The Impact of Business Analytics Strategy on Social, Mobile, and Cloud Computing Adoption

Research-in-Progress

Abhijeet Ghoshal
College of Business, University of Illinois-Urbana Champaign
1206 S. Sixth St., Champaign, IL
abhi@illinois.edu

Eric C. Larson
College of Business, University of Illinois Urbana-Champaign
1206 S. Sixth St., Champaign, IL
ecl@illinois.edu

Ramanath Subramanyam
College of Business, University of Illinois-Urbana Champaign
1206 S. Sixth St., Champaign, IL
rsubrama@illinois.edu

Michael J. Shaw
College of Business, University of Illinois Urbana-Champaign
1206 S. Sixth St., Champaign, IL
mjshaw@illinois.edu

Abstract

Information Technology is widely accepted as a catalyst for firms to develop new capabilities. Recently, technologies that can harness the potential of big data have gained traction among firms. Social, mobile, and cloud computing (SMC) technologies have been widely recognized as technologies to collect and use big data. We focus on adoption of these technologies in this research. We construct a model in which four proposed antecedents: internal demands, market demands, technological skills shortage and information security concerns, influence the adoption of SMC technologies. We develop a framework to classify firms based on their strategic objectives vis-à-vis use of business analytics which we call business analytics strategy (BAS). Different BAS profiles may influence differently the antecedents to adoption of SMC technologies.

Keywords: Big Data, Business Analytics, Technology Adoption, Organizational Innovation

Introduction

The last two decades have borne witness to drastic decreases in hardware costs, significant increases in storage capacities, an exponential growth in processing power, and increased adoption of miniature computing devices like wearable smart devices, smartphones and tablets. Together, this technology influx and ubiquity of mobile devices have contributed to the high velocity generation of massive amounts, and varied kinds of data. Not surprisingly, companies are increasingly adopting technologies that generate and process “big data” to boost profits and increase their efficiency (e.g., Kiron, Prentice and Ferguson 2014; Laney and Buytendijk 2013).

Through various “big data” efforts, i.e., harnessing and exploring the massive data repositories for business insights, firms create niche positions for themselves in the market. For instance, Davenport and
Kim (2013) highlight the use of big data in searching for new market opportunities, developing new products and marketing those products to potential customers. In fact, for some companies, big data is at the heart of their business models: page rank at Google, “people whom you may know” at LinkedIn, or new games at Zynga. For these firms, data analytics is critical for their survival and adaptation to dynamic market conditions. Even traditional firms now recognize the immense value of using big data for understanding their customers and better personalizing the customer experience, monitoring internal organization performance and improving supply chain efficiency. Together, these initiatives help firms remain competitive in increasingly dynamic marketplaces.

The adoption of Big Data is primarily driven by three capabilities that firms seek to develop – analysis of external environment, analysis of internal process, and decision making. In order to understand how Big Data help firms in developing these capabilities we use the theoretical framework of Technological Adoption provided by Tornatzky and Fleicher (1990). This framework suggests that there are three elements that influence the process of technological innovation – organizational context, technological context, and environmental context (OET). It is recognized in the literature that although OET framework provides a general understanding about technological innovation, studies in different contexts are necessary in order to understand how a specific technology related factors influence adoption of the technology in an organization. Specifically, big data is used by a firm to support its larger business strategy through use of business analytics tools and techniques for improving processes related to the three contexts. Since big data is now crucial to the success of firms, a thorough scientific study is required in order to properly analyze the factors affecting big data adoption (McAfee and Brynjolfsson 2012). In this research, we use the adoption of social, mobile and cloud computing (SMC) as an outcome measure since SMC technologies are recognized as the most important technologies that contribute to the growth and analysis of big data (Howard and Plummer 2013, Srikanth 2013).

