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An Overview of Big Data for Growth in SMEs

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Abstract

Potentials and promises of Big Data are significant for SMEs. Big Data can nurture alliance in SMEs by creating real-time solutions to challenges in every industry. This can be achieved by utilizing the openness for decision-making. SMEs are specifically selected within context for two main reasons: a) A small change in SMEs can have larger macro level effect due to their overall position in the economy; b) They have the advantage and flexibility for quicker adaptation to changes towards efficiency. The Big Data context, however, still have significant contentious issues as; storage, capabilities of the companies in terms of processing and generating sensible information from it, and last but not least, security and privacy. This article is aimed to propose grounds for future Big Data research for SMEs by examining main potentials and threats that have to be addressed. Finally, we recommend potential practices that will help SMEs and researchers for capturing the full potential of Big Data.

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Keywords: Big Data ; SME ; Growth

1. Introduction

We are having a huge information explosion across the world. Before communication era –often stated as 20-30 years ago– the amount of information was increasing arithmetically. Today, information is expanding in geometric series. 10 years ago, telescopes were able to draw the map of the universe with 50% confidence. Today, this number is increased to 90%. In 2000, the most developed telescope in the world was located in New Mexico, USA – Apache Point Observatory-. Within a month time, it was able to provide more data than all historical data of modern astronomy.

Nowadays, something different is being faced. ALMA Observatory -located in Atacama Desert, Chile- will produce more data than astronomy history in every five days. ALMA is also 10 times stronger than Hubble in

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resolution (Kastrenakes, 2013). However, making sense of this information, processing it in a systematic way and ways to make it useful are real questions behind.

It is needed to make this data useful or it can only stay as meaningless points. This huge bulk information is called 'Big Data'. This concept is the main driver in changing the way of competition with corporate ecosystems, transforming processes and facilitating innovation (Brown et al., 2011). As a supporting fact, Frizzo-Baker et al. (2016) demonstrate that big data is being studied more in the business focused scholars. Their study indicates that the number of publications on big data per year is growing each year and reached 107 publications in 2014.

The European Commission announced Horizon 2020 as their next framework program for research and innovation, which invests about €120 million on big data-related industrial research and applications. The program defines a research and innovation strategy to guide a successful implementation of big data economy, including excellent science, industrial leadership, and societal challenges. In Horizon 2020, Information and Communication Technology (ICT) 15 and 16 mainly address industrial research on big data. Specifically, the former focuses on open data innovation, whereas the latter focuses on big data research, including technologies, benchmarks, and support actions like competitions (Jin et al., 2015).

In annual report of European SMEs (2014), the data on number of SMEs, number of people employed and value added for EU average in all sectors in comparison to number of all enterprises are introduced. It is stated that the number of SMEs form 99.8% of total number of enterprises, employ 66.9% people of all enterprises, adds 57.8% value of all enterprises (Muller et al., 2015). Although the employee and annual turnover definitions of SME show regional differences, they are key for every economy (Tavana and Puranam, 2014). In other words, investigating the potential impact of Big Data in SMEs is the key for the growth in both micro (firm-based) and macro (economy) levels. Therefore; the core objective of this research is "To explore the growth opportunities stemming from Big Data."

The qualitative side of this research is focused on observing existing SMEs and open another gate in the big data literature for future research by offering a new management system and a technique. In addition to this, the article is aimed to enlighten a new path for SMEs. It is aimed that an SME manager and a researcher can explore new opportunities that arise alongside with the new hot topic, big data. It is seen extremely important due to SMEs' large share in the value of the economy. Given the reason, any improvement that could be made in SMEs will have a direct relation to the economy. To be more specific, it can reduce unemployment and generate larger GDP per capita. Therefore, it can contribute to increase levels of public welfare.

