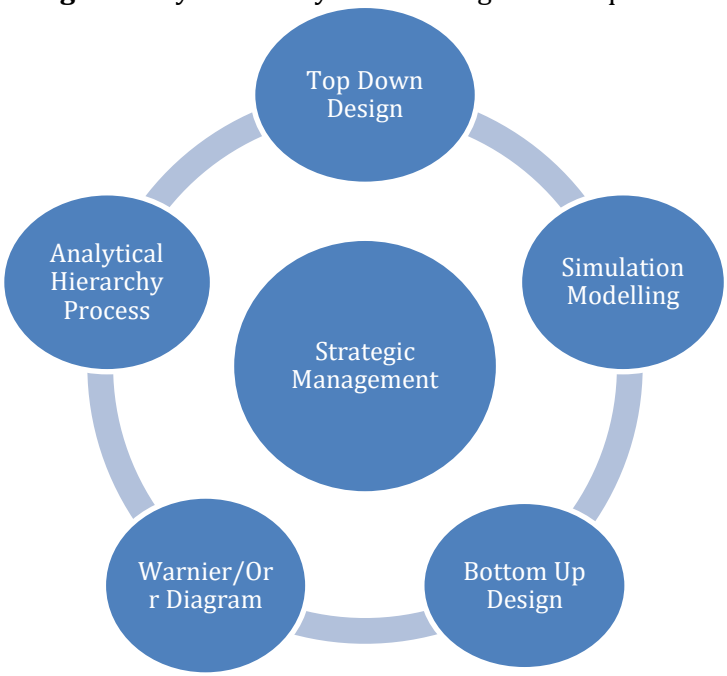
Strategic formulation stage includes determining vision and mission statements; identifying strengths, weaknesses, opportunities and additionally, it is the step to determine whether firm should enter into a new business or not, which markets

are available for the firm, which operations should be expanded for the next period, and so on. However, the strategy implementation step is the step to put formulated strategies into action. In this stage, employees, resources, and policies are prepared to implement new strategies. Then, strategy is implemented with the aim of being successful. Finally, in the strategy evaluation stage, new strategy and old strategy are compared and corrective actions are determined by managers. Figure 2 represents the system analysis and design techniques used in strategic management stages to handle the complexity in real systems (Scoggings, 1986). In strategic formulation step, top-down activities are defined by senior executives in order to achieve company goals and bottom-up identification of problems that may be encountered in achieving these goals (Egels-Zandén and Rosén, 2015). Top down modelling goes to sub-systems from the real system to see the problems, while bottom-up goes to whole system from desired outputs (Munive-Hernandez et al., 2004). Some of process description languages for top down modeling are (Grzybowska, and Kovács, 2017);

- IDEF0 (Integrated Definition methods)
- Petri net (place/transition net)
- EPC (Event-Driven Process Chain)

In addition to top-down and bottom-up design, another tool used in strategy formulation in terms of problem definition and information gathering is Warnier/Orr Diagram. It is the graphical representation of a system to make describing and planning parts of a structure easier and to determine the requirements for formulation of a strategy [Davis, 1983; Orr, 1981; Warnier, 1976]. On the other hand, in strategy implementation step, simulation modelling may be used. Simulation modelling provides to see all the effects of an alternative without changing anything and enables to find most valuable alternative to implement in real system (Shannon, 1975). Furthermore, in strategy evaluation step, analytical hierarchy process might be useful. Analytical hierarchy process looks at the problem from a broad perspective, tries to find most significant criteria, evaluates the alternatives and aims to reach best conclusions (Saaty, 1980). Also, it can be used in other steps of strategy management, or project selection and prioritization (Vargas, 2010).

Figure 2: System Analysis and Design Techniques



Afonina (2015) listed the tools that may be used in strategic management stages: SWOT analysis, customer satisfaction analysis, analysis of customer's complaints, analysis of employee satisfaction, market segmentation based on customer needs and wishes, market share analysis, customer profitability analysis, level of service analysis and so on.