The decision to adopt such technologies is not straightforward. For instance, multitudes of technologies are available that complement other organizational or technological capabilities. Further, certain technologies or organizational capabilities are interdependent, i.e., to extract the full benefit of one technology, other related technologies are necessary to be in place (Leonardi 2013). The use of these technologies is primarily driven by the firm level business strategies. Based on the strategic goals of a firm, the firm develops its own business analytics strategy (BAS) – the intention or position the firm takes regarding the analysis of data and use of the insights from that data to advance specific organizational objectives. However, the relationship between business analytics strategy and adoption of SMC technologies is influenced through various firm level antecedents of adoption of SMC technologies. On one hand, firms may be motivated to adapt SMC to understand external customers and improve internal efficiencies. On the other hand, problems regarding integrating these technologies, such as technical skill shortages and uncertainties with the security aspects of the new technologies inhibit firms from adopting them swiftly. Based on a firm’s business strategy, the firm may selectively focus on the technical enablers or the organizational barriers which would determine their degree of adoption of the technologies. Building on prior theory and employing data collected through a global corporate survey, we propose a model that enables us to answer the question - how much influence endogenous strategic position and exogenous drivers for technology adoption have on the degree of adoption of SMC technologies in organizations.

Information Systems has a strong tradition of technology adoption research at the individual and group level (e.g., Karahanna et al. 1999, Venkatesh and Davis, 2000, Sarker and Valacich 2010, Sun 2013). Several of these past research on technology adoption within firms are closely related to this study. Meyer and Goes (1988) examined the assimilation of innovations into organizations, a process unfolding in a series of decisions to evaluate, adopt, and implement new technologies impacted by both the context and the technology. Top management participation in the assimilation of enterprise systems in the post-implementation stage (Liang et. al. 2007) and the interaction of top management tasks with the technology (Cooper and Zmud 1990) are critical for successful adoption. Bala and Venkatesh (2007) characterized assimilation of new standard inter-organizational business processes as dependent on the relationship with business partners, pressure to mimic competitors and institutional inertia. Swanson (1994) proposed an extension of OET framework (Tornatzky and Fleicher 1990) to emphasize the communication link between the IS organization and the business to drive adoption. However, none of these studies explain the adoption of technology specifically relevant to the use of big data and the
relationship between the antecedents of their adoption and the firm’s strategy related to the use of Business Analytics.

In essence, our study aims to provide insights that will help managers at all levels of a firm, including C-level executives and IT managers focused on big data initiatives. Leveraging big data for competitive advantage requires significant investments in manpower and technology (Gartner 2013). Also, these technological investments have a maturation period and therefore often require significant time for benefit realization (Gooch 2013). Our well-timed study will provide important evidence regarding the connections between a firm’s BAS, antecedents of adoption, and adoption of emerging technologies. Our first contribution is to characterize the firm according to its BAS – a profile of the dominant strategic objective for the firm’s use of big data. The second contribution is an understanding of the influence of various antecedents of adoption of technology on the adoption of SMC in the context of the firm’s BAS.

Our analysis is divided into two parts. In the first stage, we analyze the data across more than 1,200 organizations to explore the business analytics strategies adopted by firms. This data exploration is required to develop a concrete understanding of the strategies employed by organizations that uniquely define the business analytics objectives of the firm. In the second stage, we develop hypotheses regarding the relationship between various business analytics strategies and adoption of SMC mediated by various firm level antecedents of SMC adoption. We acknowledge that there may be mediation, moderation or a direct effect, although our preliminary analysis does not show any support for the moderation effect of the four antecedents of adoption. Further analysis will examine this empirical question.

Characterizing Business Analytics Strategy

The OET framework suggests that technological innovation within firms is influenced through three factors – organizational, environment, and technological. Firms perform business analytics on big data for improving efficiencies along these three dimensions. Business Analytics is used by firms for managing risks in decision making by using data and verifying the effects of various decisions on overall business. In the context of environment, use of business analytics help firms in identifying new markets, understand customer demands, and accelerate product development. Finally, in the context of technology, business analytics help firms in reducing internal cost of production, improve employee productivity, and improve internal supply chain performance.

