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Big Data consumer analytics and the transformation of marketing

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ABSTRACT

Consumer analytics is at the epicenter of a Big Data revolution. Technology helps capture rich and plentiful data on consumer phenomena in real time. Thus, unprecedented volume, velocity, and variety of primary data, Big Data, are available from individual consumers. To better understand the impact of Big Data on various marketing activities, enabling firms to better exploit its benefits, a conceptual framework that builds on resource-based theory is proposed. Three resources—physical, human, and organizational capital—moderate the following: (1) the process of collecting and storing evidence of consumer activity as Big Data, (2) the process of extracting consumer insight from Big Data, and (3) the process of utilizing consumer insight to enhance dynamic/adaptive capabilities. Furthermore, unique resource requirements for firms to benefit from Big Data are discussed.

1. Introduction

> "It's not what you look at that matters, it's what you see"Henry David Thoreau

The study of consumer analytics lies at the junction of Big Data and consumer behavior. Data provide behavioral insights about consumers; marketers translate those insights into market advantage. *Analytics* generally refers to tools that help find hidden patterns in data. For the past few decades, businesses generate more data than they are able to use or know how to use (Fayyad, Piatetsky-Shapiro, & Smyth, 1996; Friedrich, Stoler, Moritz, & Nash, 1983).

What is different today is the unprecedented volume, velocity, and variety of *primary* data available from *individual* consumers, resulting in the so-called Big Data revolution; potentially, a revolution that will lead to entirely new ways of understanding consumer behavior and formulating marketing strategy. In this paper, *Big Data consumer analytics* is defined as the *extraction* of hidden insight about consumer behavior from Big Data and the *exploitation* of that insight through advantageous interpretation. Although Big Data is considered a new form of capital in today's marketplace (Mayer-Schönberger & Cukier, 2013; Satell, 2014), many firms fail to exploit its benefits (Mithas, Lee, Earley, & Murugesan, 2013). To profit from this new form of capital, firms must allocate appropriate physical, human, and organizational capital resources to Big Data.

As data become larger, more complex, and more inexplicable, the limited mental capacities of humans pose difficulties in deciphering and interpreting an unknown environment (Sammut & Sartawi, 2012). A major shift, turning the scientific method around, from fitting data to preconceived theories of the marketplace, to using data to frame theories has been occurring (Firestein, 2012). Technological and methodological advances enable researchers to identify patterns in Big Data without forming hypotheses (Lycett, 2013). Such scientific inquiry requires less reliance on existing knowledge and more focus on what is unknown (Sammut & Sartawi 2012). Focusing on the unknown reflects a realization that "knowledge alone is not adequate to run the world" (Vitek & Jackson, 2008, p. 7) and requires a transition from a knowledge-based view into an ignorance-based view (Sammut & Sartawi, 2012).

Failure to benefit from Big Data (Mithas et al., 2013) often derives from its unique resource requirements. To stimulate more discussion of Big Data among marketing scholars, a conceptual framework is introduced to illustrate the impact of Big Data on various marketing activities. Using this framework, the following two research questions are explored: (1) *When* and *how* does Big Data enable firms to better create value and gain a sustainable competitive advantage? (2) What are the specific resource requirements for firms to take advantage of Big Data to gain a sustainable competitive advantage?

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2. Defining consumer Big Data

Today, technology has turned the average consumer into an incessant generator of both traditional, structured, transactional data as well as more contemporary, unstructured, behavioral data. The *magnitude* of the data generated, the *relentless rapidity* at which data are constantly generated, and the *diverse richness* of the data are transforming marketing decision making. These three dimensions help define Big Data, commonly referred to as the three Vs: volume, velocity, and variety (IBM, 2012; Lycett, 2013; Oracle, 2012).

2.1. Volume

The volume of Big Data is currently measured in petabytes, exabytes, or zettabytes. One petabyte is equivalent to 20 million traditional filing cabinets of text; Walmart is estimated to create 2.5 petabytes of consumer data every hour (McAfee & Brynjolfsson, 2012). Today's measurement tags will be inadequate as data sets continue to surge in size. The size of the digital universe in 2013 was estimated at 4.4 zettabytes (1 zettabyte is equivalent to 250 billion DVDs (Cisco, 2014); by 2020, the digital universe is expected to reach 44 zettabytes (IDC, 2014). As a result of firms' efforts to rein in the challenge of ever-increasing Big Data volume, the global market for software, hardware, and services for storing and analyzing Big Data is estimated to double in size every 2 years (IDC, 2014). Contributing significantly to the explosive growth in volume is the Internet of Things (IOT), whereby computerization is incorporated into cars, toys, appliances, turbines, and dog collars. Thirty-two billion objects are expected to be connected online by 2020 (IDC, 2014). Although volume is a primary distinguishing characteristic of Big Data, some firms possess massive data sets that lack the other characteristics of Big Data (velocity and variety).

