Title: Managing Big Data for a Sustained Competitive Advantage

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Abstract: A firm's stakeholders are interested in its operational as well as financial performance. Achieving a sustained competitive advantage in the industry is vital for a firm's long-term survival. Big Data has been mentioned as a powerful competitive tool in the literature. This study examines the influence of Big Data Analytics in achieving competitive advantage by a firm in its business operations. From a competitive advantage standpoint, Big Analytics capability has implications for three key resources such as Big Data Technology, Big Data Technical skills, and Data Scientist skills. In this paper, we do a critical analysis of Big Data Analytics in terms of resource-based view of the firm. Based on resource-based theory, we conclude that Data Scientist skills could be considered a driver to provide sustainability. This study has implications for incumbent firms and new entrants who are heavily dependent of data-driven decision making to gain competitive advantage.

Keywords: Big Data, Competitive Advantage, Analytics, Resource-Based View.

1. Introduction

Much research and strategic management theory exist on understanding sources of sustained competitive advantages for firms (Barney, 1991; Wernerfelt, 1984; Porter, 1990; Porter, 2008; and Rumelt et al., 1991). A variety of factors have been identified in maintaining a sustained competitive advantage, including lowering cost position of a firm, a firm's ability to differentiate its products, and the ability of firms to cooperate in strategic alliances (Barney, 1991; and Mata et al., 1995). In this early 21st century big data has been identified as one of the key drivers for maintaining competitive advantage (Baker, 2014; Bedeley & Nemati, 2014; Bernstein, 2013; Detwiler, 2015; Lewotsky, 2014; McGuire et al., 2012; Martin, 2014; Panda, 2014; and Saran, 2014).

This research is based upon these questions: (1) Can Big Data Analytics provide a sustained competitive advantage to a firm? (2) What implication does Big Data Analytics capability have for three key resources such as Big Data Technology, Big Data Technical Skills, and Data Scientist skills? In this paper,

we conduct an analysis as to whether big data can create a sustained competitive advantage. We also identify as to which attributes and investments could be the sources of sustained competitive advantage. Kohli et al. (2012) findings indicate that the influence of IT investment on the firm is statistically significant in terms of firm value.

Nearly every business decision today is shaped by technology because technology has the power to transform market, relationships, and processes. How companies deploy social, mobile, analytics, cloud, the Internet of Things (IoT) and big data analytics to drive growth and increase productivity or how do they redesign business processes to apply these new insights from the disruptive technologies is a fundamental theme for IT organizations around the world (Stevenson, 2015).

Over the past decade enterprise IT work load has been dominated by enterprise application workload like ERP, SCM, CRM and Mail, etc. These workloads are moving to the Cloud primarily in the form of Software as a service (SaaS). On top of conventional data sources big data is now providing a new kind of data set which means providing new business value. Simultaneously, analytic workloads of enterprises are exploding (Stevenson, 2015). Companies can use this data to know customers' interaction with their products and then quickly deliver according to customer wants and needs (Detwiler, 2015). The unique advantage of big data is it tells something about customers that business organizations did not know before. "As your competitors learn more, you'll need to learn, too," said Hilary Mason, coauthor of "Data Driven: Creating a Data Culture." (Detwiler, 2015). The CEO of another advanced analytics company maintain that "We don't believe in asking customers. We believe in observing customers and understanding from their transactions, their actual behavior" (Goldberg, 2013b).

McAfee and Brynjolfsson (2012) in their Harvard Business Review article, "Big Data: The Management Revolution" stated that by exploiting big data (a new flow of information) companies can improve their performance. They called big data a movement which allows to derive intelligence from data and

translate that into business advantage. McGuire et al. (2012) assert that “in most industries, established competitors and new entrants alike will leverage data-driven strategies to innovate, compete, and capture value.” Porter (1990) points out that a nation’s competitiveness is dependent on its industries’ capability to innovate. Various government and non-profit organizations have started big data projects to tackle complex social problems such as human trafficking (Desouza and Smith, 2014).

With the advent of commodity hardware (to process big data), computer processing power (thanks to Moore’s Law), maturity of computer and software engineering, network bandwidth, increasingly low cost of data storage, companies are able to capture, process, transform and store a large volume of data.