A firm’s BAS is shaped from its higher-level business strategy. While business strategy deals with the question – “how do we compete effectively in each of our chosen product-market segments?,” (Venkatraman 1989), we conceptualize BAS as focusing on the analysis of the context of the firm through the use of analytics tools and big data to support the larger organizational business strategy. A firm performs three essential functions in order to run its business: external communications with customers and society, governance for coordinating decision making, and internal operations. Corresponding to the priorities across these three dimensions, a firm adopts a BAS aligned with its larger business strategy.

Miles and Snow (1978) proposed a typology for firms - Prospectors, Defenders, and Analyzers– based on the business strategies adopted by firms, i.e. growth and innovation-oriented, cost efficiency driven, or a hybrid approach. Researchers have extended (Doty et al. 1993, Delery and Doty 1996) and adapted this characterization to consider IT strategy (Sabherwal and Chan 2001). Business Analytics is used by all these types of firms, albeit in different ways. The firms put emphasis on using big data for understanding the customer market, improving organizational governance, and/or driving efficiency of internal operations to different degrees based on their higher level business strategies. These degrees of strategic emphasis create various configurations of use of business analytics that form the basis of distinct profiles based on which firms are segregated. Firms are expected to fall on a spectrum based on the use of business analytics across the three domains. At one end of the spectrum should be a firm with a profile “Analytics Leader” that is expected to use business analytics across all the three domains. On the other end of the spectrum is a firm with a profile “Analytics Laggard” that is expected to lag in the use of business analytics, lacking any concrete strategic objective for business analytics. As the needs for data and their strategic value of such data is expected to vary dramatically based on the unique objectives of each firm, the adoptions of SMC technologies is expected to be dependent on the BAS profile of each firm.
Research Setting and Data

The data for this study comes from the 2012 IBM Business Analytics survey (IBM 2012). A questionnaire was designed and executed by IBM to survey technology and business executive decision makers in 1,200 organizations across various industries. The survey contains questions designed to generate formative constructs to measure each firm’s emphasis with respect to business analytics: (i) market sensing, (ii) internal operations, and (iii) governance. We employ k-Means clustering to create the profiles of firms based on their BAS and establish groups of companies pursuing similar business analytics strategies. If each of the three dimensions is used to sort firms high or low on those dimensions, there are theoretically eight (2x2x2) potential clusters defining BAS. As such, we explore values of k from two to eight, and find support for the presence of five clusters that are intuitive and possess high face validity. Future work will employ cluster analysis other than k-means in order to test the validity of the clusters.

In Table 1, we show the final cluster centers with average scores on each of the dimensions corresponding to the three business analytics strategies. We have designated names for each of the clusters: Analytics Leader, Market Responder, Organization Optimizer, Efficiency Seeker, and Analytics Laggard.

<table>
<thead>
<tr>
<th>Business Analytics Domain</th>
<th>Business Analytics Strategy</th>
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<tbody>
<tr>
<td></td>
<td>1 Analytics Leader</td>
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<tr>
<td>Market Sensing</td>
<td>2.57</td>
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<tr>
<td>Governance</td>
<td>2.67</td>
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<tr>
<td>Internal Operations</td>
<td>2.55</td>
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As summarized in Table 1, aggressive analyzers called Analytics Leaders focus on exploiting business analytics across all the three business domains (Cluster 1), Market Responders are dominant analyzers who focus on using business analytics for market intelligence and for developing their relationships with their customers (Cluster 2), Organization Optimizers, who focus on using business analytics for decision making for governing the organization (Cluster 3), Efficiency Seekers who are internal operations dominant analyzers seeking to use business analytics primarily for improving internal operational efficiencies (Cluster 4), and Analytics Laggards who minimally use business analytics in any of the business domains (Cluster 5). The smallest cluster has 96 firms (Analytics Leader) and the largest cluster has 390 firms (Analytics Laggard), indicating the nascent opportunity in this context. Next, we develop the hypotheses to relate these five business strategy profiles with adoption of SMC technologies.