2.2. Velocity

The second key dimension of Big Data is velocity (Lycett, 2013) or the relentless rapidity of data creation. Marketing executives with access to rich, insightful, current data are able to make better decisions based on evidence at a given time, rather than on intuition or laboratory-based consumer research. To better appreciate the difference between large data sets and Big Data, consider the difference between U.S. census data and consumer data collected by a leading women's clothing retailer—whose marketing executive knows at any given time how many consumer transactions are occurring; which product, styles, and colors of merchandise are moving off store shelves as well as the retailer's website; and what consumers are posting on social networks about the retailer. Both types of data are rich, large, and provide insights. Only the latter, however, gives the marketing executive the ability to make current and evidence-based decisions that competitors without Big Data insight will be hard-pressed to match.

2.3. Variety

Many sources of Big Data provide a diverse richness that far surpasses traditional data from the past. A major difference between contemporary Big Data and traditional data is the shift from structured transactional data to unstructured behavioral data (Integreon Insight, 2012). Structured data (scanner or sensor data, records, files, and databases) have been collected by marketers for some time. Unstructured data include textual data (e.g., from blogs and text messages) and non-textual data (e.g., from videos, images, and audio recordings). Much unstructured data are captured through social media, where individuals share personal and behavioral information with friends and family. Semi-structured data incorporate various types of software that can bring order to the unstructured data. For instance, Standard Generalized Mark-up Language (SGML) software enables the viewing of videos to determine common elements that an organization wants to capture (e.g., of the videos posted on YouTube showing people using its product, how many of them seem to be happy?).

2.4. Two additional key Vs associated with Big Data

Although the three Vs are used to define and differentiate consumer Big Data from large-scale data sets, two more Vs are important in collecting, analyzing, and extracting insights from Big Data: veracity and value (Ebner, Bühnen, & Urbach, 2014; Lycett, 2013). Veracity underscores the need to be aware of data quality (IBM, 2012). Not all Big Data about consumers is accurate. Thus, the veracity of Big Data is a major issue at a time where the volume, velocity, and variety of data are constantly increasing (IBM, 2012; Oracle, 2012).

The ever-increasing amounts of Big Data lead to the question of value. The task is to eliminate unimportant and irrelevant data, so that the remaining data are useful. Further, the remaining pertinent data need to be valuable for obtaining insight and domain-specific interpretation (Lycett, 2013). The challenge is to identify what is relevant and then rapidly extract that data for timely analysis (Oracle, 2012).

3. Theoretical framework

3.1. Resource-based theory (RBT)

3.1.1. Types of resources

RBT, utilized by numerous marketing scholars in recent years (e.g., Barney, 2014; Day, 2014; Kozlenkova, Samaha, & Palmatier, 2014; Wu, 2010), offers a valuable explanation of Big Data's impact on marketing. RBT suggests that a firm's resources, both tangible and intangible, facilitate its performance and competitive advantage when the resource is valuable, rare, imperfectly imitable, and exploitable by the organization (Barney, 1991; Lee & Grewal, 2004). A resource is *valuable* when a firm's bottom line is improved or when the resource generates something of value to customers that competitors cannot achieve. A *rare* resource is one that is not abundant, whereas an *imperfectly imitable* resource indicates that the resource cannot easily be copied. An *exploitable* resource enables a firm to take advantage of the resource in a way that others cannot.

Resources include physical capital resources, human capital resources, and organizational capital resources (Barney, 1991). In the context of Big Data, physical capital resources include software or a platform that a firm uses to collect, store, or analyze Big Data. Traditional software is simply not capable of analyzing Big Data (Bharadwaj, El Sawy, Pavlou, & Venkatraman, 2013). Thus, firms need to establish a platform that is capable of storing and analyzing large amounts (volume) of data continuously flowing in real time (velocity) from many different sources (variety) (Davenport, Barth, & Bean, 2012). Second, human capital resources include the insight of data scientists and strategists who know how to capture information from consumer activities, as well as manage and extract insights from Big Data. Third, organizational capital resources include an organizational structure that enables the firm to transform insights into action. Firms may need to alter organization and business processes to act on the insights from Big Data (Viaene, 2013). As illustrated in Fig. 1, physical capital, human capital, and organizational capital resources moderate the process of transforming consumer activities into a sustainable competitive advantage at different stages.

