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Big Data: Innovation and Competitive Advantage in an Information Media Analytics Company

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Abstract. The advent of technology has allowed for the capture of large volumes of data from a variety of sources. This has led to an ever-increasing number of firms collecting large amounts of data with the belief that this will give the firm an advantage over its competitors. However, the question is, does big data by itself really lead to firm advantage? And if not, how can firms gain an advantage from big data? This paper investigates the role that big data plays in innovation and firm advantage. Using the Resource-Based View and Dynamic Capabilities framework, this paper looks at how a firm can gain an advantage from big data. Through the analysis of a case-study concerning a global information/media analytics company, this paper provides an example of how to build a capability in Digital Data Generation that can lead to improved product or service innovation, and possibly help a firm gain an advantage over its competitors.

Keywords. Competitiveness, Information System, Innovation Strategy, Open Innovation.

1 Introduction

With greater availbility of broadband and advances in IT technologies, the volume of data being captured and stored has increased substantially. Every minute, approximately 50,000 apps are downloaded from the Apple store, Amazon makes $80,000 (USD) in sales revenue, and 300,000 tweets are sent (DOMO, 2015). Even though the numbers in these examples are quite large, there is an even greater amount of data being generated behind the scenes of these transactions – the click stream. For example, when someone goes to the Amazon site, data is captured concerning searches, pages accessed, how much time was spent on each page, what products were clicked on, what products were placed in the shopping cart, what was removed from the shopping cart, IP address of shopper, how they reacted to product promotions, etc.

In addition to the massive volume of data being captured and stored, the speed at which transactions are occurring has also increased. The faster that web pages can be served to the website visitor, and the faster that IT technology can process transactions, the more data will be generated. For example, the speed at which Amazon can process a transaction happens very quickly (Amazon, n.d.). An order is placed, the inventory management system is checked and updated, the customer's payment is verified, the customer is issued

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a receipt for their transaction, and the order is then scheduled for packaging and shipping (tracking), all within a very short span of time. The speed at which transactions are taking place is dependent upon bandwidth and the speed of the internal IT technologies that support the transaction process. As speed increases, so will the amount of data that is generated.

Data are also available from a rapidly growing variety of sources. In addition to collecting data from its own website, Apple can collect data concerning its customers, as well as its products, from many sources, such as social media sites, product review sites, news media, and actual data obtained from the usage of the products. Therefore, there are many varieties of data that can be collected, such as images, text, GPS, RFID, metadata, event logs, etc.

Big data (Laney, 2001) refers to the large amount of data that is continuously being collected, stored, and managed, along with the evolving IT technologies that make this possible, together with analytic techniques used for gaining an understanding of the data. Since the data comes in a variety of formats (structured and non-structured), it does not fit neatly into most relational-type databases. And since the data is in some cases streaming (real-time), different IT architectures may be required. Therefore, the size of the data sets, the heterogeneity of the data, and the velocity of the data make analysis more complex. However, it is the joining together of the data from a variety of sources that gives organizations a better, and more complete understanding of their customers, products/services, competitors, etc.

Firms that want to innovate and achieve a competitive advantage using big data need to understand that just collecting data and setting strategy based on that data will probably not lead to the advantage they hoped to obtain. In most cases, it will lead to data overload. To innovate and obtain an advantage from data is more complex than just collecting lots of data.

This paper, utilizing a case study (Prescott, 2014), explores how data can drive innovation, and, in response to turbulence in the environment, enable a firm to maintain its competitive advantage. Using the Resource-Based View (RBV) (Penrose, 1959; Wernerfelt, 1984; Barney J. , 1991), and the Dynamic Capabilities framework (Nelson & Winter, 1982; Teece, Pisano, & Shuen, 1997), this paper seeks to operationalize the role that a capability in Digital Data Genesis (Piccoli & Watson, 2008; Vitari, 2009) plays in product/service innovation and competitive advantage.

2 Literature Review

2.1 Resource-Based View

The Resource-Based View of the firm (Penrose, 1959; Rumelt, 1984; Wernerfelt, 1984; Barney J. B., 1986; Nelson R. , 1991; Peteraf M. A., 1993) states that a firm's resources (tangible and intangible assets to include capabilities and routines), some of which can be

purchased in the factor markets and others that cannot (Peteraf & Barney, 2003), could be a source of competitive or sustained competitive advantage. Those resources that cannot be purchased in the factor market (intangible assets) (Kogut & Zander, 1992) are typically idiosyncratic to the firm and, whether by themselves or as complementary to a tangible asset (Itami & Roehl, 1987), provide a firm with a more durable advantage than only tangible assets by themselves. If a resource is valuable and rare, it can provide a firm a competitive advantage; however, it will not be durable. If a resource is valuable, rare, inimitable, and with no substitutes (Barney J. , 1991), it can give a firm a sustained competitive advantage. Isolating mechanisms (Rumelt, 1984) are barriers to imitation that protect the firm's competitive advantage and the erosion of that advantage by competitors (Ingemar & Cool, 1989). The length of time a sustained competitive advantage can endure is until something unexpectedly disrupts or causes turbulence in its business environment (Barney, 1991; Teece, et al. 1997). Therefore, when faced with turbulence in the environment, a firm must alter its capabilities or risk losing its advantage. When a capability that once gave an organization an advantage is no longer able to do so, it becomes a "core rigidity" (Leonard-Barton, 1992) and is no longer capable of providing that firm with an advantage.