The rest of the article is organized as follows: Section 2 is to give detailed insight to Big Data by evaluating its source, potential and use. It is followed by the contentious issues of Big Data in section 3. Section 4 is evaluating correlations of Big Data and SMEs. Finally, conclusion and future research suggestions are introduced in sections 5 and 6 respectively.

2. Big Data: Source, Use and Potential

"Google's director of research, Peter Norvig, explained it well by saying: "We don't have better algorithms. We just have more data."" (Sanders, 2014, p.7)

Various scholars identify 'big data' as the "next big thing in innovation"; "the fourth paradigm of science"; "the next frontier for innovation, competition, and productivity"; "the next management revolution"; and that "big data is bringing a revolution in science and technology". The basis behind given arguments is that the capability of big data by changing competition by process transformation, altering corporate ecosystems and innovation; exposing value of business organization by releasing organizational capabilities and value; as well as tackling key challenges of business. (Wamba et al., 2015).

Seizing potentials of new concepts and technologies should be the main focus of businesses. However, the potential of 'Big Data' is not fully understand to gain competitive advantage by most of the leaders (Bughin et al., 2011). Given

the reason, it is fair to say that people are searching for it on Google more and more to have an insight about it as shown in figures 1.

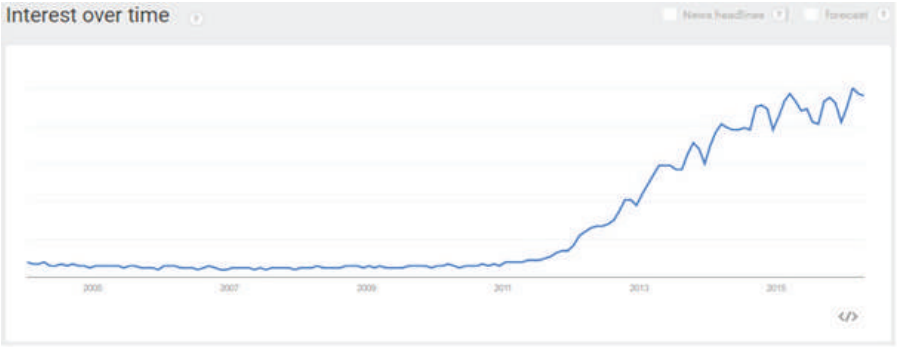

Fig 1. Google Trends for Big Data
Source: Google

Huge amount of data is produced with smartphones' increased role in our daily lives. E-mails sent, posts on social media (text, image, and video), credit card purchases, phone calls, places we have been being all parts of big data. When the data gathered by machines (i.e. smart counters, sensors etc.) are included, data sets reach enormous sizes. This concept brings the potential of improved decision making and performance outputs alongside with smart decision support systems (McAfee and Brynjolfsson, 2012).

Not only the science itself but also 'we' as human beings are forming the Big Data as well. To expand it further, Google can detect the location of potential epidemic diseases earlier than states, and international organizations and warns them afterwards by using Big Data (i.e. Google Flu Trends). This is done by observing Google searches and resulting with prediction of the disease earlier than them. In addition to this, researchers identified 45 search terms by testing 450 million models that predict the flu spread more rapidly than the Centres for Disease Control (Lenard, 2014). Furthermore, insurance companies may realize the illness potential of a person by checking the amount spent for alcohol with credit card purchases.

Signals sent by mobile network operators (MNOs) are other significant data sources. Both health organization and insurance company of a person may become aware of his/her potential cancer disease with mobile signals if a person usually visits locations near nuclear power plants. Moreover, traffic jam can be predicted with a similar way by receiving mobile signals of people who are on the same direction (Simcoe, 2015).

The study of Lenard (2014), the big data analysis as demonstrated by Google Flu, involves patterns and correlations typically involves data use that were not predicted at the time the data were collected. Many scholars emphasize that the age of big data couldn't have been imagined before the use of the first data collected. Hence, big data is expanded the primary purpose of the valuable information.

