The Role of Big Data Analytics in Innovation: A Study from The Telecom Industry

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Abstract

Organisations are looking for new definitions and guidelines for innovation direction due to the changing nature of technology, user behaviour, competition and market trends. Data sources, types and analysis mechanisms have changed dramatically in the last few years, and there are pieces of evidence that these are influencing the level of innovation in a firm. We found that it is very important to explore how telecom companies capture, analyse and make innovation insights from big data. Our review shows a clear scarcity of research on this topic. The study aims to use qualitative methods of both interviews and documents review in three telecom companies in Jordan, with an opportunity to extend the study to different regions and countries. The understanding of how big data and its analysis are carried out by companies will support our effort in building more systematic procedures and guidelines for companies who wish to utilise big data for different types of innovation with different levels of maturity indicators.

Keywords: big data, big data analytics, big data analytics capabilities, innovation, absorptive capacity.

1. INTRODUCTION

In the last few years, particularly after the advancement of ubiquitous and social computing, data became the information era's new oil. Data is a resource, much like water or energy, and like any resource, data does nothing on its own, and has become part and parcel of modern times. Recently, we entered the era of what is called big data (BD) which is a term devised to clearly distinguish between the known old structured data and this new form of data. Goes (2014) defines BD as a massive amount of various data types which support different types of decisions. Firms are struggling to make sense of the huge amount of data flow that is generated from different resources (internal and external) and in different formats (Kiron et al. 2014). Wong (2012) states that the key factor for value creation and competitive advantage in today's rapidly evolving business environment is the ability to harness BD to generate useful insights for decision-making and innovation. Being able to use BD allows firms to achieve superior performance against their competitors (Oh et al. 2012). To get the most out of BD, companies are required to implement an analytics process (Tan et al. 2015). This process is addressed as a big data analytics (BDA). The implementation of BDA increases an organization's ability to capture vast amounts of data, integrate it, analysis various format and structure, and transform into the knowledge for decision making. BDA is defined as an approach to manage, process and analyse data related characteristics (volume, variety, velocity, veracity, and value) in order to uncover useful information to generate insights for making better decisions, measuring performance, and establishing competitive advantages (McGuire et al. 2012; Wamba et al. 2015). BDA has become a critical competition resource and over the last several years has been ranked amongst the top agenda items of senior executives. Previous studies present BDA as "a next big thing for innovation", " new paradigm of knowledge asset", " a source of knowledge management" (Côrte-Real et al. 2017; Manyika et al. 2011; Wamba et al. 2015, see Hagstrom 2012). The main role of BDA is to provide firms with the recognition of what has happened, what is happening now, what is likely to happen next, and what needs to be done to get more optimal results (Lavalle et al. 2011). BDA presents insights by uncovering hidden patterns to enhance decision-making, make more real-time decisions, support innovation and improve a firm's performance (Manyika et al. 2011).

Innovation is very important to the survival and growth of any organization. Nowadays, organizations rely on internal and external knowledge to innovate. Chesbrough (2006) pointed out how firms are 'opening' up their research and development (R&D) borders to tap into external sources of knowledge. In this contemporary knowledge-intensive business environment, firms should rely on knowledge driven by external sources in order to complement their knowledge base and develop innovation in a better, faster and more effective way. In a recent report "Innovating with Analytics" published in the MIT Sloan Management Review, Kiron et al. (2014) claim that "data-savvy organizations are using analytics to innovate and increasingly to gain competitive advantage". In the BD era, conducting innovation based on BDA is the future trend of innovation. According to Hill et al. (2014), managers must always find ways to innovate again and again in today's environment of change. That is, they must continually introduce new processes, services, products or ideas to the organization (Hult et al. 2004). The complement between internal and external knowledge is by far an established result in innovation. The extent to which this complement works and turns into innovation depends on the firm's capacity to search and manage external knowledge sources (Chesbrough et al. 2006). A special role is played by what Cohen and Levinthal (1990), more than 20 years ago, called absorptive capacity (ACAP); that is, "the firm's ability to identify, assimilate and exploit knowledge from the environment (Cohen and Levinthal, 1990). Therefore, a firm's openness to its external environment improves its ability to achieve and sustain innovation. Besides the knowledge driven by BD, companies need to have the internal capability – ACAP to enhance their innovation performance. The concept of ACAP is defined as the ability to enable firms to effectively acquire and utilize external knowledge (Lane and Lubatkin, 1998), as well as internal knowledge, which affects their innovation. Lane and Lubatkin (1998) suggest that ACAP enables organizations to accumulate relevant knowledge bases and to leverage them for future endeavours. Companies cannot rely solely on their own knowledge, but also have to develop their absorptive capabilities to obtain knowledge actively.