2.2 Dynamic Capabilities Framework

Dynamic capabilities are the reconfiguration of capabilities and routines through the use of a capability and its accompaning routines in response to environmental turbulence (Zollo & Winter, 2002). As with other capabilities, dynamic capabilities evolve through learning, and can be improved with use. Dynamic capabilities include capabilities and routines for acquisitions or mergers, for research and development, for business process reengineering, for quality control, and for technology transfer. For example, in the Schumpeterian environment of creative destruction, firms are working to improve upon or create new products and services through their research and development (R&D) efforts, or mergers and acquisitions (M&A) activity, in order to stay ahead of the competition (Teece, Pisano, & Shuen, 1997).

Dynamic capabilities (Teece, Pisano, & Shuen, 1997; Eisenhardt & Martin, 2000; Zollo & Winter, 2002; Pavlou & El Sawy, 2006; Zahra, Sapienza, & Davidsson, 2006; Eaterby-Smith & Prieto, 2008) allow firms the ability to sense and seize opportunities, manage threats, and transform by adapting, modifying, or extending their resource base in turbulent environments. During turbulent environments, organizations need to match or create market change; therefore, dynamic capabilities impact firm strategy by shedding those capabilities, routines, and processes that no longer provide an advantage, and recombining those assets into new capabilities which can provide the firm with a competitive advantage (Kogut & Zander, 1992; Teece, 2007).

The foundations of dynamic capabilities are (Teece, 2007):

1. "Analytical systems (and individual capabilities) to learn and to sense, filter, shape, and calibrate opportunities."

2. "Enterprise structures, procedures, designs, and incentives for seizing opportunities."
3. "Continuous alignment and realignment of specific tangible and intangible assets."

These foundations support the dynamic capabilities of sensing, seizing, and transforming through the organizational and managerial processes of learning, coordination/integration, and reconfiguration.

It is through the mechanisms of sensing, learning, integrating, coordinating, and routinizing that organizations can respond to turbulence in the environment:

> Sensing – Sensing mechanisms provide information about changes in the internal or external environment. The more timely and accurate the information is, the more accurate the response can be. For example, a business intelligence information system can sense changes in the environment, provide notification to managers about those changes, and then provide data and information that can help management analyze the issue or problem (Teece, Pisano, & Shuen, 1997; El Sawy & Pavlou, 2008).
>
> Learning – Managers use their knowledge of the organization and its resources, along with its capabilities and routines, to create or adapt organizational capabilities and routines to the changing environment. It is through this learning process that a solution is formalized (Cohen & Levinthal, 1990; Von Hippel & Tyre, 1995; Grant, 1996).
>
> Integrating – Based on the developed solution, managers can implement changes to tasks, routines, and capabilities, and integrate those new or revised ways of operating into the fabric of the organization (Teece, Pisano, & Shuen, 1997; Eisenhardt & Martin, 2000).
>
> Coordinating – The dissemination of the learned information throughout the organization (Helfat, et al., 2007).
>
> Routinizing – And finally, the new processes become routine. They are now how the organization does business (Zollo & Winter, 2002; El Sawy & Pavlou, 2008).

The output of a dynamic capability is the change in the organizational capability (routines) and/or accompanying resources (Eaterby-Smith & Prieto, 2008). It is important to note that dynamic capabilities by themselves really do not confer a sustained competitive advantage to the firm unless they meet the criteria outlined in the resource-based framework. It is the *output* of the dynamic capability that has the potential to provide a firm with a sustained competitive advantage over other firms.

The Resource-Based View and Dynamic Capabilities framework are viewed by some as tautological, routines for learning routines, and vague. Some have asked if capabilities actually exist – are they real? And if they are, do they provide a firm with a real business advantage (Williamson, 1999; Priem & Butler, 2001; Winter, 2003; Kraaijenbrink, Spender, & Groen, 2010)? It seems that this critique stems from the issue that in most Resource-Based View studies, competitive advantage can only be confirmed *after* a firm has achieved a competitive advantage, and then the cause of the advantage is attributed to the capabilities or resources of the firm, while ignoring other variables. Therefore, it would appear there is a lack of studies that have focused on why the Resource-Based View, and

the Dynamic Capabilities framework, do not provide a competitive advantage. Additionally, this critique can be partially answered by demonstrating that dynamic capabilities do alter, or have an effect upon, core capabilities.

2.3 Digital Data Genesis and The Knowledge Staircase

The Knowledge Staircase. The Knowledge Staircase framework (North, 2011; Sain & Wilde, 2014) is a series of sequential steps that describe the process an organization goes through to turn data into information, information into knowledge, and knowledge into employee competencies. Data is information that has meaning. Information becomes knowledge once it is has been purposefully processed. When employees use knowledge/skills in the performance of a job (actions), they create competency. Competency is built through learning and experience, and implies a certain level of proficiency. As a competency is to the individual, a capability is to the organization; therefore, it implies a certain level of proficiency. A capability is a higher-order routine which coordinates and makes decisions about the performance of lower-order or sub-routines. Therefore, a capability is comprised of competencies and sub-routines, of which there is a tacit component. They are path dependent, and if that capability meets the criteria as outlined in the resource-based framework, then that capability can turn into firm advantage.

Organizations can be classified when using the Knowledge Staircase by the following stages:

- Stage 1 – The firm collects **data** and stores that data in data repositories; however, the data is not shared throughout the organization.
- Stage 2 – **Information** is turned into knowledge. Knowledge is used and exchanged throughout the organization to solve business problems.
- Stage 3 – **Knowledge** is integrated into business processes.
- Stage 4 – Employee **competencies** and organizational **capabilities** are developed.
- Stage 5– The organization uses knowledge to **innovate** and create core capabilities which can give the organization a competitive advantage.

