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A Study of Big Data for Business Growth in SMEs: Opportunities & Challenges

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Abstract— In today's world the data is considered as an extremely valued asset and its volume is increasing exponentially every day. This voluminous data is also known as Big Data. The Big Data can be described by 3Vs: the extreme *Volume* of data, the wide *Variety* of data types, and the *Velocity* required processing the data. Business companies across the globe, from multinationals to small and medium enterprises (SMEs), are discovering avenues to use this data for their business growth. In order to bring significant change in businesses growth the use of Big Data is foremost important. Nowadays, mostly business organization, small or big, wishes valuable and accurate information in decision-making process. Big data can help SMEs to anticipate their target audience and customer preferences and needs. Simply, there is a dire necessity for SMEs to seriously consider big data adoption. This study focusses on SMEs due to the fact that SMEs are backbone of any economy and have ability and flexibility for quicker adaptation to changes towards productivity. The big data holds different contentious issues such as; suitable computing infrastructure for storage, processing and producing functional information from it, and security and privacy issues. The objective of this study is to survey the main potentials & threats to Big Data and propose the best practices of Big Data usage in SMEs to improve their business process.

Keywords— *SME, Big Data, Efficiency, Analytics, Competitive Advantage*

The World Wide Web (WWW) or simply Web is the significant essence of twenty first century and it continuously empowering the society with countless benefits. Today, the Web is the playing pivotal role in decision making for

individuals and organizations. The Web technology is continuously changing and it transformed from Web 1.0 (Read only medium) to Web 2.0 (Read/ Write Medium) and finally reached at Web 3.0 (Semantic Web). Table 1 depicts the key concept of web transformation stages.

Presently people are using Web infrastructure numerous purposes, such as: for content searching, businesses, education, research, etc.

TABLE 1: WEB CLASSIFICATION

Classification	Key Idea	Tool
1.0	Reading Information	HTML
2.0	Reading/Writing Interactive web	XML, AJAX
3.0	Executing mode Semantic web	RDF, OWL

Today, the size of data is expanding in exponential fashion and this extreme growth brings new challenges & opportunities to individuals & companies. Big Data refers to a massive volume of both structured & unstructured data. Figure 1 illustrates the concept of big data in three dimensions.

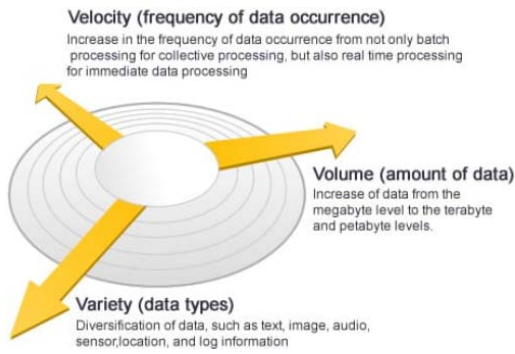


FIG. 1: BIG DATA ILLUSTRATION WITH 3VS

The last decade has witnessed the intense progress in companies' revenues that employed Big Data technologies in their businesses. However, due to lack of expertise in Big Data technologies many SMEs are unable to earn broad benefits from it. In this era, different heterogeneous sources, such as Social Network Sites (SNS), health, government, marketing companies, financial etc. are producing large data volumes every day. This is due to many new technology trends, including the Internet of Things (IoT), the proliferation of the Cloud Computing [1]. Additionally, internet enabled devices also played a key role in massive growth of data.

As a supporting fact, Chen et al. [2] revealed that big data is being considered by different global business and IT firms to achieve their goals. Their study also indicates that the number of research publications on big data per year is growing each year and reached 95 publications in 2011. In another study conducted by McAfee and Brynjolfsson [3] reported that 2.5 Exabyte of data are produced each day and its size is doubling every after 40 months. An Exabyte is 1000 times of gigabytes i.e. one billion gigabytes.