What's more, distinctive approaches are used in London and some cities in the USA. In those countries, police system warns with the detection of anomalous activities of criminals who were previously committed serious crimes. Ambulance and police can be allocated to that region in advance to prevent a possible crime and minimize the risk if many ex-convicts go towards the same direction. This example can be considered as the use of Big Data for public welfare.

In energy industry, smart grid user can be a buyer or seller in the electricity market, a participant to help low carbon-emission targets, or a stakeholder in investment decisions (Pitt et al., 2013). According to the studies of Zhou et al. (2016), big data can be a helping hand to achieve smart energy purposes by allowing large amounts of data

through the advancement of sensors, network communication, wireless transmission and cloud computing technologies.

This can be extended to business. Library of US Congress is the world's largest library with all its resources. On the other hand, Wal-Mart -one of the top 5 companies in the world- produce 167 times more data than Library of Congress in an hour by saving answers of: "Who bought which product(s) with which bank's credit card at what time?" with all its details (Bailey and Jensen, 2015).

Given the examples above, Big Data can be widely used in variety of industries such as finance, retail, telecommunications, energy, high technology etc. As long as they can answer the questions below:

- Can we sense this data?
- Can we generate sensible result from it?
- Can we use it for better service?
- Can we convert it to a profit?

New information technologies (IT) like big data, cloud computing, machine learning, data mining, the internet of things etc. intertwine with each other to help answer the questions.

Cloud computing and big data are considered as two sides of a coin: cloud computing's killer application is seen as big data, whereas IT infrastructure of big data is provided by cloud computing (Jin et al., 2015).

Machine learning and data mining are in research areas that investigate Big Data. By using machine learning techniques, it is possible to forecast tomorrow's Euro/Dollar parity with given variables (i.e. FED's announcements, extraordinary events, historical data etc.). These forecasts can yield more precise and accurate results with higher confidence levels when more data is available. Hence, Big Data has huge potential in it. This is where future lies.

What's more, the concept of big data cannot be explored further without the internet of things (IoT), which is an IT technology that can lead to many developments. To explain it further, it allows manufacturers to use real-time data from sensors to part-tracking, monitor machinery, and guide actual operations (Manyika et al., 2011). Moreover, IoT allows everything to be connected. Day-to-day things like cars, TV's and washing machines as well as industrial things like pumps, shipping containers, and machinery. All of the connected things are combined with cloud and mobile devices (Council Global, 2015).

Smart companies -especially telecommunications- collect significant information with data mining. For example, MNOs (mobile network operators) can predict the potential of a customer to leave them for their rival. By checking call data, a MNO may want to know the exact customer who is going to leave in two months' time. Executives can take further action to regain the customer or leave in case if the effort does not seem valuable.

Chinese e-commerce company Alibaba that provide C2C, B2B and B2C services via web portals disclosed in March 2014 that 100 peta-bytes (PB) of processed data has stored in their data center, which approximately amounts to 100 million high-resolution movies. During the "Singles' Day" (also known as "Double 11 Day"), Alibaba pulled in 9.3 billion Chinese Yuan in 2014 from shopping event, which corresponded to around 278 million orders. In addition to this, Alibaba developed a real-time data processing platform called Galaxy that can handle 5 million transactions per second. The total amount of data that Galaxy can process every day is about 2 PB. (Jin et al., 2015)

Large data collections and data centric computing play a central role in the vitality of the public and private sectors and will continue to be critical in science and engineering, commerce, health care, government services, and national security. For example, advances in machine learning procedures and practices have led to significant improvements in core technologies, such as speech recognition, face recognition, translation, and image interpretation that now appear in commercial services. Such advances also have led to compelling demonstrations and prototype fielded systems such as self-driving cars, real time speech-to-speech translation, and automated image-captioning systems.

3. Contentious Issues

"Compared to traditional data, the features of big data can be characterized by 5V; namely huge Volume, high Velocity, high Variety, low Veracity, and high Value" (Jin et al., 2015).