3.1.2. Dynamic capability vs. adaptive capability

In today's hyper-competitive business environment, firms must constantly update and reconfigure resources by responding to changes in the external environment to develop a sustainable competitive advantage (e.g., Day, 2011; Kozlenkova et al., 2014; Lin & Wu, 2014; Wu, 2010). A firm's ability to respond to change (dynamic capability)

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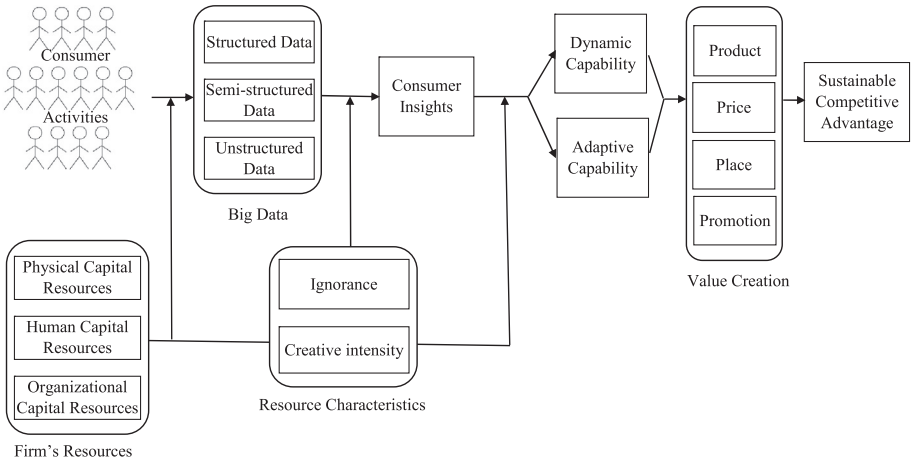

Fig. 1. A resource-based view of the impact of Big Data on competitive advantage.

incorporates skills and knowledge embedded within the organization to alter existing resources and create new value (e.g., Day, 2014; Kozlenkova et al., 2014; Teece, 2007). A firm using novel consumer insight extracted from Big Data to understand unmet consumer needs enhances dynamic capability.

Southwest Airlines records conversations between service personnel and consumers to extract insights using a speech-analytics tool (BigData Startups, 2013). Insights are used to develop measures of key performance that are sent constantly to service personnel to improve performance (Infotech, 2013). Southwest Airlines has equipped itself with speech-analytics software (i.e., physical capital resources) useful in extracting consumer insights and re-engineered its organization (i.e., organizational capital resources) by enhancing information flows and further training its service personnel (i.e., human capital resources). To regain excellence in service, Southwest is utilizing insight from Big Data to facilitate its dynamic capability by meeting hitherto unrecognized consumer needs.

Firms should be proactive in responding to changes in the external environment by capturing even weak signals from consumers to predict market and consumer trends (adaptive capability), thereby foreseeing the future (Day, 2011, 2014). Adaptive capability derives not from a specific change in organizational structure but from the overall ability to capture consumer activities and extract hidden insights (Ma, Yao, & Xi, 2009). When successfully exploited, Big Data provides firms with opportunities to enhance adaptive capability (Banker, 2014; Ritson, 2014).

Target utilizes consumer insights from Big Data to proactively predict consumer behavior. Target is able to estimate whether a female shopper is pregnant and her due date weeks before competitors or even the woman's family knows of her pregnancy (Duhigg, 2012; Hill, 2012). Target is utilizing exclusive predictive data to substantially enhance its adaptive capability to influence the customer's purchases for baby items capturing sales before competitors and initiating a long-term customer relationship.

As illustrated in Fig. 1, both dynamic capability and adaptive capability achieved through consumer insights obtained from Big Data facilitate value creation in various marketing activities (Ambrosini & Bowman, 2009; Day, 2011). Specifically, value is created as a result of improved decision making enabled by Big Data (Bharadwaj et al., 2013). The value creation may result in a sustainable (Ambrosini & Bowman, 2009) or temporary competitive (D'Aveni, Dagnino, & Smith, 2010) advantage. One of the limitations of RBT relates to the origin of these resources and capabilities (Barney, 2014). To address this issue, the concept of ignorance is introduced as a unique resource requirement for firms to achieve sustainable competitive advantage using Big Data.