Over the last two decades, big data technologies have been gradually employed in big & small enterprises and given opportunities to bring lucrative change in their organizations which were not possible through traditional platforms. Nowadays, smart asset manager's interest in big data techniques has been picking up. Jin et al. [4] reported that European Commission is heavily investing on big data projects which aims to boost industrial and applications research.

The success stories of East Asian countries discussed in [4], where SMEs has played evidently significant role in progress of their countries. These countries have enhanced their exports due to proper utilization of SMEs. In short, SMEs emergence in Japan, Taiwan and Korea become visible instrument in poverty reduction efforts.

In annual report of WTO about SMEs (2016), the SMEs are playing key role in employment creation in majority of countries. The report stated that SMEs share of employment is 67% people of all enterprises in developing and developed countries. In plain words, considering the important role of

Big Data in SMEs is the key factor for the growth in micro, small and medium levels economies. The key factors of micro, medium and macro enterprises is presented in Table 2.

TABLE 2: MICRO, SMALL AND MEDIUM-SIZED ENTERPRISES KEY FACTORS (ADOPTED FROM EUROPEAN UNION DEFINITION)

Enterprise Category	Number of Employees	Turnover	Balance Sheet Total
Medium	<250	≤ € 50 million	≤ € 43 million
Small	<50	≤ € 10 million	≤ € 10 million
Micro	<10	≤ € 2 million	≤ € 2 million

Previous studies on big data focused on describing its evolution, technologies, opportunities, challenges, and its role in smart cities [26] [27] [28] [29] [30]. Previous studies have missed out exploring opportunities of big data in business especially SMEs. This study is focused on observing the key areas of existing SMEs and open new avenues in Big Data literature for readers of this domain by contributing an improved management system and techniques. Additionally, the study is attempt to explore latest approaches to help SMEs. Current research efforts are mainly targeting SME managers and researchers to survey new opportunities and challenges in deployment of Big Data in SMEs. The remainder of this paper is organized as follows: Section 2 presents thorough literature review of Big Data technologies. In Section 3, we discuss some contentious issues of Big Data. Section 4 is reserved for evaluating correlations of Big Data and SMEs. Finally, conclusion and suggestions are presented in sections 5.

I. BACKGROUND

A. Defining Big Data

The term Big Data describes the huge volumes of high velocity, complex and variable data that need sophisticated methods and technologies for data management and analytics. An International Data Corporation (IDC) report [16] forecasts that "worldwide incomes for big data and business analytics (BDA) tools will shift from \$130.1 billion in 2016 to more than \$203 billion in 2020". Global trends of big data is presented in Figure 2.

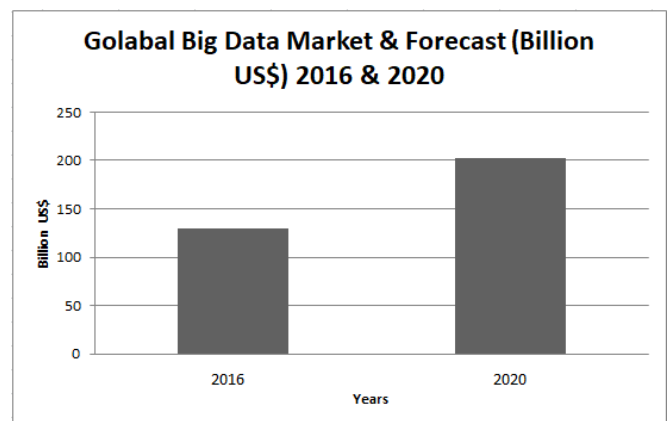


FIGURE 2: GLOBAL BIG DATA MARKET SOURCE IDC [16]

Briefly, the big data is a very important topic in today's business world. Below are some eye opening statistics about

big data, which highlights its importance in business intelligence and decisions.