- Volume: Large volume of data that either consume huge storage or consist of large number of records (Exabyte, Zettabyte)
- Variety: Data generated from greater variety of sources and formats, and contain multi-dimensional data fields
- Velocity: Frequency of data generation and/or frequency of data delivery data creation like streaming and aggregation
- Value: The extent to which big data generates economically worthy insights and or benefits through extraction and transformation
- Veracity: Inherent unpredictability of some data requires analysis of big data to gain reliable prediction. (Wamba et al., 2015)

Although there are not significant theoretical opponents of Big Data, almost every scholar focus on several questions that needs to be dealt with:

- What is the capacity to store the data?
- How to process it?
- Who will generate sensible information from it?
- How to protect the security and privacy of the data?

Although capacity constraints to collect, store and analyze the data is often associated with cost concerns, it can also be negligible if valuable outputs are reached.

Given the reasons, traditional analytics methods do not apply for Big Data processing. Thus; distinctive data mastering, collection and metadata are significantly important especially for the analysis of unstructured data (i.e. social media posts) in terms of computational linguistics (Chen et al., 2012). On the other hand, Boyd and Crawford (2012) discuss the use of social media posts especially Twitter. In their study, the legitimacy of Big Data is questioned due to its subjectivity. This subjectivity is discussed under the terms of bias and limitations of data collection.

Even if Kaisler et al. (2013) and Almeida and Calistru (2013) state the importance of discovering the critical pieces of information and turning straw into gold by choosing the best among a set of feasible solutions for real-time analysis and decisions in getting the right picture, interpreting the data through inferences, and defining and detecting anomalies; Boyd and Crawford (2012) cautiously approach to data interpretation.

The study of Jagadish (2015) discusses that the analysis of high dimensional datasets can lead analysts to false discoveries. False discoveries can also yield wrong judgement on the data hence, to low decision support. To avoid this, there are many crucial decisions and challenges are required to be considered at each step to the Big Data analysis flow. First, the it is required to make the imperfect data, perfect. Then, it is required to make the data analysis for possible extraction. The analysis phase -received significant attention of scholars and companies- show us that poorly understood complexities within the context of multi-tenanted clusters where several users' programs run concurrently. The final step is possibly the most vital, because it cannot be substituted to anybody else – someone is responsible for decision making grounded on the outcome of the data analysis and this person has to comprehend and trust the results obtained. Gaining this assurance will often require background and clarification, may potentially need conjuring up, may even need sensitivity analyses of numerous kinds. All of the given facts above have to be deliberated for and completed efficiently for the Big Data analysis to produce a real value. Concepts discussed by Jagadish (2015) are also in line with our suggestions.

Although Anderson (2008) supports the idea of numbers speaking for themselves, many researchers hold the opposite opinion of data is not self-explanatory. Hence, this brings the necessity of data interpretation. However, deciding on which data is going to be used redirects concerning questions towards 'data cleaning' process: which data

is counted, which is ignored. Inherently, answer of the question is subjective. Selected data can also lead the researcher to nowhere or nonsense results similar to the butter production in Bangladesh and S&P 500 Index as introduced in the study of Leinweber (2007). Therefore, can it represent the objective truth? (Bollier, 2010; Boyd and Crawford, 2012)

Finally, it was easy to protect our privacy in the past but not today. After the hearings at European Court of Justice, European Commission recently announced that framework provided by Safe Harbour legislation cannot guarantee privacy of EU citizens' data when sent to the US by American internet firms such as; Facebook, Skype and Apple (Gibbs, 2015). Not only Europe is discussing these issues but also the other side of the ocean. The recent example is the increasing pressure on President Obama's shoulders to cease the mass domestic bulk phone records collection (Ackerman, 2015). Moreover, the study of Colombo and Ferrari (2015) suggest that the platforms of Big Data combine the rudimentary forms of access control and protection of data structures, nonetheless no endowment for discretion strategies. For example; big data platforms like MongoDB, Cassandra, Redis, HBase, CouchDB, Hive, Hadoop, Spark has no support for privacy policies. Although, the Data Protection Act. (1998) and EU Data Protection Directive (1995) are to govern the protection of personal data and privacy, this topic is still under discussion as the limit of the things that can be done with data, is the sky.