Many previous studies have discussed the techniques currently employed in BDA (Chen and Zhang 2014; Hahn and Packowski 2015; Rodríguez-Mazahua et al. 2016). Literature also provides overviews of emerging and future trends in BDA (Chang et al. 2014; Kambatala et al. 2014). Newer studies have investigated the impact of BDA on business performance (Salehan and Kim 2016; Xu et al. 2016), and data analytics capability on a firm's performance (Akter et al. 2016; Wamba et al. 2017; Wang et al. 2016). Furthermore, previous studies indicate that BD provides a venue for firms to improve their innovation (Manyika et al. 2011; Tan et al. 2015; Wong 2012). However, our review shows that there is

still a scarcity of empirical research investigating the role of BDA in enhancing innovation. It is not clear from the literature how companies are utilising their different capabilities to capture, store, analyse and build insight out of various forms of BD. We know from previous studies that firms achieve competitive advantage by building capabilities, which in turn are created by combining and deploying several firm-level resources (Bharadwaj 2000). In this present study, we consider BD as a resource which is necessary but not sufficient to create BDA capability. To create BDA capability, organizations should focus on many resources such as infrastructure and people. We draw on resource-based views and dynamic capability theory to conceptualize BDA use as a unique information processing capability that brings competitive advantage to organizations. The methodology in the present study is a qualitative method, and the research questions will be answered by conducting semi-structure interviews with stakeholders that are working in different departments from three telecom companies in Jordan.

The remainder of this research paper is organized into the following sections: first, a literature review with a more detailed explanation around big data analytics capability, big data analytics enabling a firm's absorptive capacity, and the absorptive capacity as an innovation utiliser. Secondly, the research focus and questions, followed by describing the methodology of the present study. Finally, we conclude the paper with the anticipated theoretical and practical contribution(s).

2. LITERATURE REVIEW

2.1 Big Data Analytics Capabilities

To define BD, the notation of "V" is considered to highlight data-related dimensions. McAfee and Brynjolfsson (2012) present three main "Vs" as 'Volume, Variety, and Velocity '. The 'Volume' described the quantity of data collected by organizations to obtain important knowledge. The volume of BD is currently measured in petabytes, exabytes, or zettabytes. The 'Variety' represents the huge volume of data that is generated from various sources in different formats. It consists of structured, semi-structured and unstructured data which has been difficult to handle by traditional analytics systems. The speed of data generation and analysis from various sources focuses on 'Velocity'. By considering the potential economic benefits of BD, Wamba et al. (2015) presented BD by five "Vs": Volume, Variety, Velocity, Veracity, and Value. 'Veracity' refers to the degree of trustworthiness of the information used in order to take decisions. According to Dijcks (2012) definition, BD is frequently characterized by low value density, meaning that the value of processed data is proportionately low compared to its volume. Seddon and Currie (2017) included two additional dimensions in the definition of BD: Variability and Visualization. Variability refers to the dynamic opportunities that are available by interpreting BD, while Visualization has to do with the representation of data in meaningful ways through artificial intelligence methods that generate models.

Organizations want to understand the meaning and importance of the data, and use it to aid them in making decisions. The BDA approach is the process for uncovering potential insights from data. According to Wang and Hajli (2017), there are three main types of analytics: 1) descriptive analytics refers to what has already occurred, 2) predictive analytics refers to what is likely to happen next, and 3) prescriptive analytics means what should to be done to achieve more optimal solutions. A review of literature shows that there are many techniques that can be used for analysing BD. For instance, Hadoop distributed file systems (HDFS), Extract-transform-load (ETL) tools, data warehouse tools (SQL database, Not Only SQL (NoSQL)), in-memory database and cloud computing are using for storing cleaned that are collected and extracted from external sources for further processing and analysis. MapReduce, machine learning, data mining, statistical analysis, social media analytics, online analytical processing (OLAP), and Ad hoc querying analyses are used to process all kinds of data and perform appropriate analyses for harvesting insights. Moreover, visual dashboards/systems and reporting systems/interfaces are using for generating outputs, such as various visualization reports, real-time information monitoring, and meaningful business insights, derived from the analytics components to users in the organization (Chen and Zhang 2014; Hahn and Packowski 2015; Rodríguez-Mazahua et al. 2016). Using BDA enables managers to make decisions on the basis of evidence rather than intuition (Lavalle et al. 2011). Organizations are always looking for ways to increase efficiency. According to a Mckinsey Global Institute (MGI) report, BD is becoming the key basis of competition, productivity and creation of new products and services (Manyika et al. 2011). BDA is of great significance in this era of data overflow, and can provide unforeseen insights and benefits to decision makers in various areas. Companies try to use data analytics to better understand their changing environment, which will affect their competitive position and detection of new business opportunities.

