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How 'Big Data' Can Create Significant Impact on Enterprises? Part I: Findings and Implications from Longitudinal Analysis and Systematic Review

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ABSTRACT
Big data is the latest buzz word in the BI domain, and is increasingly gaining traction amongst enterprises. The prospect of gaining highly targeted business and market insight from unmanageable and unstructured data sets is creating huge adoption potential for such solutions. The scope of big data moves beyond conventional enterprise databases to more open environments, covering new sources of information typically relating to various social networking sites, wikis and blogs. Moreover, advancements in communications and M2M technologies are also contributing to the massive availability of big data.

***Keywords*:** Analytics, BI, Big Data, Business Value, Enterprises, IT Services, Hadoop, NoSQL, Visualization, SMEs

I. INTRODUCTION

For the last few years, the analytics domain has been greatly impacted by the hype around 'big data', and organizations are looking to understand this concept and use such solutions to analyze huge volumes of structured and unstructured data [1].

With the help of platforms such as Hadoop and NoSQL, enterprises are looking to mine and analyze the raw data available from social networking sites to get useful insights about customer behavior, buying patterns, and changing market trends [2]. Moreover, with the addition of certain interactive and visualization features, big data tools can also be used by line of business users other than senior executives and analysts, which is expected to increase the penetration rate of such solutions amongst enterprises.

Meanwhile, BI vendors are also looking to tap this growing market and are investing widely to develop and improve their capabilities in the big data space. Furthermore, the study expects that in the coming years, vendors will look to provide big data solutions in a virtualized environment. In addition, BI vendors are working on integrating Hadoop solutions with advanced BI tools and data discovery & visualization tools in order to help customers to analyze data in a visually compelling and interactive interface. The study therefore notes that the market for big data has tremendous potential to transform the BI segment, and IT vendors will have to enhance their offerings in this space to make sure that they do not lag behind their counterparts [3]. The below mentioned Table (1) and Fig (1) illustrates the number of small enterprises responded for ICT survey.

Table 1: Small enterprises ICT survey data geographic breakdown

Countries	Count
Spain	75
Italy	74
France	74
UK	68
Russia	66
China	62
Brazil	61
Germany	60
US	54
India	40
Australia	37
Canada	36
Others	496

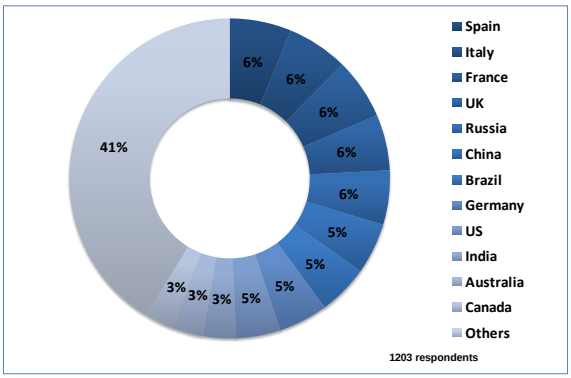

Fig.1. Small enterprises' ICT survey data geographic breakdown

ENTERPRISES TAKEOUTS

Enterprises: need to adopt various analytical and visualizations tools and skills to generate useful insights from the big data they have generated. IT departments: need to devise a robust data governance plan to reduce security breaches.
Employees: need to be trained properly to make use of these advanced analytical tools, failing which the investment will go in vain.

The below mentioned Fig (2) shows the overall ICT budget change pattern (flat, growth or shrink) from FY 2013-14 to FY 2014-15.