4. Big Data and SMEs

Oxford Economics Survey (2013) pointed technology and innovation as strategic priorities for SME growth and Big Data is considered as one of the key drivers of it. Being able to analyze and predict market and customer behavior with Big Data is a new paradigm shift for SMEs. When it is implemented correctly, it can yield increased flexibility, productivity, responsiveness, anticipation and ability to meet customer need through capturing blind spots and making better decisions.

Thompson et al. (2013) suggests that the common belief is that the innovative orientation will potentially increase the growth of SMEs. It is mainly because of the firm's ability to generate knowledge from a new technology like the use of big data is one of the determinants of the competitive advantage. Given that, technological leadership, R&D of new processes, creativity can help to achieve innovation. Therefore, SMEs must take business-related risks and should not be afraid of the failure for advancements towards the future (Abebe, 2014).

Although former Data Editor of 'The Economist' Cukier (2014) suggested that Big Data is better data, Campbell Williams -Marketing Director of Six Degrees Group- dismisses the necessity of Big Data for SMEs. However, not everybody agrees with this view. Big Data and Analytics leaders including Lauren Walker from IBM UK & Ireland are vigorous that SMEs ought to be looking at Big Data to gain competitive advantage and growth. This can be done by analyzing their past performance and combining it to external data to understand the market behavior before market does and uncover new insights. (MacInnes, 2013; Simons, 2013; Preez, 2014).

According to the data presented in 2012; SMEs introducing product or process innovations is 30.6%, SMEs introducing marketing or organizational innovations is 36.19%, SMEs innovating in-house 28.68%, innovative SMEs collaborating with others is 10.32%, sales of new-to-market and new-to-firm innovations is 12.4%, SMEs selling online 14.61%, SMEs purchasing online 22.01%. As it is introduced before, SMEs consists 99.8% of all enterprises. Why should they have low innovative and technological ratings? It should be considered as a huge waste to the economy.

Apart from the large unawareness of Big Data potential for SMEs and general major concerns for data security and privacy; advocates reduced the challenges to six main points for SME growth:

- Ways to compete with enterprises & franchisees
- Inability to invest in customer acquisition
- Inability to manage supply chain, distribution & sales force
- Lacking timely insights into market movements
- Inability to deliver large order size with short cycle times
- Lacking Big Data expertise

Cloud technology and open source Hadoop systems for storage and computing are considered as cost-effective solutions in terms of hardware and software investments to process and analyze structured & unstructured data as well as reducing the total number of IT employee within the company. Also, reducing the focus on IT with intelligent business systems can lead SMEs to innovate hence, to growth. On the other hand, it takes us back to the privacy and security concerns.

As SMEs create and store more transactional data in digital form, they can collect more accurate and detailed performance information on everything from product inventories to sick days, and therefore expose variability and boost performance. Big data allows ever narrower segmentation of customers and therefore much more precisely tailored products or services.

McKinsey Global Institute's analysis report states that big data helps organizations to make more efficient demand forecasting, shaping and supply planning, sensor data-driven operations analytics, "Digital Factory" for lean manufacturing, product sensor data analysis for after-sales service, concurrent engineering, design-to-value, crowd sourcing possible. (Manyika et al., 2011)

Larger ships cannot reach small bays. This approach can be carried to large companies for their lacking agility due to their globally implemented strategies. However, SMEs have more flexible IT infrastructure, fewer legacy issues and quick adaptability nature. With the use of Big Data; SMEs can create new businesses, gain higher efficiency and focus on innovation. Given that, some of the major challenges can be eliminated.