To use knowledge strategically, it is important that firm leadership creates a culture of openness with regards to the exchange of information and knowledge throughout the organization. This openness facilitates the strategic use of knowledge. The business strategy is the starting point to begin using knowledge strategically to gain an advantage. There must be alignment between the business strategy/plans and the intentional generation of information/knowledge needed (knowledge strategy) to accomplish that strategy (knowledge strategy) (Nelson & Winter, 1982; Dosi, Nelson, & Winter, 2000; Eaterby-Smith & Prieto, 2008).

Digital Data Genesis Capability. In order to maintain its advantage, a firm must have information concerning its competitors, its internal operations, its interactions with customers, suppliers, partners, etc. It is through analysis of data that the firm understands and makes sense of what is happening in the marketplace so that it can react to changes.

Data is an essential element of everyday firm performance, as well as firm advantage. A firm that runs its operations on, and makes decisions from data that is of higher quality (DeLone & McLean, 1992) than its competitors use, will be able to make more accurate decisions. Therefore, data that is generated digitally will provide a firm with higher-quality data than data that is generated by other means, such as through a data-entry process. This digital data is considered to be "born digital," also referred to as Digital Data Genesis (Piccoli & Watson, 2008; Vitari, 2009).

The complementary nature of IT and organizational processes means that IT infrastructure is typically implemented throughout organizational processes and routines. And it is through these processes that IT interacts with customers, employees, suppliers, etc. (Brynjolfsson, Hitt, & Shinkyu, 2002; El Sawy & Pavlou, 2008). A capability in Digital Data Genesis is the process of choosing IT to intentionally generate/capture data digitally at the source, integrating that technology into the appropriate business processes, and then managing the data once it has been captured and stored. The Knowledge Staircase is concerned with turning the information that was generated into knowledge and building competencies and capabilities that allow a firm to innovate and gain an advantage over its competitors.

A Digital Data Genesis Capability (Piccoli & Ives, 2005; Piccoli & Watson, 2008; Vitari, 2009) consists of the following:

1. Choosing IT to *generate* and *capture* digital data at the source. It is important that IT personnel and consultants have current knowledge of enabling or emerging IT technologies that generate and capture data digitally. They must also be able to pair that knowledge with business issues to solve business problems. In this initial step in the Digital Data Genesis process, business management must have a thorough understanding of the business need or problem it is trying to solve, and an understanding of what the end result(s) should/will be.
2. Combining business processes and IT. In this step, the IT technology that was selected for generating and capturing digital data must be integrated into key business processes.
3. Managing digital data, which is concerned with the *quality* and the *accessibility* of the data. Data is information that can be transmitted while maintaining quality, once the syntactical rules for understanding it are known (Shannon & Weaver, 1949; Kogut & Zander, 1992). The information capability of a firm consists of the processes and routines necessary for receiving, storing, and disseminating the digital data. Assuring and maintaining the quality of the digital data is an important component of the Digital Data Genesis IT information capability. The information repository is also an important Digital Data Genesis asset, because it allows for the use of the data that has been collected (Piccoli & Ives, 2005).

The Outputs of a Digital Data Genesis Capability. The outputs of a Digital Data Genesis Capability (Figure1), are high-quality data that are accessible for analysis and use in decision making (Culnan, 1985; DeLone & McLean, 2003; Gray & Meister, 2004; Hirsh & Dinkelacker, 2004; Zimmer, Henry, & Butler, 2007).

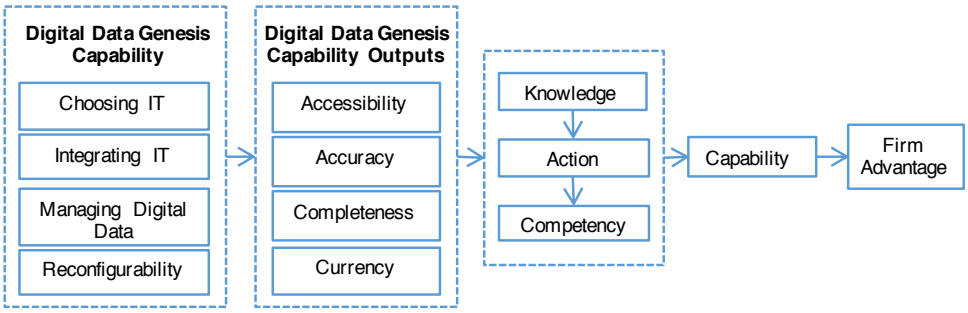

Fig. 1. Digital Data Genesis Capability Model.

Digital data quality is defined as digital data accuracy, completeness, and currency (Nelson, Todd, & Wixom, 2005). Since information is used by business management (Sambamurthy, Bharadwaj, & Grover, 2003) to make business decisions and set strategy, only the highest quality, most accurate, complete, and current data will suffice. By choosing to use digital data, a firm is choosing data that is of higher quality than data obtained by other means.

Accuracy implies that the data is correct, and represents that the data that was sought to be generated is highly correlated with the data that was actually generated. It is also an important component of accuracy that the user should experience the data as being accurate. Accuracy also implies that the data generated through a Digital Data Genesis Capability must be reliable, or the user will grow to distrust the data.