TABLE 2: BIG DATA IMPORTANT FACTS

Feature	Fact
Data Management	24 PB of data manages by Google every day
Query searches	1 billion searches are conducted by Google every day
Email	250 billion email communication happens every day
Video new Visitors	1 Billion unique visitors per month on YouTube
Videos watched	6 billion hrs. of video watched per month on YouTube
Data Volume	90% of the data has been created in the past 2 years
Data forecast	double every 2 years until 2020

B. Contentious Issues

Small data can be easily managed & analyzed by humans and machines, but when the size of data gets big, immense problems can arise. The core features of big data can be characterized by 3V; namely Volume, Velocity, Variety, low Veracity, and high Value [13].

Volume: At present large volumes of data are being generated persistently from multiple sources, such as Smart phones, Social Network sites (SNS), Product codes , logs, sensors etc. McAfee [7] et al. reported in their study that approximately 2.5 Exabyte were generated each day in year 2012. Moreover, according to IDC report, the growth of data will reach to 40 Zeta bytes by 2020[8]. As a result, nowadays a big number of large companies have Terabytes and even Petabytes of data in their storage systems. This data is helpful for organizations to revolutionize their processes to make good and quick decisions.

Velocity: The term velocity refers to the speed with which data is being created and in order to extract useful information, it should be processed quickly. For example, Walmart generates more than 2.5 PB of incoming transaction data every hour from its customers. YouTube, Google and Facebook are another good examples that accept large incoming flow of data and at the same time process it fast. Beaver et al. [10] reported that Facebook processes up to one million photographs per second.

Variety: Big Data are being produced from humans or by machines and in multiple formats (e.g., text, videos, audio, comments, logs). Big data consist of structured and unstructured data, public or private, local or distant, shared or confidential, complete or incomplete, etc. Simply, variety is all about the ability of system to classify the incoming data into various categories [9].

C. Big Data Applications

At present, Big Data technologies are helping companies to boost their production efficiency by mining useful information from large dataset. To be more explicit, big data applications

can be seen in different domains. Here, we are discussing some examples of Big Data applications:

Big Data Contribution in Banking

These days, banking sector is heavily using big data applications for the fraud detection. Big data applications can detect misuse of credit and debit cards, archival of inspection tracks, customer statistics modification, and public analytics for business.

Big Data role in Transportation

Big Data is helping public sector, private sector and individuals by retrieving statistical data form area-oriented community networks. Additionally, the use of cellular networks data has influenced journey policies for people.

Big data significant impact can be seen in public sector, private institutions and people, which includes [11]:

- Public and private sectors can use the big data technologies in traffic management, direction preparation, and congestion control.
- Individuals can use big data for direction forecasting to accumulate on fuel and time.

Smart Grid

Nowadays, in order to optimize the generation, distribution and consumption of electricity, the use of smart grid technology is very common phenomenon. Smart grids take quick decisions by analyzing h data which is coming from multiple sources such as smart meters, control centers and other infrastructures [9]. Big data analytics helps to figure out at-risk transformers and to sense malfunctioning connected devices. The real-time analysis through big data helps the energy companies to choose the best decision.

D. Five Significant ways to leverage Big Data

Big Data can be functional in numerous companies despite their size and these companies could pull the benefits of Big Data by getting below 5 significant characteristics:

- Big Data is helpful by unlocking important data by making information transparent;
- Companies can create and store transactional data in digital form
- Big Data allows to audit detailed and accurate performance of customers and consequently much more precisely tailored products or services
- Advanced analytics can largely improve decision making, minimizes risks, and reveal valuable knowledge that would otherwise remain hidden
- Big Data can be employed in organizations to develop advance and optimize products and services

II. BIG DATA CHALLENGES AND PITFALL

Big data technologies offer numerous opportunities and its potential is undeniable. However, data scientists are facing different challenges when dealing with large data sets to dig out knowledge from such mines of information. Oussous et al. [9] indicate that challenges exist at different levels such as

data capture, storage, searching, sharing, analysis, management and visualization. Additionally, distributed data driven applications also face security and privacy issues. The implementation of big data technologies also passes numerous challenges, which ultimately poses challenges to researchers and deployment experts [7]. Figure 3 illustrates the current challenges to organizations.