3.2. Ignorance and inductive reasoning

One goal of science is the pursuit of knowledge (Smithson, 1985). In pursuing knowledge, researchers and marketers generally focus on what they know; however, "understanding what we do *not* know, referred to as ignorance, is as important as understanding what we do know" (Proctor & Schiebinger, 2008; Sammut & Sartawi, 2012). In other words, the pursuit of knowledge sometimes requires that researchers recognize ignorance (Smithson, 1985; Ungar, 2008). For instance, supercomputers and knowledge in mathematics enabled scientists to model complex phenomena such as climate systems (Ungar, 2008). Simultaneously, however, the technology and the knowledge obtained enabled meteorologists to understand the complexity of the processes associated with the phenomena, thereby realizing the unknowns and uncertainties involved with predicting the weather (Ungar, 2008).

In turn, ignorance enables knowledge, because realizing what one does not know is critical for the discovery of new knowledge (Smithson, 1985). By surveying its editorial team, *Science* magazine identified 125 questions that reflect ignorance in science (Kennedy & Norman, 2005). Although not exhaustive, identifying 125 important, unanswered questions illustrates that ignorance is critical in the process of scientific inquiry.

Continuous scientific inquiry has contributed to the creation of today's knowledge economy. According to those embracing a knowledge-based view, sufficient knowledge exists in a knowledge economy to implement various activities (Ungar, 2008; Vitek & Jackson, 2008). However, according to the ignorance-based view, "What we don't know (i.e., ignorance) is actually much more than what we do know (i.e., knowledge)" (Firestein, 2012; Vitek & Jackson, 2008). Thus, scientists and marketers must rely not only on knowledge but also on ignorance for various activities involving scientific inquiry (Vitek & Jackson, 2008). Ignorance facilitates latitude and freedom that are critical for stimulating creativity within an organization, whereas demanding perfect knowledge may hinder creative activities (Smithson, 1985, 2008). Thus, as the source of competitive advantage moves from the knowledge itself to the speed of generating creative ideas (Erevelles, Horton, & Fukawa, 2007), ignorance is likely to become a crucial cultural orientation for facilitating creativity within an organization.

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Furthermore, ignorance enables researchers to develop an open-mindedness that facilitates new scientific discovery (Sammut & Sartawi, 2012; Smithson, 1985). Open-mindedness helps researchers frame better questions that are critical for the discovery of knowledge (Firestein, 2012). Inductive reasoning, one method of scientific inquiry, assumes that research starts with observing a phenomenon before forming hypotheses derived from existing theory (e.g., Anderson, 1983). The analytical capability associated with Big Data should benefit inductive reasoning as such analysis enables researchers to observe phenomena and mathematically identify patterns hidden in Big Data using algorithms without relying on existing knowledge (Anderson, 2008; Lycett, 2013). In such a context, an ignorance-based view, rather than a knowledge-based view, enables researchers to observe phenomena using inductive reasoning without being biased by existing knowledge – to facilitate the discovery of hidden insights in Big Data.

4. Development of propositions

4.1. Expanding what marketers don't know

With the proliferation of new technologies, channels, and consumption approaches, the understanding of contemporary consumer behavior is becoming more complex. Simultaneously, advances in technology allow marketers to capture rich consumption data with greater volume, velocity, and variety. Often, these rich and newly available sources of information (Big Data) enable marketers to realize new gaps or areas of ignorance in marketers' understanding of consumer behavior (Firestein, 2012). As the richness of data increases, marketers are better able to recognize new gaps and advance their understanding of consumer behavior.

Marketers today, for example, have access to geospatial data to map the geographical mobility of consumer activity (Rijmenam, 2014), in addition to other forms of structured/unstructured data associated with each geospatial location. Marketers question whether past geospatial information is able to predict where a consumer will be at any given time and day in the future. Sadilek and Krumm's analyses suggest that this prediction indeed is possible with a high degree of accuracy even years into the future (Sadilek & Krumm, 2012). Building on their findings, what other types of consumer information (e.g., physiological data from wearable multiple sensors) are possible to combine with geospatial data to generate useful consumer insight? Will marketers be able to generate previously unknown insight on future consumer behavior by combining predictions on geospatial consumer location with past purchase histories at online and physical stores? Large volumes of real-time data (e.g., geospatial information), combined with a variety of information (e.g., physiological data, past purchase histories) to generate previously unknown insight, provide rich consumer data that lead marketers and researchers to realize new gaps in understanding consumers. Overall, Big Data can raise more questions than answers (Weber & Henderson, 2014).