Completeness refers to the data being inclusive of the information needed for its intended purpose from the user's point of view. In order for users to trust the data, it must also be perceived by them as up-to-date, current. Users will experience a great degree of frustration when analysis is performed on data that is not *current*, because that can lead to inaccurate conclusions being drawn and inappropriate decisions being made.

Accessible data is well-located (convenient) for usage and is reliable. An example is a browser-based dashboard containing key performance indicators. Even though the data may be of high quality, if it is not made readily accessible to those who need it, since accessibility is a determining factor in information use, the reasons or purpose for generating data digitally will have been lost. Therefore, accessibility is an important consideration in the design of IT architecture in general, and Digital Data Genesis specifically. Since there is a positive relationship between information choice and accessibility of information, whatever information source is the most readily available is the information source of choice. However, when given a choice of high-quality and low-quality information, if accessibility is equal, then the high-quality information will be the first choice. High-quality information is information that is ready for use by the user for the purpose it was generated. Therefore, quality of information produced by the Digital Data Genesis Capability, and the accessibility of that information, are both important to the actual use of Digital Data Genesis.

A possible barrier to the use of information generated by Digital Data Genesis is data or information overload (Grise & Gallupe, 2000; Chen, Shang, & Kao, 2009). Information overload is the limitations of people's cognitive ability to process high volumes of relevant information. During the analysis of information, it is often necessary that individuals sift through large volumes of data to determine what is relevant or irrelevant for the task at hand. The large volume of information that must be analyzed can exceed the capacity of the individual to cognitively process it. This inability of individuals to perform analysis on a large amount of relevant information leads to digital data overload, which can impact the analysis and, therefore, the quality of the decisions that are made from Digital Data Genesis data.

The storage of data in an information repository (Marchand, Kettinger, & Rollins, 2002; Lin, 2005; Yoon, 2005; Mathews & Healy, 2007) enabled by the IT infrastructure, allows a firm to build up information that can provide the firm with a competitive advantage. These technology and information asset stocks are path dependent and built up over time, making it difficult for competitors to duplicate the ensuing innovations and business strategies that result from the analysis of the data.

Digital Data Genesis Dynamic Capability. In turbulent environments, a Digital Data Genesis Capability functions as a dynamic capability. The sources of dynamic capabilities are firm assets, firm history, and the organizational processes of sensing, learning, integrating, and coordinating. And it is through these organizational processes that the firm is able to reconfigure existing operational capabilities, to respond to opportunities, and to manage threats in the environment. Most importantly, it is through sensing (Wade & Hulland, 2004; Pavlou & El Sawy, 2006) that the organization becomes aware of changes in the external/internal environments.

A Digital Data Genesis Capability is more than just the use of IT technology to obtain data. It is a dynamic capability (Tanriverdi, 2005) that can be leveraged to reconfigure itself. Through the use of its outputs, it can provide high-quality information that can be turned into knowledge to reconfigure operational capabilities. And, in line with the resource-based framework, a Digital Data Genesis Capability can provide a firm with an advantage over its competitors.

3 Methodology

In qualitative research, an interpretive approach is used to understand data and their relationship to research questions. This development of the relationship is brought about through an iterative process which begins with an initial understanding of phenomena being researched. This understanding is then refined with the addition of new data, and the analysis of that data, until an in-depth understanding of the phenomena is reached. When it is necessary to understand how or why something worked, the case study (Yin R. , 1984; Benbasat, Goldstein, & Mead, 1987; Miles & Huberman, 1994; Eisenhardt & Graebner, 2007) is an indispensable research tool. The use of a case study gives the researcher a

method to operationalize concepts and make them more understandable. Weakness in case-study research can occur when the researcher's preconceived ideas about the topic influence the research. Since the purpose of the case used in this paper was to operationalize an IT capability to provide an example of how a complex process, such as a dynamic capability, actually works in the real world, a single-case design was used.

Building off prior research on the Resource-Based View (Wernerfelt, 1984; Barney J. , 1991; Peteraf M. A., 1993; Eisenhardt & Graebner, 2007), Dynamic Capabilities (Teece, Pisano, & Shuen, 1997; Teece, 2007), Digital Data Generation (Piccoli & Ives, 2005; Vitari, 2009), IT Capability Development, and IT's relationship to firm performance improvement (Huber & Power, 1983; Duncan, 1995; Mata, Fuerst, & Barney, 1995; Ross, Beath, & Goodhue, 1996; Broadbent & Weill, 1997; Bharadwaj, Sambamurthy, & Zmud, 1998; Bharadwaj A. , 2000), this empirical study sought to:

- Operationalize a Digital Data Genesis Capability and show its functioning as a dynamic capability in turbulent business environments. Environmental turbulence has a moderating effect upon organizational capabilities. For example, a firm has a strong competitive position in the market in which it competes, when along comes a disruptive technology. The firm must either adapt to this change or risk losing its competitive position. When turbulence is sensed in the environment, dynamic capabilities, which are constrained by the firm's path dependencies and asset position, must reconfigure organizational capabilities to match or create change in the environment. It is believed that the outputs of a Digital Data Genesis Capability, which consist of generated digital data that is accessible, and of high-quality (accurate, complete, and current), are associated with helping the organization reconfigure its capabilities in reaction to turbulence in the environment. Therefore, a Digital Data Genesis Capability should help negate the effects of environmental turbulence by allowing for the reconfiguration of existing capabilities.
- Show the role that a capability in digital data plays in firm innovation and competitive advantage. With the advent of big data, more firms are setting their strategy and competing on data. Both IT infrastructure and data repositories are organizational assets that are capable of giving a firm an advantage. But in order for them to do this, they must meet the criteria as outlined in the resource-based framework. Due to the inherent difficulty in isolating one variable and attributing the competitive advantage of the firm to that variable, the best method to determine the effect of IT on competitive advantage is by looking at the efficiency of processes (Ray, Muhanna, & Barney, 2005). How well do the processes perform their intended function? In the case of this paper, how well does the effective implementation of a Digital Data Genesis Capability perform its function by providing data that is accessible and of high-quality so that a firm can innovate and maintain its advantage. Therefore, the outputs of a Digital Data Genesis Capability (Digital Data Accessibility and Quality) could have a positive effect upon competitive advantage.