Theory and Hypotheses

Our model suggests that firms will face different levels of the antecedents to adoption depending on their BAS profile. For example, an Analytics Laggard may face higher or lower market demands than an Analytics Leader. In Figure 1, we propose the model we test showing arrows from the five profiles to the antecedents of adoption to indicate the relationships. The four antecedents of adoption are theorized to influence SMC adoption.
Antecedents of SMC Adoption

Digital technologies are seen as central to improving the operational efficiencies of organizations by optimizing processes, increasing transaction processing speed and cutting cost (e.g., Mithas et al. 2013). In the recent past, enterprise systems (such as ERP) were proposed as solutions to enhance process efficiencies due to their ability to improve data quality for decision-making, provide efficiency gains across business processes, and enable better coordination between different units of a firm (Gattiker and Goodhue 2005). Malhotra et. al. (2005) posit that supply chain partners use information technology infrastructure to process information and create new knowledge. SMC technologies are precisely meant for collecting and processing data to find patterns that are insightful and drive innovation in business processes to alleviate inefficiencies (Trkman et al. 2010). Numerous companies including HP, Dell, and IBM offer such services and solutions to firms (Niccolai 2011). Hence, we submit that *internal demands*, the felt need to improve internal efficiency, is an important catalyst for companies adopting SMC technologies.

Recently, digital technologies have also gained a center stage in developing customer centric organizations. Organizations have taken great strides in improving customer satisfaction and service. Wachovia Bank (now part of Wells Fargo) established a policy of contacting an unhappy customer the same day (Berry et al. 1994). Continental Airlines has adopted a data warehousing platform to gain access to real-time customer and flight information that helps them better understand and meet their passengers’ needs and wants (Watson et al. 2006, Setia et al. 2013). Similarly, Barclay’s Bank, and Best Buy focus on improving their customer services by collecting and analyzing data about their customers (Cisco 2007, Kovac et al. 2009). SMC technologies that are used for storing and analyzing large volumes of data are vital for these firms to recognize customer discontent and improve customer satisfaction. We propose that *market demands*, the extent to which the organization must monitor the customer market and the requirement of customers for personalization in products and services, are a factor that propels adoption of SMC technologies as part of the broader business analytics strategy. Market demands are even considered part of an organizational culture that drives customer value through monitoring needs and responding accordingly (Setia et al. 2013). We hypothesize that internal demands and market demands are positively correlated with the adoption of SMC technologies (as shown in Figure 1). Market and internal demands are the precursors, not the realization of the satisfaction of those demands,
meaning that market and internal demands are clearly distinguished from the outcome variable of adoption and ensuring the falsifiability of our hypotheses.

Aoki (1990) emphasizes the importance of efficient and effective integration and coordination among different divisions within organizations. Emerging technologies like cloud computing are known to be associated with integration challenges pertaining to old legacy systems (Linthicum 2009). As firms age, it becomes complex for the organizations to get rid of older systems due to unique cultures and routines developed over time. Radical organizational re-engineering is often required to support the new capabilities provided by new technologies (Abernathy and Clark 1985, Teece 1997). As highlighted in a recent research report from IBM and University of Oxford (McKenna 2012), anecdotal evidence points to an industry-wide shortage of people who can use structured and unstructured data generated by the emergent tools for crafting actionable strategies. As a result, organizations may face a dearth of employees who can steer through the challenges faced during the implementation of SMC technologies. Companies possess heterogeneous technological skills, the human capital resources to design, develop, build and maintain information systems (Ravichandran and Lertwongsatien 2005). Firms facing technological skills shortages are less likely to produce usable and reliable systems and experience higher SMC adoption.