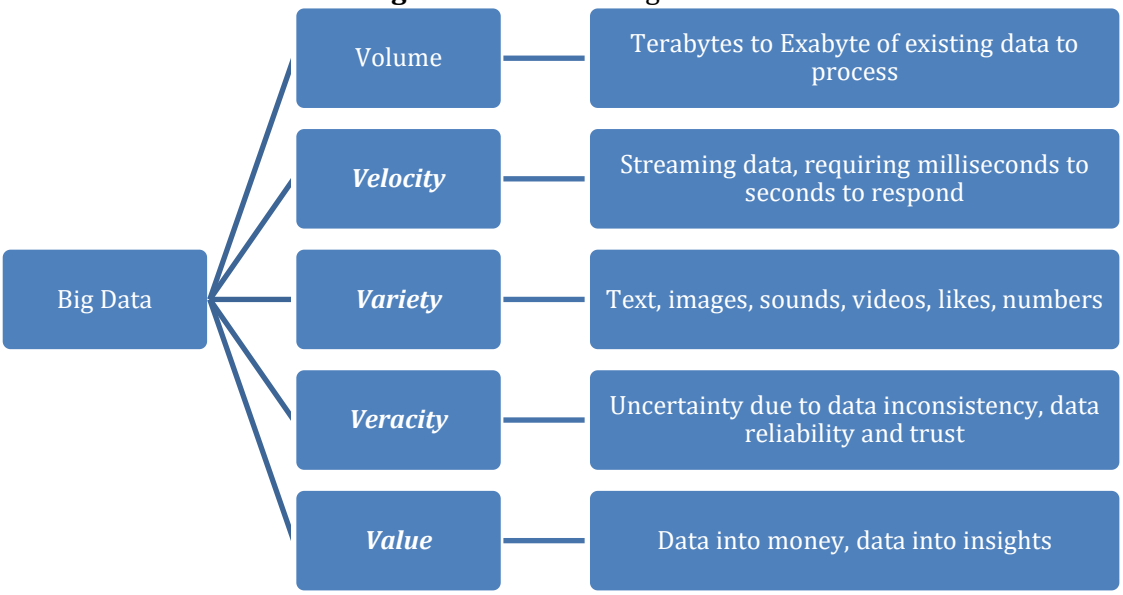
On the other hand, experiences, perceptions, or intuitions are also used to make a decision or improve a strategy previously established. Papulova & Gazova (2016) provided numerous ways of thinking adopted by decision-makers. Those are mechanical thinking, intuitive thinking, and strategic thinking. Mechanical thinking is made based on logic while intuitive thinking is made based on creativity and experiences. Strategic thinking is the one that is made based on prediction and supported by understanding the differences between the past and the future of firms.

2.1. Strategic management and big data analytics

Technological developments mean new opportunities; but also new threats for firms since it affects every process and elements of an organization, especially its strategic position. Technological advancements can create new markets and new competitive advantages that are more powerful than existing ones. They can change the relative competitive cost and positions of an industry, can result in changing values and expectations of employees, managers, and customers (David, 2013). This means that new technologies such as data science, big data and big data analytics are becoming significant for organizations day to day. Hence, it is important to keep up with these changes and developments. Big data analytics may also be used in strategic management steps which are mentioned in previous part of this paper. In this section, the relationship between strategic management and big data analytics will be explained in terms of challenges, advantages and disadvantages using literature review.

Provost and Fawcett (2013) studied about data science and its relationship between decision making. The authors stated that data science and traditional decision-making techniques should be considered together and provided that there is strong relationship between business performance improvements and data-driven decision making, and data-science techniques based on big data. Big data provides several advantages to organizations. However, it is challenging to deal with big data in terms of decision making and strategic planning since big data has so many dimensions, five Vs (***Velocity, Volume, Value, Variety, and Veracity***), and be in various formats (Çalış Uslu and Fırat, 2019; Zikopoulos, and Eaton, 2011). It can be complicated to reach potential value of big data because of velocity of data generation and quality of data resources [McAfee et al., 2012; Watson, 2012]. Erevelles et al. (2016) also found that as data grow, become more complex and unexplained, people encounter difficulty in deciphering and interpreting of an unknown. Since the firms do not know how to analyze big data exactly and the importance of it, they can get face to face with some difficulties. Some problems can occur because of unclear data management, insufficient technologies to support high volume unstructured data (Watson, 2012).

Figure 3: Five Vs of Big Data



In figure 3, five Vs of big data and main issues about them are represented. In the literature, big data is defined based on those five characteristics (Hadi et al., 2015). Additionally, challenges and advantages of big data are also arisen from these characteristics. *Volume*, *velocity*, *variety* and *veracity* may be resulted with challenges, but, having access to big data is only useful it can be turned into a *value*.

Despite the challenges of big data, advantages of being big data-driven are non-negligible, especially for decision making and strategic planning. Big data provides behavioral insights about customers to turn those into a strategic advantage, supports strategic management focusing identification, evaluation and selection; helps to optimize supply chain and human resources, improves metrics used in decisional processes, and offers the company growth faster [Bhimani, 2015; Wamba et al., 2015; Bertei et al., 2015; Erevelles et al., 2016]. In addition, many

successful and popular firms such as Facebook, Google, Uber and Netflix, use big data to enhance their competitive abilities (Etzion & Aragon-Correa, 2016). In substance, if a company is more data-driven, it become more productive [Brynjolfsson et al.,2011; Tambe, 2012].