This paper, using a published case study, "Big Data and Competitive Advantage at Nielsen" (Prescott, 2014), adds to the literature on the Resource-Based View and the Dynamic Capability Framework, and further investigates and operationalizes Digital Data Genesis as a capability *and* as a dynamic capability, and shows the role it can play in firm advantage.

4 Case-Study

Since 1923, A. C. Nielsen (Prescott, 2014) has had a monopoly in the collecting and providing of data/metrics to its media and advertising industry customers concerning data about consumers' television viewing and purchasing behavior. Nielsen is the ratings engine for the advertising industry. It provides data to its customers so they can determine what decisions to make concerning programming, advertising, gaining a better understanding of what the consumer is buying, what television shows are watched, and what shows are not watched. Nielsen has maintained its monopoly by being entrenched in the way its customers do business – from what television shows get canceled or renewed for another season, to the cost of an advertising slot. Initially, Nielsen had a strong capability in data generation that was developed providing data to the radio advertising industry. This capability was made up of certain tangible assets, such as the meters and diary that Nielsen used to collect data on radio use. It also consisted of certain intangible resources such as the routines for installing the meters in sampled homes, routines for collecting the data that was generated, etc. The meters that Nielsen used to collect data were exclusive to Nielsen; they were developed by Nielsen and they were not available for purchase in the marketplace. Once the data had been generated, it was stored, processed, and made available to Nielsen's customers for them to make decisions about advertising, etc. Therefore, there are tangible assets and intangible assets in the form of routines that make up Nielsen's capability in data generation. Since the tangible and intangible assets are exclusive to Nielsen, it would not be easy for a competitor to copy Nielsen's capability in data generation. Therefore, isolating mechanisms/barriers to imitation should act to keep Nielsen's sustained competitive advantage from being eroded (Rumelt, 1984; Ingemar & Cool, 1989).

With the introduction of television, Nielsen adapted its capability in data generation for radio and began collecting information on television-viewing behavior. Nielsen intially used the diary method for collecting data from sample households, without the use of a meter. Not only was the diary completed manually, but the data, once collected, was manually prepared for use by Nielsen's customers. In the beginning, this data was trusted and used by Nielsen's customers to make business decisions. However, over time the use of the diary method of collecting data resulted in many complaints by the television networks and the advertising industry, as well as television viewers. They knew that data collected using this method had the potential to contain errors, and be open to misrepresentation of what was actually being viewed by people completing the diary. This dissatisfaction was a sign of turbulence in Nielsen's business environment.

In response to the dissatisfaction, Nielsen's Research and Development (R&D) function, using knowledge of the updated business plan created by Senior Mangement, developed the people meter to obtain data digitally from the television. The people meter is a set-top type box that is connected directly to the television. It captures detailed information on televsion viewing at the source, and transmits this data electronically to Nielsen's servers. The R&D function of Nielsen used their knowledge of information technology that was currently available to create the people meter. IT was woven into the data-generation process, which was built from the routines that Nielsen used to collect data via the diary method. From the generation of data and the error-checking of data for quality, to the storing of data in data repositories, all of the routines were adapted to the meter technology. The result of the reconfiguration of the data collection process was higher-quality data that was available for use by Nielsen's customers.

With the advent of broadband, people were no longer viewing television programming only on the television. They were also viewing television programming on the Internet and on their mobile devices such as cell phones. Initally, Nielsen's customers were demanding data on Internet usage. So Nielsen adapted its people meter technology to collect data on computer Internet usage. Nielsen's customers were now getting a more complete picture of the consumer, but technology usage by the general public was changing very quickly, and Nielsen's customers were demanding more data on consumer media consumption. They now wanted data from all three screens (television, computer, and cell phone).

Along with these advances in technology, new competitors were starting to appear. Cable and satellite companies, using advances in technology, were now able to collect very detailed (second-by-second) data on television viewing and Internet usage from their set-top boxes installed in people's homes, and sell that data to television networks and advertisers. They were also selling their data to firms that were interested in mining these big-data sets and selling that information directly to the television networks and advertisers.