Public policies, regulatory bodies, intellectual property regimes, tort laws, etc. can pose several external challenges for the firms in the process of implementing new technologies. These laws vary across states, countries and industries. Security of customer data is a priority in many countries (Flood 2013). The problem of security may get compounded due to the large volume of data generated by SMC technologies. The increasing number of security-related incidents in the field (e.g., TJ Maxx, Target (Sidel et al. 2013)) and their accompanying legal ramifications have increasingly driven firms to decelerate their pace of emerging technology investments and to rethink the security implications of every technology that the firms adopt. We term this construct as the information security concerns of the firm. The security environment and the extent to which security concerns force the firm to incur higher costs or delay in implementation act as a potential barrier to firms adopting SMC technologies. We hypothesize that information security concerns are negatively correlated with the adoption of SMC technologies (as shown in Figure 1).

Relation of Business Analytics Strategy with Antecedents of Adoption

A Market Responder firm uses business analytics capabilities to develop better understanding of the customer and acquire new customers. Therefore, we posit that a market responder firm should have positive correlation with market demands. An Organization Optimizer firm uses the business analytics capabilities to make decisions at executive levels of the organization. Therefore, such a BAS profile should have positive correlation with internal demands and market demands. Such a firm is also expected to be very concerned about the security of its assets, intellectual property rights etc. Therefore, we posit that organization optimizer would demonstrate a negative correlation with technological skills shortage and information security concerns. An Efficiency Seeker firm is expected to use business analytics to improve the efficiencies of its internal business processes. Therefore, we expect to observe a positive correlation between this BAS profile and the construct internal demands. Finally, an Analytics Laggard is expected to wait until firms of other profiles develop expertise in using business analytics for different functions and help mature the technologies. Moreover, such firms are expected to be wary of using the technologies if the challenges in using them are substantial. Therefore, we expect an Analytics Laggard to show a negative correlation with technological skills shortage and information security concerns.

Influence of IT Investment

Forman (2005) provides strong evidence that IT investments impact technology adoption in general. Any important IT initiative requires extensive organizational restructuring and training on new hardware and software (Anderson et al. 2006). Moreover, new project execution requires substantial investments in coordination, preparation, monitoring and launching for controlling costs which tend to be high during new project implementation (e.g., Kim and Mukhopadhyay 2011). We expect that IT investment is therefore positively correlated with the adoption of SMC. Thus, we control for the increase in information technology investments as a predictor of adoption of SMC.
Methodology

We have already discussed the source of the data in a previous section. The data also contains questions that are relevant to study (i) the degree to which firms adopt social, mobile, and cloud computing technologies, (ii) the presence of antecedents of adoption – internal demands, market demands, technological skills shortage, and information security concerns, and (iii) the increase in IT investment anticipated by the firm in the next two years.

Measurement

The dependent variable, Adoption of Social, Mobile, and Cloud Computing, is a formative construct that measures the current adoption status of the three emerging technologies by the firm. Adoption status is measured on a scale of 1 to 5 denoting no plans, planned within 24 months, pilot stage, limited set of capabilities deployed and significant capabilities deployed, respectively. SMC, via their generation and use of big data, help firms differently in developing the capabilities to compete in dynamic market places. For instance, while SMC helps increase the firm’s communications with customers, these three technologies help in the communications in different ways. Mobile devices, such as smartphones, are used to track individual customer data. Nordstrom tracks data on – how many customers came through the doors, how many were repeat visitors, etc. (Clifford and Hardy 2013). Social computing is used to gain and use insights derived from interactions of people in a network of individuals. Tibco and Yammer develop internal social platforms that can help companies organize their functions requiring interactions of employees (Hardy 2012). Levy (2014) discusses tools that companies may use to analyze data over social media platforms such as Facebook, Twitter etc. in order to spread the word about products and track how the product popularity changes. Both mobile and social computing are means to interact with the customers (Davies et al. 2013).

Internal Demands are measured as the extent to which the organization is motivated to adopt big data technology to facilitate communication and collaboration, responding to internal employee demand and providing business scalability. Market demands are the extent to which the organization is motivated to adopt big data technologies to understand customer sentiment, respond to partner/customer demand and enable faster time to market.