FIG. 3: BIG DATA INDUSTRY CHALLENGES

The rest subsection covers some details about technological issues.

A. Big Data Management

Big data management deals with organization and governance of large datasets. One challenge to big data is how to collect, store and integrate multiple source data with minimum hardware and Software requirements. The second challenge is Big Data management. Big Data analytics is based on proper data management. Properly managed Big Data must be accessible, reliable and secure. Hence, Big Data can be applied in different domains such as industrial applications, atmospheric science, astronomy, etc.

B. Big Data Cleaning

One of the main requirement for taking the appropriate action through big data application is to minimize the complexity of Big Data nature (velocity, volume and variety). In fact, the reliability of data sources and data quality check is paramount requirement for achieving desired results. However, data sources may hold noises, errors or incomplete data. One of the real challenge to big data community is how to clean such massive datasets and how to come to a decision about data reliability.

C. Big Data Analytics

Big data brings immense opportunities and transformative possibilities for various organizations; however, it also causes unprecedented challenges to utilize such large rising volumes of data. In order to produce trustworthy results; big data technologies need advanced analysis algorithms, which can determine the relationship among big data features. These algorithms can help organizations to extract valuable information and monitor the business patterns. At the moment, there are a variety of analytical techniques which includes: data mining, visualization, statistical analysis, and machine learning [9].

To summarize, the big data has pushed the researchers and industry to develop and improve the analytical algorithms.

III. BIG DATA FOR SMEs

In today’s world, data is considered to be the most prominent asset for companies. Enterprises across the globe, from big to small and medium enterprises (SMEs), are exploring new avenues to harness data. Big Data usage is not just for multinational organizations. Presently, SMEs, too can acquire the benefits of the enormous amount of data to make quick & accurate decision to improve their business functionality. Various Scholars [9,10,11] reported that the big data is paradigm shift to improve the business processes, so there is a desperate requirement for SMEs to seriously think about big data adoption.

SMEs can derive value from voluminous data by utilizing and developing partnerships with big data technologies, be they in supply chain management, logistics, customer & business insight etc. The adoption of big data in SMEs can be fruitful in tackling key challenges of business [12]. As a matter of fact, the possibilities of big data are not fully explored by people & companies, but individuals are continuously finding big data term on Google to discover its benefits (see figure 4).

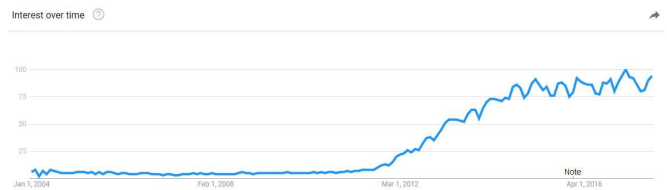


FIG. 4: GOOGLE TRENDS FOR BIG DATA

Large enterprises are consistently buying big data and machine learning startups. However, SMEs can also employ big data to better understand their clients, enter into new market and cut down unnecessary costs of business, all in real-time. However, the real challenge to SMEs is started when they start thinking to invest capital to transform big data into business application, the associated hardware and software cost is real difficulty for small companies.

Economic survey of Pakistan (2013-14) reported that Securities and Exchange Commission of Pakistan (SECP) has taken imperative decision for SMEs by approving the Regulations for listing of SMEs to generate their funds through IPOs [14]. Additionally, SECP has also introduced electronic submission of subscription form (e-IPO).

According statistics reported by Government of Pakistan [15] shows that SMEs sector has recorded a remarkable growth of 14.7% during 1987/88 – 1996/97. Moreover, the estimated capital output increased from Rs. 19,683 million to Rs 67,541 million. Interestingly, SMEs in Pakistan are playing very important role for employment generation and poverty reduction. The same report revealed that 78% of non-

agricultural labour force is employed in SMEs and they also contributed 30% of GDP.

The study of 'Oxford Economic Survey-2013' revealed ICT and innovation as pillars of SME growth and big data is an important factor in success of organization. Big Data professionals such as Lauren Walker from IBM UK is confident in saying that SMEs should utilize big data technologies to gain maximum productivity & growth, it can only be achieved by examining their company performance and combining it to big data to understand market behavior [17].