Broadband and the availability of set-top box data had caused a major shift (turbulence) in the competitive environment for Nielsen. Nielsen was no longer a monopoly, its sustained competitive advantage had been eroded, and its customers were forming relationships with its competitors. Nielsen's competitors, using big-data technologies, were now collecting data across all three screens. Even though Nielsen was not entirely caught off guard by these major changes reshaping its industry, it did not respond quickly enough because of strategic decisions made in the past. The influx of competitors had not only cost Nielsen its sustained competitive advantage, but Nielsen was in debt and ended up being sold to a group of investors, who hired David Calhoun as the CEO. Prior to Calhoun taking over, Nielsen's business units were functioning independently. Therefore, even though business intelligence data was being collected according to Nielsen's knowledge strategy, it was not being shared across the business units, causing an incomplete picture of the competitive environment. Nielsen did not respond to the advances in technology or set-top box data in a timely manner. Nielsen was not in immediate danger of going out of business. It still was the major provider of data to the network television and advertising industry. Due to the relationships with its customers which had been built up over time, and its capability in

data generation, and more specifically Digital Data Genesis, its advantage had not completely disappeared, although it was under serious attack (Ingemar & Cool, 1989; Teece, Pisano, & Shuen, 1997).

Once Calhoun understood why Nielsen did not respond to turbulence in the environment, he began integrating IT platforms so data could be shared more effectively and timely across the company. Next he analyzed the data and began formulating his plans to accomplish what needed to be done to strengthen his company. He also understood that the relationship between IT and senior management was very important (Sambamurthy, Bharadwaj, & Grover, 2003; Zimmer, Henry, & Butler, 2007). He was aware that IT technology could solve Nielsen's business problems, and he made sure his IT management team was very aware of the IT and business decisions and issues that needed to be coordinated to positively impact Nielsen's business plans (Duncan, 1995; Bharadwaj, Sambamurthy, & Zmud, 1998; Kearns & Lederer, 2003; Piccoli & Ives, 2005). Calhoun had to ensure that IT was current on enabling and emerging technologies, and that they had the appropriate context for their understanding of Nielsen's business issues (Wheeler, 2002; Ray, Muhanna, & Barney, 2005). He also made sure that Nielsen's knowledge strategy was aligned with its business strategy. He was confident that this would provide senior management with relevant information upon which strategic business decisions could be made and firm strategies set for a successful future (Bharadwaj, Sambamurthy, & Zmud, 1998).

Nielsen's new business strategy, formulated by Calhoun, was pointing towards capturing data from all three screens. However, while Nielsen did have a strong capability in data collection, it did not have the necessary technology to collect data from the Internet and smart phones that would allow for a more complete and integrated picture of consumer media use.

To address this challenge, Nielsen began a process of acquisitions and strategic alliances to obtain the needed data-collection technology. This was accomplished by IT having good knowledge of the business plan as set by senior management, coupled with their knowledge of enabling and emerging technologies (Wheeler, 2002; Williams, 2003; Piccoli & Watson, 2008; Vitari, 2009). Those competencies made it possible for Nielsen's IT function, in line with the business and information/knowledge strategy, to make solid and practical recommendations to senior management of companies that it should acquire, or with whom to form strategic relationships. This coordinated planning process allowed Nielsen to gain access more quickly to cutting-edge technology and give it an advantage over its competitors, as it had enjoyed in the past. Once the companies were either acquired or entered into a strategic relationship, Nielsen would then store and aggregrate the newly acquired data in its repositories so it could be more easily accessed by customers. Nielsen was trying to create change in the environment through its robust scanning processes (Wade & Hulland, 2004; Pavlou & El Sawy, 2006), and as soon as turbulence was spotted in the environment, the process described above would be repeated. No longer did Nielsen just generate data on television viewing. They began generating data anytime and anywhere across all three screens. In addition, Nielsen sought to collect data from other sources to complement the data it was collecting over the three screens. This way it could meet the

needs of its customers by providing a more complete picture of the consumer ahead of its competitors. Nielsen was not only providing a more complete picture of the consumer, it was also providing information which was of high-quality, and accessible to its customers for decision making.

5 Findings

5.1 Digital Data Genesis Capability

Using the Nielsen case (Prescott, 2014), this research sought to operationalize Digital Data Genesis Capability. Senior management makes decisions based upon data. Therefore, data is a critical organizational asset (Huber & Power, 1983). Those decisions impact the resource allocation and the business strategy of the firm, and the competitive advantage and even survival of the firm. It is absolutely imperative that decision makers have access to high-quality data on which to base their decisions. It is possible that gaining knowledge or making decisions from information that is not of high quality can result in the wrong decisions being made (DeLone & McLean, 1992).

As a company advances sequentially along the Knowledge Staircase, it develops a capability in using knowledge to innovate. Therefore, it is important that the strategic use of information and knowledge is aligned to the business strategy, and that the data that is collected is the data that is needed to accomplish and support the business strategy.

Nielsen had a strong capability in data generation using the diary method. This capability gave Nielsen a sustained competitive advantage for many years. Working backwards from its business strategy, Nielsen's business plan and its knowledge/information strategy were linked and implemented throughout the company. Therefore, the data that was generated by Nielsen was intentionally collected to accomplish the business goals of the company – which were providing information and metrics to its customers. The diary-collection method that met the needs of Nielsen's customers in the beginning, became a source of dissatisfaction (turbulence) as Nielsen's customers became more sophisticated in their understanding of Nielsen's data collection processes, and demanded higher-quality data.

Data that is generated by non-digital methods is of lower quality than that obtained digitally, referred to as digitally generated data (Piccoli & Watson, 2008). When data is collected using a data-entry process, it is possible for errors to be inputted into the data. Therefore, data that is initially captured through non-digital means must be checked for errors. However, error checking cannot catch all errors in the data, such as the truncation of numbers, the misspelling of a name, or entering the wrong numbers in the wrong field, etc. Higher-quality data (Zimmer, Henry, & Butler, 2007) is obtained when the data is gathered digitally at the source.