On the other hand, the antecedents, technological skills shortage and information security concerns, are measured as the human capital with specific knowledge in a broad set of IT and business domains and presence of IT security policies and practices insufficient to meet the firm’s needs, respectively. For example, if we consider the construct technological skills shortage, cloud computing implementations may require knowledge about cloud architecture and implementation procedures of on-site solutions (Florentine 2013). Technological skills shortage regarding mobile computing include development of user interfaces and applications that can communicate over the mobile networks and Wi-Fi (Sacco 2008). Finally, social computing requires knowledge and skills to handle and use large amount of unstructured data to develop insights using advanced technologies such as Hadoop. Technological Skills Shortage is measured as a formative construct that captures inadequacy of IT skills related to the emerging technologies of social, mobile and cloud computing respectively. The construct, Information Security Concerns, is measured formatively as the existence of challenges in securely provisioning access control and protecting confidential data across social, mobile and cloud computing.

Preliminary Results and Analysis

As we are in the process of analysis, we present our preliminary findings in this section. First, factor analysis on the data shows clear and expectation-consistent loadings of the questions on the constructs shown in Figure 1. We avoid presenting the results of factor analysis for brevity.

We perform linear multiple and ordinal regressions (including generalized ordered regressions) with degree of adoption as the dependent variable. Given the structural form as in Figure 1, the antecedents of adoption are endogenous constructs. In Table 1 we provide the results of the linear regression model for degree of adoption.
After controlling for the change in IT investment expected to drive adoption, the constructs – internal demands and market demands, are positive and significant predictors of adoption. The coefficients of the constructs – technological skills shortage and information security concerns - are negative and significant. Therefore, our hypotheses for the relationship of the degree of SMC adoption with the antecedents of adoption are supported. In the future, we will include additional control variables in order to derive robust conclusions regarding the relationship of SMC adoption with the antecedents of adoption of SMC. Our analysis up to this point does not leverage the BAS profiles in the structural model, however, we expect that the profiles will provide additional insights. Preliminarily path regression analysis indicates that the antecedents to adoption are experienced differentially depending on the BAS. We will also perform structural equation modeling and mediation/moderation tests to analyze the full model.

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<tr>
<th>Table 1. Linear Regression Results (Degree of Adoption)</th>
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<td>Coefficient</td>
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<tr>
<td>(Constant)</td>
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<tr>
<td>Internal Demands</td>
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<td>Market Demands</td>
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<td>Technological skills shortage</td>
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<td>Information Security Concerns</td>
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<td>Change in IT Investment</td>
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***: p-value < 0.01; **: p-value < 0.05; *: p-value < 0.1

Discussion and Conclusion

In this research, we study various business analytics strategies of firms and their relationship with adoption of SMC. These technologies serve as foundations for capabilities in business analytics. Such capabilities enable firms to create their niche positions in dynamic market environments. Whereas adoption of SMC technologies are influenced by the firms’ business analytics strategies, the specific relationship with the adoption of SMC is shaped by firm level antecedents of technology adoption of SMC.

Based on our analysis, we first find that firms may be divided into five clusters based on their business analytics strategies, the relative position they take in using big data across three business domains – market sensing, governance and internal operations. While an Analytics Leader uses business analytics for improving its performance across all three business domains, an Analytics Laggard is a minimal user of business analytics for any of the three domains. The firms in the other three profiles focus their use of business analytics primarily on one of the three business domains.

Next, we find that internal demands and market demands, play a role in driving SMC adoption. However, because these technologies are new, they pose significant challenges to firms adopting them. Primary among them are the technological skills and the broad information security concerns specific to SMC. Both these constructs are negatively related to the adoption of SMC technologies.

The implications for top managers in the firm are that understanding the specific business analytics strategy of the firm and anticipating the antecedents of technology adoption that drive SMC adoption are critical for success. While the manager may have leverage to drive adoption through other mechanisms, the environment of the firm matters in terms of achieving desired SMC outcomes.

References


IS Strategy, Structure and Organizational Impacts