In addition to this, almost every scholar and business professionals mentioning the importance of smart approach to grasp the needle within the data.

"Even within large enterprises, you don't need mountains of data to gain insight from it: you simply need to be asking the right questions, and smaller companies are just as capable of asking intelligent questions as big companies."- Matt Assay, Vice-President of Corporate Strategy at 10gen

Finally, with correct approach, Big Data can yield significant improvements in terms of productivity, efficiency, new business creation, financial control, and innovation. Therefore; their reflection can be observed in revenue, cost, profit, and growth.

It is expected that SMEs can focus on growth opportunities stemming from Big Data in order to evaluate its use and potential. SMEs can implement Big Data for in-depth data analysis to point out correlations, risks, opportunities as well as for predictive maintenance, demand forecasting, process optimization, predictive inventory planning, market segmentation, analyzing and predicting market and customer behavior and so on. This wide range of use of Big Data can lead SMEs to see the big picture The detailed identification forms the basis of systematic view and will yield significant ideas through the big picture.

5. Conclusion

Data managed by big data platforms can come from any source as in either physical world or the virtual world so that if the data can be processed effectively, the results of collective data analysis certainly will show the bigger picture which will come close to reality.

Big data receives data from all fronts and it would be a helpful decision making tool to use if it can be analyzed properly sure, but it also has huge data complexity which in turn make the computation of the data complex. Also it makes installing the system complex. And it is time consuming. So why bother? The IT investment required to be able use this technology is big however the cost of being left behind in digital age would be more in the long run. So a top-down management model should be adopted. The goal should be to solve the entire problem by an integrated solution, rather than striving for isolated successes in a few aspects. Big data analysis brings machine learning into the picture and the implications of improvements in manufacturing in SMEs is huge.

Big data can enable SMEs to notice new things about their system by analyzing data and pointing out correlations, risks, opportunities etc. that they couldn't notice before. Because of that it has the potential to improve decision support systems. It also can help SMEs simulate different scenarios. So it can improve existing product – service or it can help SMEs to develop new ones. However, at the very beginning decision makers have to decide which data to be used and collect, how to collect it, how to process it etc. They also have to have a clear vision of what do they want to achieve, what questions do they need answered. Improving the system as it goes would be costlier than it would have been had the system have been planned at the start.

Not only big data can create opportunities for in-depth analysis of SMEs' own data, but also can generate insight in competition. The given undeniable fact is mainly because of the high working correlation of SMEs. Therefore, large collection of datasets can allow deeper understanding of the existing and potential state of the company within the competition and can provide grounds for future qualitative and quantitative research.

The implementation and the use of big data may very well become the next stage of innovation in businesses and SMEs alike for a higher level of strategic management and increase companies' position in the competitive environment by generating future opportunities. By considering all the facts and potentials that are discussed in the study, big data should be considered as a key to generate competitive advantage in the next frontier of business.

6. Future Research

Since this study is aimed to propose grounds for the use of big data in SMEs for growth, future studies need to be implemented to prove its benefits.

Future works on this subject should focus both on quantitative and qualitative aspects. First of all, variety of Big Data practices should be investigated within the concept of SME which will not only structure future case studies, but also form the basis of systematic view and yield significant ideas through the big picture.

As both theoretical and empirical studies suggest, case companies hold its important position within research. Hence, action research case studies should be inclined towards SMEs in high growth industry sectors, and their associated supply chains such as; energy, high tech, media, advanced manufacturing, and nuclear. Given variation in industry sectors is essential to form a generalizable method.

Therefore, designing each case study holds an important position in the research. After the identification of each business nature, growth opportunities and challenges faced need to be well defined. It is also expected to cover some of the challenges and opportunities to be covered with correct modelling of Big Data practice by finding intersection points of Big Data opportunities and business growth. This concrete identification will help the research to develop correct model and analysis for each scenario, also to the general inquiring model.

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