We believe that SMEs globally and specially in Pakistan will concentrate their efforts to dig out maximum opportunities from Big Data Analytics(BDA). Moreover, SMEs can create correlations between risks & opportunities by employing BDA. The use of BDA will help SMEs in different applications such as customer behavior, predicting market, predictive inventory planning and so on. This wide range of use of BDA can lead SMEs to avail maximum benefits.

A. Issues and Challenges of Big Data Use by SMEs

There exist many environmental factors that are responsible for low level of big data adoption by SMEs. According to [31], SMEs may not be able to successfully implement technological and organizational frameworks in order to build the capabilities to harness big data due to various challenges peculiar to SMEs. Following are some of the most prevalent and relevant factors [18].

SMEs Awareness of Big Data: Presently, there exist very low level of understanding of big data by Pakistani SMEs and they appear not willing to get into a domain which they apparently do not understand. The situation is not unexpected as large fraction of SMEs in many developing and developed countries do not have adequate knowledge of big data. SMEs are unsure whether their data falls into the definition of big data. As such, SMEs think that the ROI from big data analytics is uncertain. According to [32], SMEs can use big data to nurture alliances with other SMEs and create real-time solutions to overcome their challenges. However, that would also mean that SMEs need to introduce openness in their decision making.

Field Specialists in SMEs: Many SMEs operate in a highly specialized field. This specialization is their particular strength. The large proportion of SME staff is field specialists and coverage of general management functions is poor. Due to this situation, SMEs often miss out new opportunities (such as big data) that could provide them competitive advantage.

Issues of Organizational Cultural: SMEs that operate in a highly specialized field, often take little to no interest in contemporary developments in management. As such, these SMEs tend to classify the emerging developments in management (such as BDA) as a hysteria and not as a futuristic opportunity. Infrastructure is another concern. Many

SMEs have data that falls into the category of big data but do not have adequate infrastructure to analyze that data. When a BDA expert comes into the organization, he/she finds it very difficult to mine value from the big data.

Lack of In-house Big-Data Experts: There is a critical shortage of in-house data-analytic experts. As such, SMEs are incapable of doing big data analytics themselves. Many factors are responsible for this shortage of data experts. Examples include high set-up costs relative to uncertain ROI from BDA; insufficient expertise to manage BDA; insufficient qualified workforce, and high staff costs. [19] identified this lack of data experts as a main obstacle against that hindered big data adoption by the businesses in the developed world. Labor market continue to witness an increasing short fall of big data analysts. In USA alone, there was a shortage of up to 190,000 data analytics experts [20] while in UK the demand for data analytics experts was expected to increase up to 243% by 2018. While large companies can distribute multiple functions to multiple people SMEs don't have this liberty. SMEs need cross-functional experts that have expertise in multiple domains (such as IT and business). The availability of such expertise is even more limited in the labor market.

Lack of Business Cases: There is a shortage of representative case studies and success stories with respect to big data analytics use in SMEs. This is important for the successful transmission of innovation among SMEs. Although guidelines and examples exist, there is a critical shortage of stimulating and trend-setting cases related to big data use in SMEs.

Access to Data Analytics Consulting Services: Many of the consulting services utilized by Pakistani SMEs today relate to operations level (such as hardware-related and software-related IT issues). SMEs, in general, do not consider hiring consultants to perform management and business analytics. One reason is that most consulting firms are large firms. The business practices of these firms is not aligned with SMEs' needs and financial resources. The main objective of these consulting firms is to sell large teams of consultant to their clients. These teams of consultants usually work on complex projects for extended periods of time. Many SMEs are unable to afford such services. Researchers have also proposed big data maturity model for SMEs that SMEs could use as a first step of adopting big data analytics [33]. SMEs can also use such models to overcome the barriers preventing them from adopting existing solutions.