To handle Big Data companies need a new set of tools and technologies on top of their existing data management and business intelligence (BI) tools. Before investing money on Big Data tools, technologies, and human capital organizations would want to know as to what value big data would add. There are certain robust capabilities of big data tools and technologies available. Fan and Bifet (2013) report that existing data mining tools are not able to handle big data due to the volume and complexity. For big data a new set of machine learning algorithms and tools have emerged. Li et al. (2013a) provide an advanced machine learning algorithm by leveraging Hadoop distributed computing platform such as MapReduce.

Kiron at al. (2012) report that in both academia and business experts believe that “analytics connected with big data is going to be a driving force in our economy and society in the next 10 to20 years.” To help organizations understand the value of big data and advanced analytics, MIT Sloan Management Review partnered with the IBM Institute for Business Value conducted a survey of nearly 3,000 executives, managers and analysts working across more than 30 industries and 100 countries. (LaValle,

2011). One of their key findings was that “top-performing organizations use analytics five times more than lower performers” (LaValle, 2011).

2. Literature Review and Theoretical Framework

Competitive strategy of a firm is thought to be of major importance in its success in the industry (Gatignon & Robertson, 1989; Kumar et al., 2011; Lawless & Fisher, 1990; Mathews, 2002; Porter, 2008). These studies reinforce the importance of understanding different forces of competition. This is true for both incumbent and the new entrants. Bush (2012) asserts that developing an organization's competitive strategies is instrumental in staying ahead of the competition. Research has shown that in a particular industry competitive strategies need to be assessed from the standpoint of the threat of new entrants (which matters to incumbents), the bargaining power of suppliers (true for both incumbents and new comers), the bargaining powers of buyers, the threat of substitute products (matter of concern for incumbents), and rivalry among competitors (Porter, 2008). Prahalad and Hamel (1990) suggest that a firm's growth depends on top executives' ability to identify, cultivate, and exploit the core competencies.

To sustain long-term profitability business organizations must respond strategically to competition (Porter, 2008). Most research in strategic IT suggests that IT can add economic value to a firm. For example, Wal-Mart relies heavily on information technology. The company uses IT to help integrate multiple stages of vertical chain – strong vendor relationships. The installation of electronic data interchange (EDI) enabled an estimated 3,600 vendors, representing about 90% of Wal-Mart's dollar volume, to receive orders and interact with Wal-Mart electronically. As a result, Wal-Mart and its vendors benefited from reduced inventory costs and increased sales (Bradley and Ghemawat, 2002). This allows Wal-Mart to stay competitive with its rivals. Similarly, some other organizations might want

to increase their products sales by leveraging IT services. In this case also a firm can achieve competitiveness.

So, organizations are able to stay competitive; reduce cost; increase revenue; and increase efficiency by virtue of IT services. But rival firms also can make effort to provide same IT services. In this case the firm that adopts this strategy first can gain competitive advantage for a short time or it can achieve first-mover advantage, but not sustained, competitive advantage (Mata et al., 1995). Barney (1991) provides the definition of competitive advantage and sustained competitive advantage:

“A firm is said to have a competitive advantage when it is implementing a value creating strategy not simultaneously being implemented by any current or potential competitors. A firm is said to have a sustained competitive advantage when it is implementing a value creating strategy not simultaneously being implemented by any current or potential competitors and when these other firms are unable to duplicate the benefits of this strategy.”

Academic and industry papers have cited benefits big data and capability big data to provide competitive advantage (Saran, 2011; Martin, 2014; Lewotsky, 2014; Bell, 2013; and Baker, 2014). Big data allows for constructing consumer profiles on social media data (Hernandez et al. 2013). Big data provides capability that creates opportunities for new kinds of businesses (Bell, 2013). This helps companies to come up with market segments of their products and offer new products based on consumer preferences. Cardenas et al. (2013) report that big data analytics has attracted security community "for its promised ability to analyze and correlate security-related data efficiently and at unprecedented scale." Turner et al. (2013) state that Big Data is providing banking and financial market companies solutions to long-standing business challenges in terms of transforming their processes and organizations themselves. Big data is making a big impact on financial services firms in terms of operational efficiency, new product development, and compliance (MarkLogic, 2012).