Investment alone on BDA is unlikely to create BDA capabilities (Ross et al. 2013). Companies should focus on other resources besides technology to build a capability, which will be difficult to match by their competitors (Barney 1995). BDA capability is defined as the competence to provide insights using data management, infrastructure and personnel capability to transform the business into a competitive force (Kiron et al. 2014). Previous studies show that organizations achieve competitive advantage by building capabilities, which in turn are created by combining and deploying several intra-firm level resources (Bharadwaj 2000). Organizations in data-rich environments require the appropriate technological infrastructure, as well as the human skills and the relational infrastructure between business units and the IT unit to build the BDA capabilities. These capabilities will allow organizations to capture and analyse the large amounts of data (Jeong and Ghani 2014), which can be used by companies to make sense out of their environment and affect their competitive position. The three dimensions of BDA capabilities are:

a) BDA infrastructure; refers to the technology and technical software (e.g. Hadoop, MapReduce based systems, OLAP etc.) that enables organizations to analyse critical business data (Chaudhuri et al. 2011).
b) BDA personnel expertise; refers to the professional skills and knowledge of technologies, technology management and familiarity with the data and the domain represented in that data (Kim et al. 2011).
c) BDA relationship infrastructure; refers to the ability of IT to create partnerships with organizational units to work together in order to achieve organizational goals (Bhatt and Grover 2005).

2.2 Big Data Analytics Enabling a Firm's Absorptive Capacity

ACAP can be understood as the firm's ability to acquire, assimilate, transform and apply knowledge to produce a dynamic organizational capacity (Lane and Lubatkin 1998; Zahra and Geroge 2002). There are two subsets of ACAP: potential and realized absorptive capacity (Zahra and Geroge 2002). Potential absorptive capacity (PACAP) involves knowledge acquisition (the identification and attainment of external knowledge) and knowledge assimilation (the analysis and interpretation of external knowledge). Realized absorptive capacity (RACAP) involves knowledge transformation (the combination of existing knowledge with newly assimilated knowledge) and knowledge exploitation (the application of knowledge) (Zahra and Geroge 2002).

BDA is used to analyse and acquire knowledge from BD (Sun et al. 2015). According to Villars et al. (2011), BD technologies help organizations to extract value from large volumes of a wide variety of data, by enabling high-velocity capture, discovery and analysis. In particular, Hadoop, MapReduce, in-memory database, business process management and others analytical technologies (Chaudhuri et al. 2011), enables organizations to capture, storage, and analyse data effectively to better understand its business and customers, as well as the environment it operates in (Chen et al. 2012). Sophisticated analytical tools help organizations to exploit existing knowledge to create new knowledge, which supports knowledge transformation and exploitation capability. Each data analytics tool can enhance a firm's ACAP. For example, a data warehouse can help store various forms of data, information and knowledge. Data mining and analytical software allow firms to transform existing data and knowledge to gain new insights and understanding, which will be used to innovate new products or services. A recent study by McAfee and Brynjolfsson of the Massachusetts Institute of Technology (2012) showed that BDA may enhance knowledge exploitation by facilitating the use of existing data to conduct organizational decision processes.

2.3 The Absorptive Capacity as an Innovation Utiliser

Innovation is defined as "the design, invention, development and/or implementation of new or altered products, services, processes, systems, organizational structure or business model for the purpose of creating new value for customers and financial returns for the firm" (Joshi et al. 2010). The ability of organizations to remain competitive within an uncertain environment depends upon effective innovation, which requires them to effectively and efficiently create, capture, harvest, share and apply knowledge (Lemon and Sahota 2004). BD is an enabler, a driver and a source of new products, processes, services, strategies, and business models (Manyika et al. 2011). Through the capturing, aggregating, storing and analysing of BD, companies from every industry and sector will have the potential to reap the benefits of innovation. Since innovation draws on many sources of ideas, access to a greater range of knowledge sources may enhance the innovation capabilities. Organizations can have generated or collected data from many sources, which include the firm's own R&D, competitors, customers, suppliers, and universities (Leiponen 2006), as well as user-generated data from social

media platforms, machine, mobile, and global positioning system (GPS) data as well as the Internet of Things (industrial and sensor data).