Since Nielsen had advanced sequentially through the various stages of the Knowledge Staircase, Nielsen was capable of using knowledge to innovate. Therefore, in response to the request for higher-quality data from its customers, Nielsen's R&D function chose IT to

collect television-viewing data digitally at the source as opposed to using other methods (Wheeler, 2002; Williams, 2003). In order for Nielsen to collect data digitally, it was necessary that processes and routines used for the collection of data by the diary method be reconfigured to work with the digital data collection technology (people meter). To do this, they combined business processes and IT (Bharadwaj, Sambamurthy, & Zmud, 1998; Pavlou & El Sawy, 2006).

The people meter collects data on a minute-by-minute basis, causing the volume of data collected digitally to increase substantially over the diary method of data collection. When the digital data was transmitted to Nielsen, it was checked for errors to make sure that the data that was collected and sent was the data that was received. Once this quality control check was complete, the data was stored in repositories and then combined with other data and made available for customer use. This store of data is also available for use by Nielsen for future innovations. The outputs of this Digital Data Genesis Capability are data that are accessible, and of high quality (accurate, current, and complete). Once the data is stored in the data repositories it is backed up on a very frequent basis so that no data is lost. The information repository is an important Digital Data Genesis asset, because it allows for the use of the data that has been collected (Marchand, Kettinger, & Rollins, 2002; Lin, 2005; Piccoli & Ives, 2005; Yoon, 2005; Mathews & Healy, 2007). It is important to note that the people meter was built by Nielsen. It was not available for purchase in the marketplace. The capabilites and sub-routines were built up over time based upon learning. Therefore, the people meter consisted of tangible (digital data collection technology) and intangible (routines) assets, which resulted in high-quality data that was accessible for use, and allowed Nielsen to maintain its sustained competitive advantage.

Nielsen was able to develop a capability in Digital Data Genesis by identifying and selecting IT technology for generating and capturing digital data, and integrating that technology into its business processes. This also resulted in Nielsen developing an information capability which allowed for the accessibility and management of the digitally collected data.

In addition to producing high-quality data, this capability in Digital Data Genesis also improved the efficiency of Nielsen's data collection processes. Therefore, it can be concluded that Nielsen's capability in Digital Data Genesis was related to its outputs (accessible and high-quality data), and that its capability in Digital Data Genesis consisted of an IT capability and an information capability (Bharadwaj, Sambamurthy, & Zmud, 1998; Marchand, Kettinger, & Rollins, 2002).

5.2 Digital Data Genesis Capability Functioning as a Dynamic Capability

Dynamic capabilities allow firms the ability to sense and seize opportunities, manage threats, and transform by adapting, modifying, or extending their resource base. Dynamic capabilities impact firm strategy by shedding those capabilities, routines, and processes that no longer provide an advantage, and/or recombining those assets into new capabilities which can provide the firm with a competitive advantage (Kogut & Zander, 1992; Teece, Pisano, & Shuen, 1997).

The first wave of turbulence for Nielsen came in the form of its customers requesting data on computer Internet usage. In response, Nielsen management used knowledge of the business plan and the organization's IT assets, as well as knowledge of the organization's IT and information capabilities, and developed a strategy to solve the issue for Nielsen's customers. An information/knowledge strategy was developed concerning what data needed to be collected from the computer/Internet that would meet the needs of Nielsen's customers, and how this would be integrated with the televison-viewing data already being collected. Nielsen R&D used its understanding of what information needed to be collected, gained a thorough understanding of the issue, and was able to reconfigure the people meter to collect data from the Internet as well as the television. That solution was routinized and then implemented throughout the organization.

Therefore, Nielsen reconfigured its Digital Data Genesis Capability using (Piccoli & Ives, 2005; Vitari, 2009):

1. The organizational processes of sensing, learning, integrating, coordinating, and reconfiguration.
2. The firm's asset position. A firm seeking to develop a capability in Digital Data Genesis needs to have IT infrastructure and data repositories in place. It is also important that the firm understand the complementary nature of IT with regards to firm processes, routines, and capabilities.
3. The firm's history with regards to its IT capabilities and its information capabilities, as well as understanding that the path the firm can travel in the future is constrained by its tangible and intangible asset base that was developed over time. Learning tends to be localized within the firm and based off previous experience with existing routines and capabilities.

The next wave of turbulence for Nielsen was related to broadband, advances in technology, and big data. Due to Nielsen's siloed organizational structure, data, information, and knowledge were not shared across business units. Therefore, satellite and cable companies using set-top box data had eroded Nielsen's sustained competitive advantage. Under Calhoun's leadership, Nielsen began the process of redefining itself (Mata, Fuerst, & Barney, 1995; Ross, Beath, & Goodhue, 1996). Using a flexible IT architecture, information platforms were integrated so that data, information, and knowledge could be shared across the organization.

In response to competitors using set-top box data, Nielsen's senior management gained an undertanding of the turbulence and altered their business strategy to address the turbulence. Nielsen's new strategy was to collect data across all devices (television, computer, and cellphone). This gave Nielsen's customers a better understanding of how the consumer uses media.