Big data is changing the dynamics of business operations by speeding up the business intelligence (BI) and decision making abilities of corporations (Safa, 2014). A good number of papers report that big data could be used for predictive analytics. Examples include predictive analytics for real-time energy management (Balac et al. 2013; and Bertino, 2013); Power supply demand response targeting (Kwac and Rajagopal, 2013); big data solutions for predicting risk-of-readmission for congestive heart failure patients (Zolfaghar et al. 2013); and alarm prediction in large-scale sensor networks (Li et al. 2013b). Retailing industry is a key customer for data-driven customization by virtue of Internet purchases, social-network conversations, and location-specific smart phone interactions (McGuire et al., 2012; Aldrete, 2014). A 2013 survey (Kiron et al. 2013) found “67 percent of respondents reporting that their companies are gaining a competitive advantage from their use of analytics,” up from 58 percent in 2012 and 37 percent in 2010" (Kiron et al. 2013; Bell, 2013).

The General Manager of Enterprise Capabilities at Intel IT said, “We wanted to empower our business groups to solve problems, identify opportunities, create efficiencies, and mine value from the information scattered throughout Intel®” (Safa, 2014). "We are using historical data to create smart algorithms and a decision support system that enhance the chips validation process" said Yogev (2014), Director of Advanced Analytics. With big data analytics incremental revenue estimates increased by USD 3 million as a result of the Intel sales organization’s efforts using the ranked list developed by our predictive analytics engine (Ronen et al. 2013).

In this paper, we make an attempt to examine a sustained competitive advantage that a firm can gain by virtue of big data. In order to evaluate sustained competitive advantage of big data management we draw upon insights from strategy papers (Porter, 1990; Porter 2008) as well as papers written on competitive advantage (Barney, 1991; Woodruff, 1997; Argote and Ingram, 2000) and resource-based view of the firms (Wernerfelt, 1984; Fahy, 2002).

3. Research Methods

We did an extensive review of existing literature published in leading journals and conference proceedings including Harvard Business Review, Journal of Management, MIS Quarterly, Stanford Social Innovation Review, Strategic Management Journal, Intel IT White Papers, and IEEE Proceedings on Big Data. We took insights from strategy papers (Porter, 1990; Porter 2008; Barney, 1991) to apply strategic implications of big data analytics. We reviewed papers on competitive advantage (Barney, 1991; Woodruff, 1997; Argote and Ingram, 2000) and resource-based view of the firms (Wernerfelt, 1984; Fahy, 2002). We went through a good number of industry papers to understand the latest development and initiatives of big data projects and benefit gained.

4. An Overview of Big Data

According to McKinsey Global Institute (Saran, 2011), the use of big data is becoming a key way for leading companies to outperform their peers. By virtue of big data tools and technologies retailers are “able to track the behavior of individual customers from Internet click streams, update their preferences, and model their likely behavior in real time (McGuire et al., 2012). Financial institutions are “rapidly deploying big data analytics to yield big results around understanding customer behavior, preventing fraud and delivering more targeted advertisement." (Martin, 2014).

Until recently, companies were only about to analyze structured data that were stored in conventional database systems. Now with the advent to social medial, weblogs, sensors data are coming from new sources which are mostly unstructured data and also a new kind of data. Big data analytics gives companies access to additional data and provides new insights that can significantly help in understanding customer needs and preferences.

4.1 Characteristics of Big Data

Big data has unique characteristics compared to handling structured data. Its volume, unstructured nature, velocity, and data consistency. This very nature of data requires a new set to tools and technologies as well as new skillset. Big data has several distinct properties (Figure 1) which are identified by five V's - volume, velocity, variety, veracity and value (TechAmerican Foundation, 2012). What is big data? Big data is so big and complex in terms of volume and other characteristics that it is beyond the capacity of conventional database systems and associated tools to capture, store, process and analyze. With the emergence of computer and the internet generated data the **volume** of data generation is much bigger (McAfee and Brynjolfsson, 2013). Given round the clock generation of data in this digital age, it has become important to have the capability to receive, process and store data in real-time (**velocity**).