ACAP is inherent with a firm's knowledge capabilities by which it acquires, assimilates, transforms and exploits knowledge resources to produce dynamic capabilities such as innovativeness (Zahra and Geroge 2002). ACAP enables firms to effectively acquire and utilize external knowledge as well as internal knowledge which in turn affects their innovation abilities (Daghfous 2004). Daghfous (2004) pointed out that the ACAP of a firm is beneficial to organizational learning and R&D activities. In addition, Cohen and Levinthal (1990) argued that the ACAP of a firm is critical to its innovative capability. Firms need to raise their ACAP to acquire, assimilate, transform and exploit knowledge which can lead to innovation (Daghfous 2004). Therefore, the ACAP of companies can affect the effectiveness of innovation activities (Cockburn and Henderson 1998). A firm's ACAP for knowledge generation and use allows it to convert knowledge into products, services and technologies (Jansen et al. 2005). Through ACAP, firms increase the distinctiveness of their innovation (Yli-Renko et al. 2001) and are able to create new innovations that differ substantially from existing products, services and processes.

3. RESEACH FOCUS

From the review of literature so far, it is apparent that BDA is increasingly being used in organizations (Akter et al. 2016; Wamba et al. 2017; Xu et al. 2016), but little is known about how BDA can contribute to innovation. Although several articles and online reports stress that BDA may enhance firms' innovation (Manyika et al. 2011; Tan et al. 2015; Wong 2012), there is no empirical evidence to substantiate the claim (that is the link between BDA and innovation). Thus, our study will attempt to address this issue and explain how BDA can affect firms' innovation. Most prior works focused on a technological understanding of BDA rather than identifying the business value of BDA and particularly in the telecom sector. Telecom companies have plenty of data. They require a proper analysis of both structured and unstructured data to get deeper insights into their service usage patterns, preferences and customer behaviour. From the initial investigations that we have conducted with the Jordanian telecom companies, we noticed that each company has a different structure to the others. Also, they use different data sources; for example, Table 1 describes the most important customer data used in telecom industry.

Data source	Data type	Extracted through
Review and comments	Social, operational	DB enquiry, manual, APIs
Call centre	Operational	CRM system
User profile	Operational	CRM/billing system
GPS	Geospatial/location	Mobile operator system
Mobile usage data	Operational/social	Mobile operator system
Recommendation	Social	Manual
Marketing survey	Social (customer preferences)	Manual, Survey reader

Table 1. Data sources and types in telecom industry

Also, telecom companies in Jordan use different kinds of data analytics tools and techniques to obtain new and useful knowledge and to use it for developing new or improving existing products and services. For example, they are using a data warehouse (DWH) for data collection and integration, SQL or procedural language/structured query language (PL/SQL) for managing data held in a database management system and SAS Enterprise Miner or SAP Business Objects to analyse data and discover unknown patterns. So, it is interesting to explore the data analytics tools that are used to capture, store, analyse and visualize the data, some of which will be foreign to the organization, that is generated from myriad sources such as social networking sites, web applications, mobile devices and location data, to improve or foster new products or services for different organizations within the same sector. In the BD era, if organizations want to be innovative they must have the right solution in place, so that they can harness the volume, variety, and velocity of data coming into their organization and leverage actionable insights from that data. Furthermore, the foundation to generate any IT business value is the link among the three core dimensions: IT infrastructure, people and process (Melville et al. 2004). However, previous studies merely focused on the BDA infrastructure angle, ignoring the people side of BDA capability. Indeed, the analytical personnel who have the right mindset play a critical role in helping drive business value from BDA (Davenport et al. 2010). In the present study, our focus will not just be on the BDA infrastructure aspect but rather other capabilities of BDA, such as BDA personnel expertise and BDA relationship infrastructure, which have received less attention in the information system (IS) literature.

In this research, we aim to investigate the relation between data analytics capabilities, ACAP and innovation within telecom companies. The main objective of this research paper is to investigate the interrelationships between data analytics capabilities and innovation in the Jordanian telecoms industry. Furthermore, the mediating effects of ACAP on the relationships are another objective.

We address the gaps in knowledge mentioned above by answering the following research questions. The general research question is: How big data analytics are related to innovation in the Jordanian telecom industry? Below are the specific research questions:

1. What is the impact of big data analytics capabilities on firms' innovation in the Jordanian telecom sector?
2. How does absorptive capacity improve innovation for the Jordanian telecom industry?
3. Does absorptive capacity have a mediating role in the relationship between big data analytics capability and innovation?