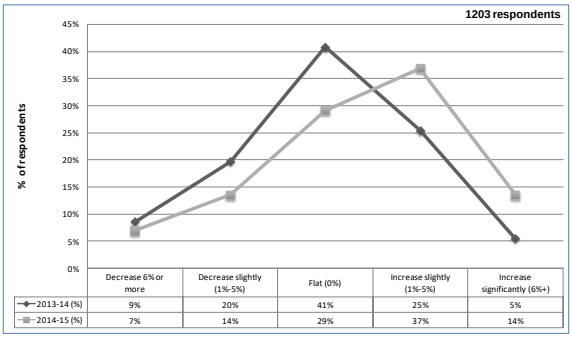

Fig.2. ICT budget change (growth or shrink) from 2013-14 to 2014-15

II. SUPPORTING ARGUMENTS AND EMPIRICAL EVIDENCES

1.1 THE FOUR LAYERS OF A BIG DATA SYSTEM

In order to draw actionable insights from raw statistics or snippet of unstructured data, data has to pass through different layers [4]. The first layer has to do with data sources. These sources could include sales records, customer database, feedback, etc. The second layer is the data storage. As the amount of data generated and stored increases exponentially, accessible systems and tools such as Apache Hadoop DFS can be used to deal with the task. These tools will help in categorizing the data. Third, when firms want to use the data they have stored to find out something useful, they will need to process and analyze it. A common method is by using a MapReduce tool. Essentially, this is done to choose the aspects of the data that they want to analyze, and then put it into a format from which insights can be derived. The fourth layer is the data output. This is the stage where the insights gleaned through the analysis are passed on to the people who can take necessary action that benefits the business. The analysis must be clear and concise. The output can be in the form of reports, charts, figures and key recommendations [5].

1.2 DATA HELPS ENTERPRISES GAIN COMPETITIVE EDGE

Organizations can significantly accelerate the growth of their business by doing enormous things with data [6]. Data can enable companies to gain competitive edge in six ways. First, the modern business landscape is such that organizations compete for information. As a result, organizations ought to have better and well performing information to get ahead in competition. Better information can enable firms to take smart decisions. Second, businesses can turn the data into active information that enables them to achieve real goals. Third, companies can use the data to move forward in directions that can enhance sales and reduce costs. Fourth, the data that has been accumulated over the years must be integrated with rest of the business. This in turn helps in connecting the dots between previous, current, and potential future transactions. Fifth, it is important to ensure that everyone in the company has access to technology and data. Jobs can be done better when employees are equipped with data. Sixth, businesses should ensure that they always have high quality data. In short, data is a big asset for companies [7].

1.3 FIRMS RUSH TO DEVELOP SMART DATA VISUALIZATION TOOLS

Advances in information technology, social networking, and communication have contributed to the massive availability of big data, paving way for development of interactive data visualization tools. The traditional visualization tools provide visual representation of data in a static and non-interactive nature that requires more time to understand and analyze. On the other hand, interactive data visualization, which was developed as an ad hoc solution to address specific questions within specific set of data, has become hugely popular. As this tool allows better understanding of the relationships and trends in data sets and enables quickly drilling down data to the smallest unit, organizations of all sizes are rushing to develop better and faster data visualization tools. This in turn is causing an irrational expectation that data visualization is the answer for handling big data. However, it is necessary that data analysts and programmers ensure they are asking the right questions and utilizing the right methods in order to analyze the data. Further, they could also include human visual perception capabilities into design. The data visualization tools should ideally be providing information on what is expected and decode what is not expected [8].

1.4 UNLOCKING BIG DATA CAN OPEN UP OPPORTUNITIES FOR SMES

Big data offers several opportunities for SMEs (small and medium enterprises); however, due to the cost factor and complexities of analyzing the data, these firms are not able to effectively unlock the potential of big data. In order to derive benefits from big data, SMEs need to follow certain steps. The first requirement is to thoroughly assess what big data can offer. They can begin the big data journey on an experimental basis. In case of a crunch in resources, they can outsource their data. Second, firms can leverage big data to test their assumptions against the available information and create scenarios. This will facilitate decision-making processes, both tactical and operational. Third, given that big data will lead to changes in the set format of decision-making process, organizations must be prepared to innovate. In fact, big data should be seen as a long-term learning experience rather than just as a short-term investment. As companies cannot achieve additional value without changing their culture, it is imperative that they develop a culture where in data-driven decision-making is the norm, not the exception. Fourth, firms need to be clear on their privacy policies to gain trust from stakeholders and convince them that the data is being used for their benefit [9].