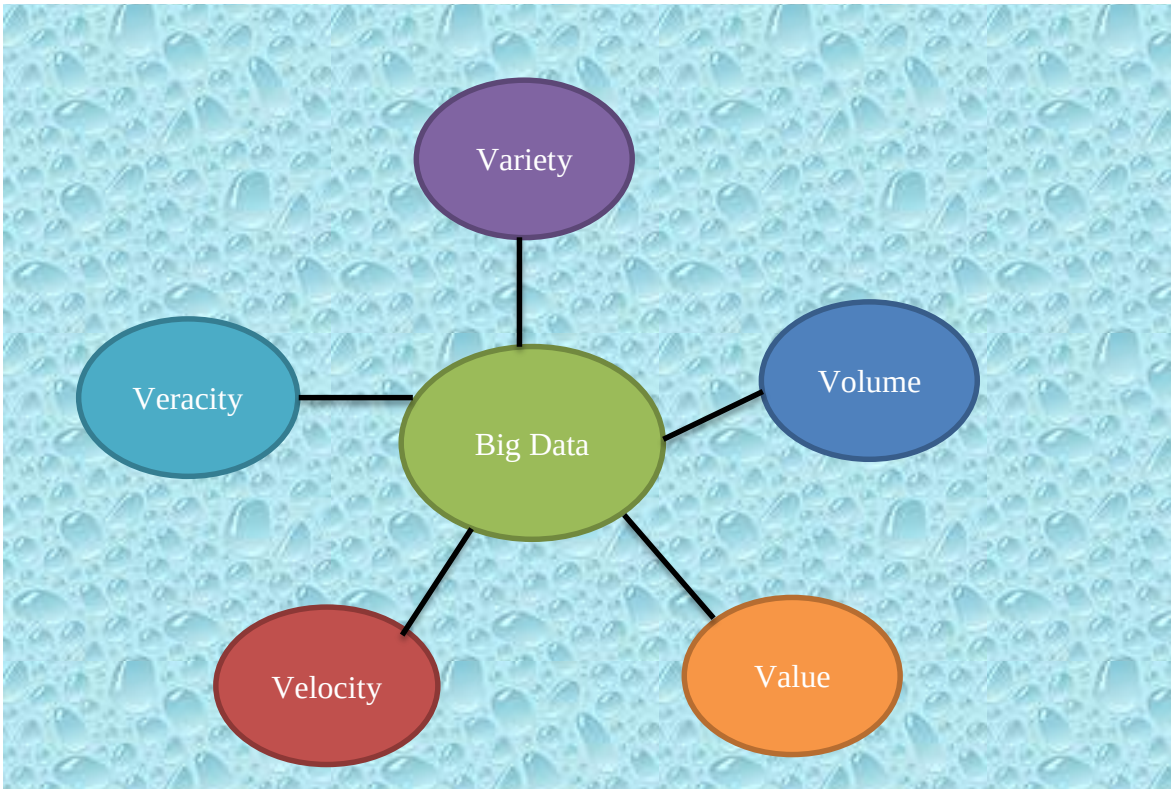

Figure 1: Characteristics of Big Data – The five V's.

Big data refers to data that comes from many sources and in different formats (**variety**). The data is unstructured (more than 90%), semi structured and structured. For example, in banking, customer records are structured data; email header information (sender, receiver, date, etc.) are semi structured data while email text messages and other bank documents are unstructured data. As big data is mostly unstructured, data consistency issues come into play (**veracity**). Big data technologies are used to extract value from unstructured data. But, extracting real value poses a question of accuracy and reliability (Dapp, 2014). To make data reliable and meaningful, big data technologies need to make sure traceability is ensured. In case of any question or doubt about the validity of data it must be addressed via some traceability mechanism and data processing is done by following some standard procedures. With regards to the characteristic, **value**, business organizations find new business opportunities in big data. One good example is using machine learning algorithms from which a bank can do a lot of predictive analytics to detect and prevent fraud. Big data systems provide capabilities for analyzing a greater breadth and depth of data (Ricknäs, 2012).

4.2 Emerging Technologies in Big Data

After studying big data white papers, industry papers, and articles from academic journals we came up with a handful of tools and technologies for handling big data. They include Storm, Flume, HBase, Hive, Pig, Mahout and Sqoop. These tools make up the big data ecosystem.