Deductive reasoning techniques—researchers form hypotheses and conduct studies (e.g., experiment) to test hypotheses and find answers—have limitations in analyzing Big Data. Although most research involves some aspects of both inductive and deductive techniques, deductive techniques have been widely used as a method of scientific inquiry (King et al., 2004; Lawson, 2005). Dominance of deductive techniques, in turn, has resulted in considerable linear (incremental/continuous) growth in understanding marketing phenomena about which much is already known, at the expense of non-linear (game-changing/discontinuous) advances in understanding marketing phenomena about which little or nothing is known. Both deductive and inductive techniques, as well as linear and non-linear advances, are important for the growth of marketing theory and practice. Non-linear advances involving marketing phenomena about which little or nothing is known, however, are more likely to be achieved with the use of inductive as opposed to deductive techniques, and with Big Data as opposed to traditional data. These observations lead to the following propositions:

Proposition 1a. *As the richness (volume, velocity and variety) of data increases, both linear and non-linear advances in understanding marketing phenomena will increase.*

Proposition 1b. *Non-linear advances in understanding marketing phenomena will occur more often with inductive techniques using Big Data than with deductive techniques using traditional data.*

4.2. Partial ignorance and adaptive capability

"When one doesn't know that one doesn't know, one thinks one knows" (Laing, 1999; Smithson, 1985). Such a false sense of knowledge inhibits chances to uncover hidden consumer insight. Similarly, complete ignorance poses a problem: "It is difficult for one to know what one doesn't know." In contrast, partial ignorance, associated with incompleteness from omission, vagueness, or ambiguity of information, is a source of motivation and curiosity and leads to the generation of insightful questions (Smithson, 1985). Thus, partial ignorance motivates researchers/marketers to seek new information and hidden insights to further understand marketing phenomena. Deductive reasoning hinders searching for new information with its emphasis on existing knowledge and theory. In contrast, inductive reasoning encourages observation without forming hypotheses derived from existing theory (Anderson, 1983). Thus, partial ignorance should better motivate the desire for new information when Big Data is analyzed through inductive reasoning than deductive reasoning.

Partial ignorance enables a firm to utilize insights from Big Data to facilitate the firm's adaptive capability. Firms sometimes rely too much on existing knowledge/past experiences hindering changes to organizational structure needed to adapt to rapid market changes (Teece, Pisano, & Shuen, 1997; Zhou & Li, 2010). In contrast, partial ignorance reduces reliance on existing knowledge, encourages openness to new ideas, and enables a firm to use hidden consumer insights to alter existing organizational structure and improve adaptive capability.

Uncovering hidden consumer insights enable marketers to predict consumer behavior better. Improved foresight drives adaptive capability enabling the firm to preemptively make changes or proactively respond to changes in market environments (Day, 2011). For instance, Netflix used Big Data to create hit movies and TV shows (e.g., *House of Cards*) by analyzing and predicting preferences of its 33 million viewers instead of relying on a creative director's instinct (Carr, 2013). Records of its subscribers' streaming activities enabled Netflix to predict that remaking the original series *House of Cards*, with actor Kevin Spacey and director David Fincher, would be a success. These foresights enabled Netflix to create a hit series by going beyond meeting existing consumer needs (Lycett, 2013). Such vigilant organizations, capable of foreseeing the future, know "how to ask the right questions to identify what they don't know" (Day, 2011). In this sense, an organization's enhanced foresight starts from realizing its ignorance. Better foresight on markets drives a firm's adaptive capability (Day, 2011). Thus,

Proposition 2a. *Firms that embrace inductive techniques in analyzing Big Data will be able to identify information needs arising from partial ignorance with greater success than firms that embrace deductive techniques.*

Proposition 2b. *Firms with greater awareness of information needs arising from partial ignorance will uncover more hidden consumer insights from Big Data that facilitate adaptive capabilities than firms with little awareness of information needs.*

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4.3. Incremental vs. radical innovation through Big Data

Both adaptive and dynamic capabilities stimulate innovation and enable a firm to create value (Liao, Kickul, & Ma, 2009; Tellis, Prabhu, & Chandy, 2009; Wei & Lau, 2010). With Big Data, firms create value through incremental innovation and radical innovation (Sorescu, Chandy, & Prabhu, 2003; Story, O'Malley, & Hart, 2011; Tellis et al., 2009). By combining a user's location information and search history, Google determines whether an ad displayed on a user's smartphone during a Google search actually resulted in a store visit (Baker, 2013). The insight enables advertisers to better measure and improve the effectiveness of digital advertising. Overall, better understanding customers through Big Data improves the effectiveness of existing marketing activities and potentially leads to incremental innovation (Story et al., 2011).