To better understand the value of big data to improve successful strategies, organizations need to use big data analytics. It is defined by Garmaki et al. (2016) as a technological method that accesses, combines and reports all available data by analyzing insights not attainable with past data technologies. As seen, usage of big data analytics makes handling with big data less complicated. Yet, to implement big data analytics, companies should have some capabilities. Data quality, bigness of data, analytical skills, domain knowledge, and sophisticated tools must be run efficiently to make effective and high-quality decisions [Davenport and Patil, 2012; Gupta & George, 2016; Ghasemaghaei et al., 2018].

There are some numerical examples about usage of big data analytics on strategic management in the literature and two of them are explained very well by Wills (2014) and Ward (2014): Target Corporation used big data analytics in their customer loyalty improvement project to truck purchasing behaviors of their customers and to predict future trends. On the other hand, Amazon.com improved a personalized purchase recommendation program using big data analytics and they saw that the 35% of purchases were coming from this program.

2.2. Strategic management and simulation

Simulation is a tool to test scenarios, gain deep understandings and make better decisions. Simulation processes includes problem definition, formulation, data preparation, validation, planning, experimentation, implementation, evaluation and documentation steps, respectively. It involves designing the real system or imaginative system and making experiments on the designed system (Yin & McKay, 2018). Thanks to these properties, simulation models can give more valuable results about behavioral assumptions rather than traditional techniques. (Levinthal & Marengo, 2016). As an analysis tool of strategic management, computer simulation tools are used since 1960 to simulate a real system and to handle the complexities while simulating a real system (Papageorgiou & Hagjis, 2011). In this part of study, relationship between strategic management and simulation modelling will be examined and benefits of simulation will be given using some example studies from literature review.

Simulation modelling can be useful to measure effectiveness of a system or a strategy and to determine the uncertainties behind a system or a strategy. Jalali et al. (2019) formed a simulation game about the effectiveness of decision-making in building cybersecurity capabilities and aimed to see the uncertainties behind these complex systems using the system dynamics simulation model. Their study helps to managers when considering making an investment on cybersecurity sector. On the other hand, to improve a system, to make a system optimal, simulation is very useful. Cleophas & Bartke (2011) aimed to maximize airline revenue, to allocate capacity and to optimize prices together with demand forecast making customer segmentation. After that they formulated a mathematical model, they evaluated

possible consequences using stochastic simulation model. As a result, they saw the effects of different customer behaviors on revenue management.

In addition, simulation modelling is also useful to predict the impacts existing or new factors. Golroudbary et al. (2018) studied on a framework for decision-making on logistics management using simulation modelling to foresee the interruptions in the operation. Furthermore, Panarotto et al. (2017) made simulation-driven design of product-service systems to help decision makers understand how a well-designed structure can contribute to customer satisfaction and requirements of stakeholders during the lifecycle of a system. However, Dimitrios et al. (2013) analyzed the simulation they've made about strategic leadership for non-profit organizations. They applied dynamic simulation model to see the important impacts of that kind of leadership which is a new perspective for non-profit organizations since there are no gain purpose.

Another benefit of simulation modelling on strategic management is about understanding the system better. It is possible to analyze "what-if" scenarios on existing system. Seo & Chae (2016) made a research about improving performance of enterprises and used multi-agent simulation to understand the current progress. Sachidananda et al. (2016) also studied on an existing biopharmaceutical manufacturing system to improve it analyzing what-if scenarios.

3. Conclusion

In this paper, big data analytics and simulation are examined in terms of strategic management. The research shows us big data is complicated to deal with. On the other side, it has so many advantages. Therefore, organizations should make effort to handle challenges of big data taking some actions such as hiring data team, using advanced tool for analysis, teaching the employees this new technology etc. On the basis of strategic management, big data can be considered as a supportive tool. Additionally, if big data is used for environment/industry/market scanning, it become more efficient in terms of strategic management. For example, big data can be used within the customer analysis and market research to create more trustworthy insights about competition in the industry. Besides, managers can use both data analysis and their experiences or their intuition while making a decision.

On the other hand, simulation is also an important tool for strategic management thanks to various benefits of itself. It helps to gain insights for strategic management processes. Simulation modelling can be used in two ways in terms of strategic management. One of them is that strategic management processes may be analyzed using it. As the second way, data related with current system to use for strategic management can be obtained as a result simulation modelling.

Additionally, big data analytics may be useful in simulation modelling to gain knowledge about the system which will be simulated and to determine the model parameters which will be used in simulation.

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