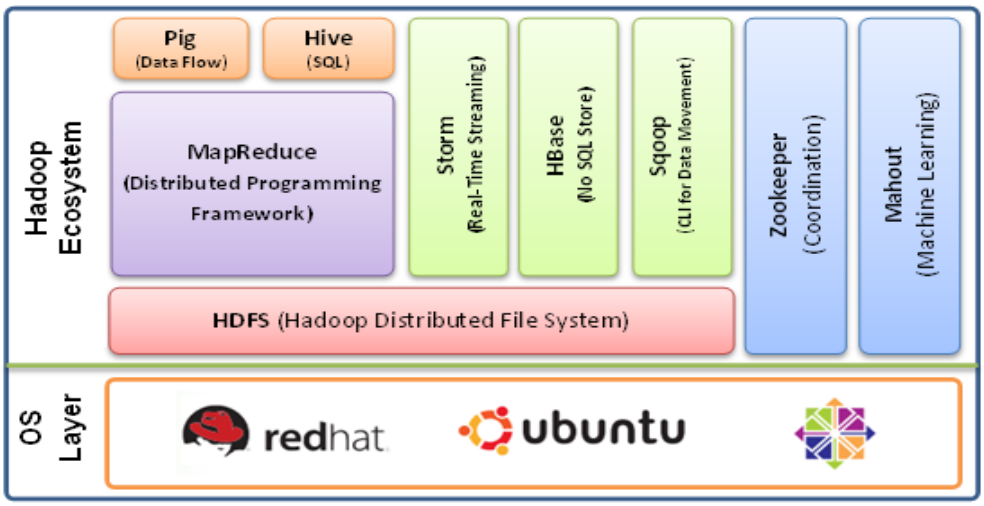

Figure 2: Big Data (Hadoop) Ecosystem.

Apache Hadoop Foundation has introduced an open source framework to deal with big data. Hadoop has two components. One is Hadoop Distributed File System (HDFS) and the other is MapReduce. The HDFS provides the capability to store information consisting of unstructured, semi-structured and structured data. The HDFS stores data in its raw format; the way it comes from the source system. MapReduce is used to manage data processing (Russom, 2013) on the Hadoop cluster. Besides HDFS and MapReduce, a completely new set of tools and technologies have emerged as part of the Hadoop ecosystem. Most of these tools are open source. They include HBase (database), Hive (SQL-like language), Pig (scripting language), Scoop (moving data between Hadoop and data warehouse), Mahout (data mining algorithms) and Zookeeper. To store semi-structured and structured data non-relational NoSQL database systems have emerged including open source database, HBase. These NoSQL databases typically sit on top of Hadoop HDFS framework.

4.3 Potential Benefits of Big Data

Survey (Porres, 2013) of 211 senior marketers about big data effectiveness suggest that big data boosts marketing effectiveness. A leading practitioner of big data-based marketing said that her company had "achieved 8-23% sales, lift via its proprietary data analytics system compared to initiatives that did not

use this resource" (Rubin, 2013). Big Data enables to create value if a business wants to compete. McGuire et al. (2012) findings suggest that "some retailers embracing big data see the potential to increase their operating margins by 60 per cent" (McGuire et al., 2012). McDonald's, for example, has equipped some stores with devices that gather operational data as they track customer interactions, traffic in stores, and ordering patterns (McGuire et al., 2012). This allows data scientists to model the impact of variations in menus, restaurant designs, and training, among other things, on productivity and sales" (McGuire et al., 2012).

Companies can predict the probability of customers' attrition based on factors such as usage activities, support requests, payment patterns, and the social impact of friends (Woodruff, 1997). Big data helps in product maintenance such as predicting equipment failures based upon product usage information, maintenance service records, and product performance history (Woodruff, 1997). By merging external data with a company's internal data, an organization can do more accurate Big Data analytics and hence, critical business insights can be revealed (Bernstein, 2013). Survey findings suggest that big data analytics provides an effective way to draw insights on consumer behavior and generate greater value from marketing campaigns (Rubin, 2013). Another leading practitioner of big data-based marketing said that "her company had achieved an 8-23% sales lift via its proprietary data analytics system compared to initiatives that did not use this resource" (Rubin, 2013).