Merely improving the effectiveness of marketing activities through incremental innovation, although necessary, is not sufficient to achieve a sustainable competitive advantage (Porter, 2008). A firm must utilize customer insights obtained from Big Data to continuously redefine its marketing activities to implement radical innovation (Story et al., 2011; Tellis et al., 2009). Amazon recently filed a patent for anticipatory shipping, in which the company uses Big Data, including order history, product search history, and shopping cart activities, to predict when a customer will make a purchase and begins shipping the product to the nearest hub before the customer submits the order online (Banker, 2014; Ritson, 2014). Amazon utilizes such consumer insights from Big Data to recreate distribution strategy rather than to merely improve those activities. Such radical innovation enables firms to create greater value through Big Data than does incremental innovation (Kunc & Morecroft, 2010). Thus,

Proposition 3. *A firm creates greater value with Big Data through radical innovation than with incremental innovation.*

4.4. Ignorance in a firm's resources

Ignorance is limitless, while knowledge is limited (Firestein, 2012). Thus, when a firm embraces ignorance and constantly seeks to transform ignorance into knowledge, the speed of knowledge creation is exponentially facilitated. Such capability of a firm is difficult for competitors to imitate (Erevelles et al., 2007; Miller & Shamsie, 1996; Richard, 2000). Furthermore, with these resources, a firm can improve performance better than without these resources; thus, the resources are considered valuable (Kozlenkova et al., 2014).

Realization of ignorance requires acceptance of uncertainty and incompleteness (Firestein, 2012); otherwise, ignorance is not exploitable within the organization (Barney & Hesterly, 2012; Kozlenkova et al., 2014). Yet, within some organizations, people believe knowledge is a source of power (knowledge-based view) and admitting his/her own ignorance to others leads to the loss of power; some find it difficult to admit ignorance (Smithson, 1985). Furthermore, ignorance challenges the completeness of an existing system (Firestein, 2012). Thus, firms must overcome these challenges to cultivate an ignorance-based view in both human and organizational capital resources, making these resources rare, as a relatively small number of firms are able to overcome these challenges (Barney & Hesterly, 2012; Kozlenkova et al., 2014). Overall, firms are able to better create valuable, rare, and imperfectly imitable resources with an ignorance-based view, rather than a knowledge-based view, to gain sustainable competitive advantage from Big Data (Kozlenkova et al., 2014). Thus,

Proposition 4. *Firms that embrace an ignorance-based view (embedded in human and organizational capital resources) will be able to create the valuable, rare, and imperfectly imitable resource from Big Data to facilitate sustainable competitive advantage with greater success than firms with a knowledge-based view.*

4.5. Creativity in a firm's resources

Creativity is essential for a firm to leverage Big Data; firms must devise new ways of analyzing Big Data, creating actionable insights and implementing new marketing activities. Without such innovative, creative thinking, firms would incur difficulty in utilizing Big Data to facilitate adaptive capabilities and broaden the scope of marketing activities that may facilitate radical innovation; however, in a hypercompetitive business environment, any new marketing activities eventually will be imitated (e.g., D'Aveni et al., 2010). Thus, a firm must accelerate the speed of transforming Big Data into hidden insights that may lead to radical innovations. Such creative intensity is essential to harness the benefits of Big Data and gain sustainable competitive advantage (Erevelles et al., 2007). Creative intensity lies in the skills of an organization's members who generate innovative ideas (human capital resources), plus in organizational culture that enables the firm to utilize innovative ideas (organizational capital resources). Creative intensity helps firms build knowledge-based resources that are relatively difficult for competitors to imitate (Erevelles et al., 2007; Miller & Shamsie, 1996; Richard, 2000). Thus,

Proposition 5. *Firms with greater creative intensity in human and organizational capital resources will extract more hidden insights from Big Data than firms with little creative intensity.*

5. Value creation through Big Data

Adaptive and dynamic capabilities, enhanced by insight from Big Data, lead to value creation (Liao et al., 2009; Tellis et al., 2009; Wei & Lau, 2010). Examples have been provided for value creation through place (e.g., Amazon's anticipatory shipping) and promotion (e.g., use of geospatial data to send specific advertising messages) in previous discussions; however, price and product benefit from Big Data as well.

5.1. Pricing

Dynamic pricing enables an organization to implement a flexible pricing strategy based on changing consumer demand. Major league baseball has frequently adopted dynamic pricing based on Big Data to improve revenue management (Steinbach, 2012). To set prices frequently during a season—sometimes multiple times in a day, many variables and sources of information have been integrated. In addition to the rate and timing of ticket sales, a variety of other inputs are now being used, including weather, construction around the ball park, teams on the rise, the potential for a record-setting event (hit, homeruns, or play), amount of chatter about a game in social media (Newman, 2014), and what tickets are selling for on StubHub, the largest fan-to-fan ticket marketplace (Laker, 2014). In the past, the secondary market, scalpers/StubHub/TicketMaster profited from the difference in demand for a given game. Now, through the use of Big Data, the organization that puts the product on the field can manage its pricing to capture the willingness of fans to pay more for a special game.