Starting with knowledge of the business plan, as well as the information/knowledge strategy, Nielsen's IT used its knowledge of the organization's IT assets, and IT/information capabilities to develop solutions that would provide high-quality data to Nielsen's customers across all three devices. IT sought enabling or emerging technologies capable

of providing the necessary data to accomplish Nielsen's new business strategy. Sometimes it is not possible to add new technology by building capabilities internally. Therefore, Nielsen obtained those new digital-data collection technologies and their accompanying routines through acquisitions, and in some cases, through joint ventures. After these new technologies were acquired, Nielsen used its flexible IT architecture to integrate the new data with its existing data and make this information available to its customers. Therefore, data would be turned into information, and then this information would be turned into knowledge. This knowledge would be turned into action in the form of competencies. The end result was a stronger capability in providing a more complete picture of the consumer to Nielsen's customers. Additionally, the data collected and stored in Nielsen's data repositories further added to Nielsen's asset stock of information and knowledge that would be available for future innovations.

The absence of a Digital Data Genesis Capability, as well as the lack of an information/knowledge strategy aligned to the business strategy, was evident in Nielsen's competitors. These included satellite and cable companies, and the start-up companies to whom they sell data. The satellite and cable companies' business strategies were built around delivering televison programming and Internet/cellphone service to consumers. While they had an IT capability and an information capability in collecting digital data on television viewing and Internet use, they did not have a capability in collecting data for the purpose of providing metrics to the television networks and advertising agencies. It would seem that the digital-data generation process, as well as the generated data, would be easily transformed into information useable by the media analytics industry. However, that was not the case for Nielsen's competitors due to the path-dependent nature of those capabilities. The knowledge, competencies, and routines were not in place to reconfigure their data generation process to totally replace the information Nielsen was providing. Therefore, while their data could serve as a substitute for Nielsen's data, it was still raw data. The cable and satellite companies were at the bottom of the Knowledge Staircase (Stage 1) with regards to turning data into information that was useable by the media analytics industry.

Nielsen's other competitors are small, start-up companies using data science techniques to mine big data sets. These companies do not typically possess a capability in digital data generation. They obtain their data directly from the cable and satellite companies. Since these companies lack a digital data generation capability, if the cable and satellite companies decided to no longer sell their data, these companies would not have data upon which to perform their analyses. Since they do not generate the data, they also have no control over the accuracy or completeness of the data, which calls into question the quality of their data.

Once they acquire the data, they mine the data looking for relationships that would provide insight into consumer media use. They then sell these insights to the television networks and advertising agencies. In line with the resource-based framework, while the insights they sell to their customers are valuable, the data that those insights are derived from are not rare. And since they purchase the data sets in the marketplace, unless one of these companies can obtain some form of exclusive rights to the data sets, they will not be able

to gain a durable advantage. Since there are no barriers to imitation in place, any would-be competitor could obtain the same data sets, perform similar analyses, and provide similar insights to the television networks and advertising agencies at a lower price. Competitors will always negate any advantage obtained; therefore, it will be difficult for any one company to earn rents.

The Nielsen case study shows that once turbulence is sensed in the environment, it must be understood in terms of its impact on business strategies and capabilities. Therefore, it is important that a firm have systems to learn about, understand, and calibrate opportunities and threats in its environment (Teece, 2007). Through the scanning process (Nelson & Winter, 1982; Rumelt, 1984; Teece, Pisano, & Shuen, 1997), once turbulence is sensed in the environment, Digital Data Genesis becomes a dynamic capability. Therefore, Digital Data Genesis, plays an important role in helping a firm sustain its competitive advantage in turbulent environments.

6 Conclusion

This exploratory research, based on a case study of an information/media analytics company (Prescott, 2014) grounded in the Resource-Based View and Dynamic Capability framework, looks at the impact of the specific capability, and dynamic capability, of Digital Data Genesis (Piccoli & Ives, 2005; Piccoli & Watson, 2008; Vitari, 2009) on contributing to firm competitive advantage. It also explores the role Digital Data Genesis plays in helping companies achieve an advantage from big data. Firm competitive advantage is defined in this paper as improving product and service offerings to customers. This study makes contributions to the research stream by providing an example of the relationship between dynamic capabilities, the output of dynamic capabilities, and their relationship to firm advantage. More specifically, this paper addresses how IT capabilities and data impact firm performance, and even more specifically, how the Digital Data Genesis Capability functions as a dynamic capability when moderated by environmental turbulence.

In conclusion, this study demonstrates that:

- A Digital Data Genesis Capability is also a dynamic capability and helps negate the effects of environmental turbulence.
- A Digital Data Genesis Capability and its Outputs have a positive effect upon Competitive Advantage.

As this paper demonstrates, competing on big data is more than just using data science techniques to find patterns in data, or providing raw data to customers. While this type of data might answer questions and provide insights, that, in and of itself, is not enough to allow a firm to gain a competitive advantage. A firm must build its advantage from assets (tangible and intangible) that are imperfectly mobile (Peteraf M. A., 1993). These assets are firm specific, they are path dependent, they are somewhat tacit, and are socially complex. They are built from organizational learning and experience using organizational information and knowledge.

The managerial implications of this research are that managers can develop an understanding of how a Digital Data Genesis Capability can help their organization gain value from their big data, and possibly give their company an advantage over its competitors. Additionally, this paper reinforces the important role that high-quality data, intentionally collected at the source and aligned with the business and information/knowledge strategy of the firm, plays in helping the firm create and maintain its competitive advantage.

The limitations of this study are that since this study was based on a single case-study within a specific industry (global information/media analytics), its findings warrant further investigation before they can be generalized across all industries. Therefore, it is recommended that these findings and model be used as a basis for further research across different industries to gain a better understanding of how a Digital Data Genesis Capability functions as a capability/dynamic capability, and its role in business strategy and competitive advantage.

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