The below mentioned Table (2) and Fig (3) illustrates the number of small enterprises responded for ICT survey across the industry verticals. The respondent size for education counts for 134, similarly respondent size for healthcare counts for 86.

Table 2: Small enterprises' ICT survey data industry breakdown

Industry	Count
Education	134
Manufacturing	130
Retail	130
Telco/service provider	94
Financial markets	94
Media	94
Healthcare	86
Utilities	74
Energy	72
Government	72
Retail banking	71
Insurance	70
Pharmaceuticals	69

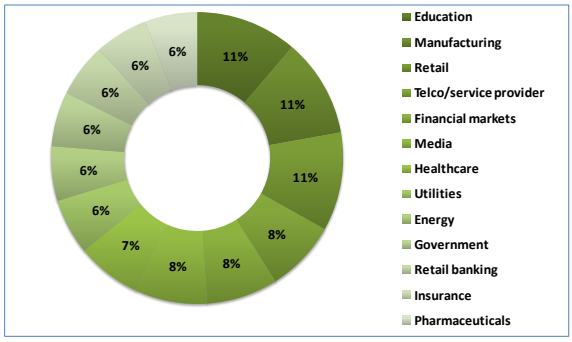

Fig.3. Small enterprises' ICT survey data industry breakdown

III. KEY ACTIONS BEFORE THE ADOPTION OF BIG DATA

1.0 FIVE WAYS TO USE BIG DATA

With big data becoming influential, companies are quickly embracing this solution. In order to successfully use big data, companies should follow certain key steps.

1. Collecting data without a proper goal will result in huge amount of data with little purpose or direction. Therefore, it is important to have a clear goal in mind before collection of the data. This will help companies in knowing what kind of data they should be going after, and enables them to form a proper data strategy.
2. Firms should base their business decisions on the data collected, rather than relying on intuition or instinct.
3. Collecting data is just one step of the process; interpreting and analyzing to get meaningful insights from the collected data requires different sort of skills and expertise. Hence, it is important that businesses have the right people to do the job. They can either hire data experts or train people who are already employed in the company.
4. It is difficult for a human mind to grasp the massive amount of data being generated. As a result, enterprises should have the latest technology or solution to process the data that is being generated at incredible pace.
5. In order to gather the data, companies need to go where customers are; in today's world, customers are using social media and firms should therefore be tapping social media [10].

2.0 BIG DATA COMES WITH BIG ISSUES

Big data offers several benefits, such as competitive advantages and operational efficiency. However, big data also comes with big issues, writes Simon Campbell for Biz Community.com. Not having a good data governance plan can lead to security breaches, unreliable data, and unexpected expenses. Given the complex nature of big data, it cannot simply be processed using traditional data

processing methods. Businesses no longer deal with megabytes or gigabytes of data; in fact, they deal with terabytes and petabytes of data, which come in several forms and through different sources. In today's competitive landscape, it is imperative for businesses to derive actionable insights from data as business decisions are hinged on that. However, the regular database and warehouse management tools are unfortunately inadequate. In order to derive complete value of big data, collection and analysis of the data is not enough; businesses need to know how and when to use this data. Data can also turn out to be a liability, especially in the event of loss or theft of data. This data could be proprietary company information, financial credentials, login details, or intellectual property. Therefore, firms need to ensure that good security, data management tools, and solid governance, compliance standards and structures are in place [11].

IV. RELATED WORKS

Three areas where big data can be helpful for start-ups: Due to limited budgets, small and start-up firms face the hurdle of eliminating waste and finding ways to experiment and expand. However, companies will be able to make use of their limited resources with big data. With this added efficiency, businesses can increase their capital and revenues easily. There are three important areas where big data can particularly be implemented [12].

First, tracking customers and potential customers is very difficult for small businesses. They might invest more or less than required, both of which are not ideal for a fledgling business. This is where big data come into use - it helps in gauging how much should be invested in marketing and where that money should be spent.