5.2. Product

To overcome challenges from relatively new competitors (e.g., Hyundai, Skoda, and Tata), Ford Motors is using consumer analytics to start its own revolution in product innovation and design. Ford captures primary consumer data from around four million of its vehicles on the road through sensors and remote app-management software (King, 2012). After analyzing the data collected from the car's voice-recognition system, Ford realized that the immediate surrounding noise interfered with the software's ability to understand driver commands, leading to the introduction of automatic noise-reduction technology and the repositioning of microphones to better capture the

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driver's voice (King, 2012). Ford facilitates product innovation in a rapid manner using Big Data without waiting for insights from traditional marketing research such as focus groups and surveys (Satell, 2014).

6. General discussion

6.1. Theoretical implications

Despite the potential benefits, some firms fail to optimize Big Data (Mithas et al., 2013). To better enable companies to leverage Big Data, this paper introduces a theoretical framework that explores *when* and *how* Big Data leads to a firm's sustainable competitive advantage. First, the physical, human, and organizational capital resources moderate the following three processes: (1) the process of collecting and storing records of consumer activities as Big Data, (2) the process of extracting insights from Big Data, and (3) the process of utilizing insights to enhance dynamic/adaptive capability. For instance, although a firm successfully extracts hidden consumer insights from Big Data, the firm may still fail to effectively utilize the hidden consumer insights to facilitate its adaptive capability. Disappointing results occur when a firm fails to streamline its organization around Big Data and to educate its members concerning proactive use of insights to improve a firm's capabilities.

Second, identifying hidden consumer insights are especially useful for facilitating adaptive capability. In other words, predicting the future often requires firms to discover hidden consumer insights from customers (e.g., Amazon's anticipatory shipping, Target's detecting a customer's pregnancy). Furthermore, an ignorance-based view (vs. a knowledge-based view) coupled with inductive reasoning techniques triggers valuable questions that are not necessarily derived from existing knowledge and may lead to the discovery of hidden consumer insights.

Third, an ignorance-based view coupled with creative intensity is essential for firms to benefit from Big Data and resides in human and organizational capital resources. Discussing specific resource requirements unique to Big Data is critical for the advancement of RBT, as RBT does not identify specific resource requirements for managers who are trying to gain a competitive advantage (Kunc & Morecroft, 2010; Teece et al., 1997). An ignorance-based view is a unique human resource that enables firms to benefit from Big Data and contribute to the creation of valuable, rare, and imperfectly imitable resources.

Lastly, the contribution of this paper is categorized as delineation (MacInnis, 2011). An entity—Big Data—is described and its impacts on other entities are discussed. More specifically, consumer Big Data is defined, and its three major distinguishing factors: volume, velocity, variety are discussed. Additionally, a roadmap, in terms of the potential impacts and moderating and mediating factors of Big Data on marketing activities and sustainable competitive advantage, is provided.

6.2. Managerial implications

Big Data is the new capital in today's hyper-competitive marketplace (Mayer-Schönberger & Cukier, 2013; Satell, 2014); however, as illustrated in the proposed framework, the process of converting Big Data into a sustainable competitive advantage is complex. Firms that have failed to benefit from Big Data are encouraged to use the proposed framework to identify issues associated with Big Data. First, a firm should identify a specific process associated with the issue. Does the firm fail to extract consumer insights from Big Data? Or does the firm fail to utilize hidden insights to enhance its adaptive capability? Second, a firm must assess which of the capital resource(s) (e.g., physical, human, organizational) seem(s) to be inhibiting success with Big Data consumer analytics.

Furthermore, managers are encouraged to assess organizational culture to determine whether members share an ignorance-based view rather than a knowledge-based view (Sammut & Sartawi, 2012). An ignorance-based view within an organization is a source of motivation and interest (Smithson, 1985), enabling a firm to discover hidden consumer insights and enhance its adaptive capability. In contrast, too much reliance on existing knowledge sometimes hinders a firm's adaptive capability (Teece et al., 1997; Zhou & Li, 2010). Thus, an ignorance-based view within the organization is essential for firms to take advantage of Big Data.