5. The Resource-Based View of Big Data

The resource-based view assumes that firms are bundles of resources (Wernerfelt, 1984; Eisenhardt and Schoonhoven, 1996; Halawi et al. 2005). Here resources mean strengths or assets of the firm that may be tangible (e.g., financial assets, technology) or intangible (e.g., reputation, managerial skills)" (Eisenhardt and Schoonhoven, 1996; Jelinek and Bergey, 2013). According to strategic management theory, the resource-based view of the firm also has two underlying assertions (Mata et al., 1995): (1)

that the resources and capabilities possessed by competing firms may differ (resource heterogeneity); and (2) that these differences may be long lasting (resource immobility). Two key features of resource-based view of the firm are that resources must enable the creation of value and must not subject to duplicative efforts of competitors (Barney, 1991; Fahy, 2002).

Here resource heterogeneity and resource immobility are the sources of sustained competitive advantage. To attain sustain competitive advantage the resources of a firm cannot be possessed by other firms. In other words, if multiple firms possess the same resource it cannot help in attaining sustained competitive advantage. If a firm possess a resource but it could be acquired by other firms by developing or other means then that resource is mobile and hence cannot be a source of sustained competitive advantage. In this case the firm that developed the resource earlier than others can take of advantage of first-mover or temporary competitive advantage – not sustained competitive advantage. In big data space with would like to evaluate if there is any scope of achieving sustained competitive advantage.

There are certain attributes of big data which could be considered as possible sources of sustained competitive advantage of a firm (Pearce, 2014). They include Big Data Technology, Technical Big Data Skills, and Data Scientist Skills which are key elements of big data. To capture, process, transform, store and analyze big data several tools and technologies are used. To handle big data and associate tools strong programming background is required. To analyze big data and vertical and horizontal communication of big data analytics data scientist skills are needed.

5.1 Big Data Technology

Big data technology consists of several software and tools. They include HDFS (storage), MapReduce (transformation), Hbase (noSQL store), Hive (SQL), Pig (data flow), Storm (real-time streaming), Scoop

(data movement), Zookeeper (coordination between software and components), and Mahout (Machine Learning) to name a few. Fortunately, all these tools and technologies are open source mostly provided by Apache Hadoop Foundation. Having said that, does big data tools and technologies help a firm to attain sustained competitive advantage? The answer is obviously no.

Now a firm makes customizes and enhances these open source technology and software which might help a firm to be competitive. This enhancement and customization might give big data technology a proprietary flavor. For example, Amazon's recently announced patent on 'anticipatory shipping', "a process which uses information about customers to anticipate their needs and moves items they are likely to order to nearby depots, ready for rapid delivery" (Baker, 2014). Thus due to customization big data technology could be heterogeneously distributed across competing firms. But, does it make the firm to achieve sustained competitive advantage? Typically, the answer could be no. Mata et al. (1995) assert that IT applications are difficult to patent and even in most case they cannot be kept secret for a long time. They also assert that "workforce mobility, reverse engineering, and formal and informal technical communication all act to reduce the secrecy surrounding proprietary technology." Thus big data technology cannot be considered a source of sustained competitive advantage. However, big data technology with enhancement and customization can make it valuable. Hence, it could provide that firm competitive advantage temporarily or it could give the firm a first-mover advantage.

5.2 Technical Big Data Skills

A second possible source of sustained competitive advantage could be big data technical skills. Technical skills refer to the know-how needed to build big data applications using the available technology and to operate them to make products or provide services (Mata et al., 1995). These technical skills enable firms to effectively manage the technical risks associated with products and services (Mata et al., 1995). Research reports suggest that there are some barriers in implementing big data. One of the most

prominent barriers is inadequate skills set (Russom, 2013) and there are issue of governance, lack of understanding of how to leverage analytics for business value, lack of executive sponsorship (LaValle et al., 2011) and compelling business cases.

As we know 'normal data' stored in conventional database are structured. All database tools and technologies developed during the last four decades very mature by now in terms of performance, knowledge and learnings of those tools. On the other hand processing and analyzing big data is easy as well. But, big data is mostly unstructured (Rahman et al. 2014). This unstructured nature of big data is the "father of mother of all evil." It made all database technologies unsuitable. The developers and analysts of conventional database tools have found their long time skillset more or less obsolete. To work in big data space as a developer a new skill set is needed (Davenport and Patil, 2012). The developers of big data needs to have a strong programming background such as in Python, Java, JavaScript, Shell scripting, and data visualization tools. A strong focus is needed on training and hiring developers and data analysts, data scientists, and data architects to develop applications for data exploration, discovery analytics and real-time monitoring to get full value from big data (Russom, 2013).