Second, pricing plays a crucial role; if companies get their pricing wrong, they can quickly be out of business. Businesses need to be careful in pricing their products. The right price makes all the difference - it brings in enough capital, and at the same time will bring customers in again and again - this is one area where big data can be extremely helpful.

Third, big data helps organizations improve performance of their either already superior employees or improve the efficiency of a struggling workforce. Big data has proven that it is effective in motivating and improving employees' performance in various sectors. As a result, it enables companies to save time and money in hiring and training new employees.

V. RECOMMENDATIONS FOR ENTERPRISES TO HARNESS BIG DATA

"Ecommerce companies are extensively using big data to better understand their customers and provide services and experiences tailored to each individual and achieve competitive advantage."

For many firms, it is no more a question of whether to use big data solutions or not; rather it is a matter of what kind of tools to be deployed and how much to be spent. Companies can harness big data in a few ways [13]:

- Ecommerce companies can choose in-house route and hire data scientists to handle their data needs. Collecting data, analyzing and presenting and spotting trends will help organizations in taking quick actions.
- Outsourcing big data needs can be another option. A retailer can seek the help of firms and let them crunch the numbers and generate insights, so that the retailer can focus on selling products, take care of customers, and grow the business.
- Cash-strapped companies can take the 'do-it-yourself' approach by making use of inexpensive tools such as Google Analytics.

The below mentioned Table (3) and Fig (4) reveals small enterprises' overall ICT budget allocation in the FY 2014 and FY 2015 (how did enterprises spend their overall ICT budget in FY 2014? How will this change in 2015?) . The survey result shows that small enterprises allocated 28% and 22% of their overall ICT budget to hardware and software respectively in FY 2014 and it remains the same for the FY 2015.

Table 3: Small enterprises' (external) ICT budget allocation, 2014 and 2015

Category	**2014**	**2015**
Hardware	28%	28%
Software	22%	22%
Services	16%	16%
Communications	15%	15%
Consulting	12%	12%
Other	8%	7%

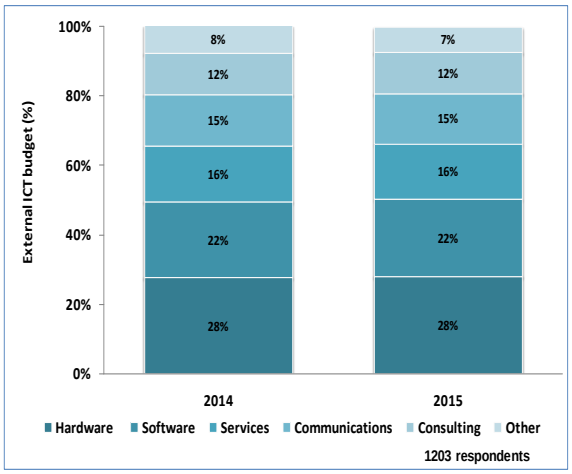

Fig.4. Small enterprises' ICT budget change from 2014 to 2015

VI. ISSUES AND CHALLENGES

1.0 STRIKING A BALANCE BETWEEN BENEFITS OF BIG DATA AND PRIVACY ISSUE ESSENTIAL

"A vast amount of data is being floated around the world due to the ubiquitous data-driven technology."

Every interaction within the digital realm, be it on smartphone, computer, through credit card transactions, is collected, stored, accessed and analyzed in real-time, with accuracy. Though big data provides many benefits, customers feel they are being constantly monitored. Therefore, it is important to strike a balance between the benefits of big data and the privacy concerns of customers [14]. There is the underlying issue of privacy when it comes to big data:

1. People are uneasy about giving personal information as it could lead to unmonitored distribution of the information to advertisers, government and other organizations.
2. Big data enables enterprises to deliver insights accurately with maximum impact, which also helps decision-makers to act thoughtfully. For this however, they need to be adequately equipped in analyzing and visualizing the information, whilst avoiding the ethical pitfalls.
3. The ability to measure and study big data can help firms in dissecting customer patterns effectively and identifying emerging trends swiftly and accurately.