Despite the significant potential of Big Data in transforming marketing activities, more than half of Big Data projects are unable to achieve their goals (Mithas et al., 2013), highlighting major challenges for marketers. First, a chronic shortage of consumer data scientists exists, as marketing departments in business schools have been slow to design curricula to generate such talent. Further, conventional database-management tools are inadequate to handle the huge sets and subsets of data generated (MongoDB, 2014). Moreover, the extent to which firms are taking decisive action to implement the marketing interpretations of Big Data insight is unclear. To fully leverage the value of consumer analytics, bold strategic decisions based on the insight from Big Data are needed.

7. Limitations and future research

7.1. Performing Big Data activities within or outside an organization

Although most firms conduct activities associated with Big Data within the organization, some firms outsource Big Data consumer analytics. For example, Epagogix helps movie studios with estimates of sales for a new movie. The company analyzes scripts with its own unique algorithm and advises movie studios concerning changes to the scripts to improve the movie's sales (Smith, 2013). Researchers are encouraged to investigate whether Big Data activities should be conducted outside of an organization using market mechanisms or within an organization. Whereas transactional cost analysis assumes that the same activity can be performed either within an organization or outside of an organization using the market mechanism, RBT assumes the existence of team-specific assets that are handled with higher productivity within an organization than outside of an organization (Conner, 1991). As Wernerfelt (2014) claims, should a firm focus on “what it can do better than others”? Answering this question not only enables scholars to better apply RBT in the context of Big Data but also helps managers in deciding which Big Data activities to perform within or outside of an organization.

7.2. Operationalizing ignorance

Consistent with other researchers (e.g., Whetten, 1989), the proposed propositions include concepts rather than measures. Researchers are encouraged to operationalize these concepts and develop hypotheses for empirical testing. Although some marketing scholars point out the importance of realizing “what we don't know” (Day, 2011), limited academic research investigates the role of ignorance in the context of Big Data and marketing. Thus, researchers are encouraged to develop appropriate measures of ignorance in utilizing insights from Big Data.

7.3. Reconsidering research methods on Big Data

Cutting edge technology and algorithms enable researchers to identify patterns mathematically without formal hypotheses (Anderson, 2008; Lycett, 2013). Taking advantage of these advancements, marketing researchers are encouraged to reevaluate the research methods associated with Big Data. The concept of ignorance, in conjunction with cutting edge technology and innovative algorithms, can be utilized to analyze Big Data with inductive reasoning. In utilizing inductive reasoning, researchers must show that the conclusion derived can be

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supported through a finite number of additional observations (Anderson, 1983). Investigations are needed to determine whether Big Data is useful for carrying out a finite number of observations to confirm a conclusion. Overall, researchers are encouraged to investigate how the ignorance-based view and the Big Data revolution play a role in possible reconsideration of the research methods in marketing.

7.4. Utilization of Big Data to enhance creative intensity

Big Data is a new source of idea generation for product development, customer service, shelf location, distribution, dynamic pricing, and so on. As Erevelles et al. (2007) argue, in a hyper-competitive marketplace where great ideas are easily copied, a firm must enhance its speed of idea generation (i.e., creative intensity) to achieve a sustainable competitive advantage; Big Data may enable firms to accomplish such a desirable goal. Researchers are encouraged to study the role of Big Data in generating ideas and enhancing creativity within a firm to improve its performance.

7.5. Utilization of physiological data for deeper understanding of consumers

Advancements in technology such as wearable multi-sensors enable firms to collect a greater variety of Big Data (Hardy, 2012; Peter, Ebert, & Beikirch, 2005). Some firms have started to collect, store, and analyze real-time physiological data such as heart rate, brain activity, and body temperature, using wearable sensors (Hardy, 2012). Such real-time physiological data, combined with behavioral measures such as store visits derived from geospatial information, offer the opportunity for considerable insight. Researchers believe that physiological measures are beneficial for analyzing behavior and obtaining deeper understanding of behavior through Big Data insights (Elcoro, 2008). Thus, researchers are encouraged to consider beneficial uses of physiological data in understanding consumer behavior.

7.6. Access to consumer Big Data

Marketers are starting to recognize the potential power of Big Data as a new capital and that access to Big Data offers a firm new ways to differentiate its products. To have access to consumer Big Data, a firm must attract a large number of users to its product or service. To achieve this goal, some firms utilize an open-source strategy instead of a closed-source strategy. Researchers are encouraged to investigate alternative strategies for firms to gain better access to consumer Big Data.

Clearly, Big Data has the potential to impact nearly every area of marketing. Firms that do not develop the resources and capabilities to effectively use Big Data will be challenged to develop sustainable competitive advantage and to survive the Big Data revolution. Thus, Big Data consumer analytics appears to be a fruitful area of research far into the future.

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