Issues of Software Market: In international market, there exist many business analytics software. In order select a solution that could provide good performance at an economical price, SMEs face a tough decision. This is because SMEs, in general, lack the required expertise. Most companies that provide comparison and evaluation of BDA software tend to favor certain BDA software developer companies and it is hard to find companies that could provide an independent comparison and evaluation of BDA software.

Lack of User-friendly, Economical Software: There exist two types of data analytics software available in the market. The first type consists of solutions that are potentially useful but highly complex. These solutions require data analytics expertise. The second type of solutions are simple but are not very effective. There exist very limited solutions (e.g. IBM's Watson Analytics) that provide an instinctive user interface together with strong analytical capabilities and shorter learning curve [21].

Lack of Business Concept and Organizational Structure: SMEs need to adopt a proper business concept and organizational structure in order to gain true economic benefits out of big data. Various challenges of big data use have been identified in literature [22]. Researchers have paid particular attention to maturity models while discussing organizational issues related to big data use. However, this discussion is largely related to large firms and the issues discussed are more relevant to large firms. This discussion is also limited in a sense that the discussion provides an assessment rather than a detailed advice as to how to utilize big data in a firm to gain competitive advantage.

Issues of Data Security: One of the major hurdles in the way of big data adoption by SMEs is security issues. SMEs consider data security issues more serious as compared to large firms. This is because SMEs lack the kind of environmental conditions and IT expertise that large firms enjoy [24]. One of the major security loophole in IT infrastructure of many SMEs is the outdated database management systems whose support has been discontinued by their developer companies. As a consequence, SMEs are exposed to significant threats of data breach, intrusion, and cyber-attacks. In a big data environment, these challenges are more intensive. In such environment, large amounts of data move multi-user and multi-owner channels. Since SMEs generally lack the data analytics expertise, they will resort to use of outside expertise for data analytics solutions. That will further reduce SMEs control over data. In cloud services, data security concerns are more intense.

Legal Issues: There exist many data protection and privacy laws that SMEs will need to abide by when performing big data analytics on customers' data. These laws have complex legal complications and SMEs with little or none in-house legal expertise would find themselves in a difficult situation. Third-party legal support would be needed to cope with this challenge. However, such support is expensive and many SMEs cannot afford it.

Business Model of SME: The business model of SMEs generally revolves around two concepts. First, the SMEs may have specific market opportunity. Second, SMEs may have some skills/resources that could provide them competitive advantage in their respective markets. One problem with such business model is that SMEs only focus on the dimension on

which their business model is based. As such, SMEs tend to overlook at other resources at their disposal. In the same way, SMEs also ignore new opportunities that can help them improve and diversify their business.

Access to Finance: Access to adequate financial resources is a significant barrier in SMEs growth [25]. Access to debt finance is generally limited for SMEs. This is because information asymmetry exists between financial institutions and SMEs. Due to this limited access to financial resources, SMEs are generally reluctant to capitalize on those opportunities that they feel do not align with their business model. For Pakistan's economy, it is crucial to enhance the ability of SMEs to innovate and adopt new technologies at a faster rate.

IV. CONCLUSION

Over the last few decades, we have seen massive growth in amount of data which is coming from physical world or the virtual world. The big data technologies are being used by small and large enterprises to process such big volume to retrieve meaning full information which leads to business intelligence and decisions. BDA can empower SMEs to notice new changes in their units by analyzing data and making correlations between different objects. Finally, by considering all the facts, figures and possibilities that are discussed in our paper, BDA must be recognized as a key factor to make their business as success story.

SMEs themselves also need to embark on a cultural change if they are to exploit the potential of Big Data. This requires them to investigate data-handling tools and methods outside their small structures, and be prepared to use Big Data actively in their decision-making processes. They need to be ready to dive in and explore the growing ocean of information that is waiting for them out there. However, exhortations alone will not help to put SMEs on the way to data analytics. The previous identified problems imply a complex challenge to all stakeholders, namely, national and international policymakers, the IT community, the business management community and the data science community.

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