The below mentioned Table (4) and Fig (5) illustrates various factors influencing small enterprises' decision to choose an IT provider in FY 2014. Various factors such as geographical reach, contract flexibility, financing options payment terms, expertise in industry and many others have been rated by respondents on a scale of one to four and shown below.

Table 4: Factors influencing small enterprises' decision to choose an IT provider

Factors	Average rating (On a scale of one to four)
Geographical reach	2.7
Financing options/payment terms	2.7
Contract flexibility	2.8
Breadth of solution offerings	2.8
Specific functionality expertise/depth	2.9
Expertise in industry	2.9
Financial stability	3.0
Leading-edge technology	3.0
Price	3.0

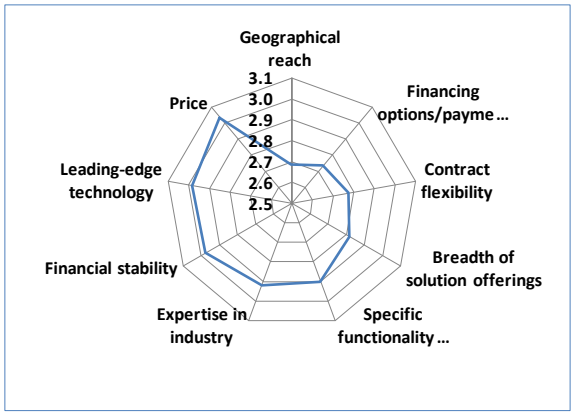

Fig.5. Factors influencing Small enterprises' decision to chose an IT provider

2.0 BIG DATA CHALLENGES EVENTUALLY IMPEDE PERFORMANCE

"Big data challenges often impede big organizations from taking complex decisions, which in turn impacts performance."

In order to deal with this challenging decision environment, some organizations are seeking analytical firepower that blends the right analytical software, so that it is finely tuned to perform on server hardware [15].

Companies can leverage big data with the right technology. By using appliances, companies can equip themselves with the ability to explore data and find insights in a timely manner. The opportunity of using analytical appliances effectively comes in three aspects:

- First, in order to enrich the decision making process, companies should have the ability to tap a broad array of data from internal and external sources.
- Second, enterprises and businesses need to have the ability to quickly analyze collected data and gain insights from it.

- Third, interpretation should be in tune with the business role and this information must be easy to use.

3.0 SMALL DATA IS THE PRODUCT OF BIG DATA ANALYSIS

"Small data is the product of big data analysis even though it may seem to be contradicting the whole big data movement."

The conventional data analysis dealt with databases filled with product information, customer information and other data [16]. However, it was difficult to efficiently analyze the high volume of data as companies did not have the capability to address the corresponding requirement for increase in scale and data processing ability. These shortcomings were addressed by creating smaller data sets. However, even these smaller data sets had shortcomings as often there was a mismatch between the data and working context [17].

1. Initially, enterprises had to face problems in analyzing big data, due to infrastructure problems. However, specific technologies have addressed these shortcomings; in turn helping firms to manage and manipulate big data [18].
2. If enterprises still consider big data as a challenging task, they might want to wait a year or two: the emergence of ubiquitous machine data is just around the corner.
3. Enterprises should not be scared; rather, they should be well prepared. Enterprises will have more data than they can imagine, and the means to capture and manage data of this scale already exists [19, 20].

VII. CONCLUSIONS AND FUTURE RESEARCH

"Big Data has big potential!"

In summary, the proposed paper analyzes the development related to Big Data technologies and adoption of these technologies in large, small and medium-sized enterprises. The paper represents a holistic view about the benefits and challenges associated in direct and cross-platform application of these technologies across all sizes of enterprises. However, in future, more attention would be made towards developing cross-platform interoperability of Big Data technologies in such a manner that a new version could use the functionalities of its previous version. This development is also expected to facilitate enterprises to gain maximum leverage of Big Data technologies in their business operations along with making better and faster decision-making based on the insights gathered from data collected.

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