4. RESEARCH METHODOLOGY

This research uses an empirical method of investigating the role of data analytics capabilities in fostering innovation in the Jordanian telecom sector. The approach of this investigation involves using a qualitative method. The qualitative method is rooted in interpretive methodological principles. This study will use a multiple case studies approach, which enables researchers to closely examine the data within a specific context. It is suitable for understanding in-depth how telecom companies use data analytics capabilities and how their use enhances a firms' innovation. We use the multi-case study method because, in order to understand the possible relationships between data analytics and innovation, we need to describe specific organizational contexts of innovation (product or process) and analyse the role of data analytics in them. Accordingly, we used a multiple case study methodology that will help us to identify common patterns from multiple innovation instances from more than one organization. The case study method is an appropriate method to conduct research in an area in which few previous studies have been conducted. The targeted population of this study consisted of all mobile telecommunication companies in Jordan. The mobile telecommunication industry in Jordan has shown immense growth in recent years and it is considered as one of the most competitive markets in the Middle East. According to the Competition Intensity Index (2014) released by the Arab Advisors Group, Jordan's mobile market is the second most competitive in the region after Saudi Arabia. According to the official statistical sources of the Ministry of Communication and Information Technology (2011) there are three licensed mobile operators in Jordan: Zain, Umniah and Orange. According to a recent index produced by Arab Advisors Group (2014), Zain Jordan has the largest market share with 40% of the market, followed by Orange Jordan with 31%. Then there is Umniah, the latest entrant that has 29% of the market share.

The present study will involve in-depth interviews with key staff working in Jordanian mobile telecommunication companies within the information technology (IT), R&D, and marketing departments. The job titles for these staff will include the chief technology officer (CTO), IT- director, IT-manager, middle manager of IT, senior manager of IT, R&D director, manager of analytics, and marketing manager in order to collect the required qualitative data. Business executives from these telecom companies were identified as ideal subjects, because they are familiar with the situation regarding innovation in their firms and are also in a good position to report upon data analytics capabilities. Interviews are one of the most extensively used methods of data collection (Bryman and Robert 1999). The individual in-depth interviews that will be conducted in this present study will be of a face-to-face, semi-structured nature, which is one of the most common approaches in qualitative research. The purpose of this study is to explore the BDA capabilities that may affect firms' innovation in a Jordanian context, and due to a lack of previous studies that address this phenomenon, the case study method will give the researchers the opportunities to seek information from the most influential and knowledgeable participants, and to consider people's experience, and perceptions towards the research topic. Using BDA for generating knowledge to enhance innovation requires an understanding of the perceptions and attitudes of participants who have experienced the phenomenon. Each interview is expected to last between 60 minutes and 120 minutes and it will be recorded. After the complete set of study data has been collected, each transcript will be read line by line and sentence by sentence several times in order to be coded to analyse the responses of the interviewees. Word processing software will be used to organize and manage the collected data from the interview transcripts and documents review. We will apply the ideas of NVivo, a computer software package, to sort and organize data using word software. The coding processes consist of creating word files for each code and collecting all excerpts

related to each code in the relevant word file, then creating folders for each category and grouping all the related code files under each category folder and so on.

5. EXPECTED THEORETICAL AND PRACTICAL CONTRIBUTIONS

In this study, we theorize and empirically examine how BDA capabilities are related to innovation. By answering the research question, we expect to make several theoretical and practical contributions.

In particular, considering the rapidly emerging data-rich business environment and companies' need to make sense of the available digital data for formulating their strategies, we expect the following contributions. First, we conceptualize BDA capability as a specific type of IT- capability that could have an effect on innovation in the contemporary digitalized world. This connection between BDA and innovation can explain why some organizations are better than others at using data to detect and react to environmental changes. In addition, in this study a theoretical basis for the relationship between BDA capability and innovation will be elucidated by adopting an ACAP perspective that is rooted in resource based theory and a dynamic capability view. The results will provide evidence of the importance of ACAP for organizations that desire to become more innovative. Finally, we enrich the empirical evidence in the search literature by utilizing a relatively new data source from Jordan, complementing past research based on the data from developed countries.

This study also contributes to management practice. First, we expect to demonstrate how companies are able to govern their data analytics related resources to become innovative using available data sources. This could inspire organizations that struggle with understanding and deciding what to do with the large amounts of accumulated data (Goes 2014). The study also provides insights for managers interested in leveraging knowledge driven by BD to increase their level of innovation. We have also several limitations. The first limitation is that our data will mainly from telecom companies. Future research can gather more data from different industries. Second, our semi-structured interviews will be in Jordan. Future research could collect data cross culturally or from other countries.

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