Given most of the firms need their employees get trained on new tools, technologies, and programming languages, can attainment of these training and skills of big data make a firm achieve sustained competitive advantage? The answer is no. Many firms can have their current IT workforce get trained or even employ recent college graduates who are trained on latest tools, technologies and programming languages. Some firm can even hire technical consultants in big data space to get required applications built. Thus big data technical skills can be used as a source of sustain competitive advantage. However, for a short time "organizations can derive competitive advantage by transferring knowledge internally while preventing its external transfer to competitors" (Argote and Ingram, 2000).

5.3 Data Scientist Skills

While big data technical skills are needed for application development the data scientist skills are very important. Davenport and Patil (2012) in their seminal paper, "Data Scientist: The Sexiest Job of the 21st Century" in Harvard Business Review gave a detailed account of a Data Scientist's roles and responsibilities. They assert that to be successful in big data analytics organizations heavily need data scientist skills. The data scientist need to play role in building big data domain, requirements analysis, design, development of the applications for data exploration, and discovery analytics to get full value from big data. Data Scientist is responsible for deriving intelligence from data and translate that into business advantage. This is a complex and challenging job as data is unstructured.

In big data analytics, examples of important data scientist skills include: (1) the ability of data scientist to understand business needs and communicate with functional managers, suppliers, and customers; (2) the ability to work with these functional managers, suppliers, and customers to develop appropriate big data applications; (3) the ability to coordinate activities in ways that support other functional managers, suppliers, and customers.

Rajpurohit (2013) observes that business managers continue to struggle to capture the business value from big data initiatives. But he suggests that business managers need to deploy data scientists to understand and play a role in big data processes. They also need to understand that big data analytics is not an IT solution to data problem. It is a paradigm to manage data and transform it into valuable insights. Business managers and data scientists have responsibility to understand the big data processes and take ownership.

A data scientist job is not just analysis of data, he/she needs to perform a much broader role in terms of understanding data; drawing insights; making alliance with stakeholders, keeping the business running and partnering with the business. Data scientist has to embed with the business. The business comes up

with the rules and objectives associated with data and data scientist determines how to provide business with advanced analytics and the information they need. The data scientists need to have a more collaborative relationships with the business which is vital for the success of business. Data scientists need to work side by side with business units to learn their processes. This deep understanding is an advantage and helps to build relationships and trust.

To be a successful data scientist he/she needs understanding of business along with suppliers and customers. They need to build strategic alliance with suppliers and customers. They need to build a domain knowledge over longer periods of time through the accumulation of experience by trial and error learning and most cases learning by doing (Mata et al., 1995). They need to build friendship, trust and interpersonal communication both vertical and horizontal. This takes years to develop such relationships.

Given data scientist skill development takes a longer period of time; interpersonal communications and building trust building take a long period of time, this data scientist skill is quite complex. This skill will vary from business organization to business organization. Hence, Data scientist skills are valuable and heterogeneously distributed across firms. Thus this skill could be a source of sustained competitive advantage.

6. Concluding Remarks

In this paper, an overview of big data characteristics and big data ecosystem was provided. We highlighted a few successful big data initiatives that were implemented in diverse areas of business, engineering, research and government organizations. Highlighted, was how organizations are driving their growth by taking advantage of big data tools and technologies.

We did a detailed review of big data sustained competitive advantage possibility based on resource-based view of the firm. We have identified three key attributes of big data analytics such as big data technology, big data technical skills, and data scientist skills. We evaluated each of these attributes through resource-based view theory to identify potential source of sustained competitive advantage. Our findings suggest that Data Scientist Skill is the possible source of sustained competitive advantage.

To take advantage of big data business, data scientists, and IT managers need to collaborate and come up with some specific plan to generate business value to the organization. Big data is not just owned by IT department. It needs to be driven and owned by data scientists as well as business managers. That will allow business organizations to maintain increasing agility, add business value, improve business performance and provide strategic directions. The challenges of becoming a big data-enabled organization can be enormous and require hands-on or in some cases hands-off leadership.

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