Understanding the Adoption of Business Analytics and Intelligence

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This is the Author Peer Reviewed version of the following chapter/ conference contribution published by Springer:

Cruz-Jesus, F., Oliveira, T., & Naranjo, M. (2018). Understanding the adoption of business analytics and intelligence. In Á. Rocha, H. Adeli, L. P. Reis, & S. Costanzo (Eds.), Trends and Advances in Information Systems and Technologies, pp. 1094-1103. (Advances in Intelligent Systems and Computing; Vol. 745). WorldCIST'18: World Conference on Information Systems and Technologies 2018. Springer Verlag. DOI: 10.1007/978-3-319-77703-0_106

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Abstract. Our work addresses the factors that influence the adoption of business analytics and intelligence (BAI) among firms. Grounded on some of the most prominent adoption models for technological innovations, we developed a conceptual model especially suited for BAI. Based on this we propose an instrument in which relevant hypotheses will be derived and tested by means of statistical analysis. We hope that the findings derived from our analysis may offer important insights for practitioners and researchers regarding the drivers that lead to BAI adoption in firms. Although other studies have already focused on the adoption of technological innovations by firms, research on BAI is scarce, hence the relevancy of our research.

Keywords: Business Analytics and Intelligence; IT adoption; Diffusion of Innovations; Technology-organization-environment; Institutional Theory.

1 Introduction

The widespread adoption of information technology (IT), together with the significant advances in computer sciences are playing a decisive role in shaping the daily actions within firms that are now living in the era of Big Data [1]. At the center of this new paradigm is the decision to adopt and use technological innovations. Grounded on the technological innovativeness literature, the information systems (IS) research discipline has been gaining interest in explaining the adoptions of technological innovations, as these are becoming more popular among firms. Our work focuses on identifying and explaining the adoption of one technological innovation - the business analytics and intelligence (BAI).

The effective implementation of BAI involves an unusual combination of practices and technologies in a firm, and calls for considerable investment, making its adoption decision unique and unsuitable to be driven by conceptual models developed for other technology-adoption decisions. To better understand this issue, we develop a new conceptual model that combines three theories: Diffusion of Innovations (DOI) [2], the Technology, Organizational, and Environmental Framework (TOE) [3], and the Institutional Theory [4].

This paper is organized as follows. In Section two, based on the literature review we provide a definition of BAI and review the literature of firm-level adoption models that are most widely used. In Section three we present the research model that we intend to test.

2 Theoretical Background

Business Analytics and Intelligence (BAI)

The widespread availability of ICTs is revolutionizing the way data are collected and used [5, 6]. The advent of data warehousing enables firms to retain, clean, load, and integrate vast amounts of data from multiple sources into a single and standardized repository, allowing the use of "analytics" in order to gain "intelligence". Hence, BAI is a generic term referring to the application of multiple analytic techniques, such as reports, slice-and-dice, drill down, ad hoc queries, real-time analysis, and forecasting models, to answer questions, solve problems, identify opportunities, reduce threats, or find hidden patterns in customers´, suppliers´, and even competitors´ behaviors [7]. Thus, BAI is not a "stand-alone" technology, but rather a group of tools and actions within a firm that are combined to analyze information and improve performance through fact-based decision making [8]. BAI has the potential to revolutionize the way a firm conducts its business. The intention is to deliver accurate information to business users in an automatic manner to save time and improve efficiency [9, 10]. However, it requires considerable investment in IT and human resources. It is, in fact, an enterprise-wide initiative. There are hardly any other initiatives that are as demanding as BAI. BAI is not limited to a single department or area within an enterprise. At the same time, it does not require the involvement of other business partners (as does EDI, ERP, or e-business, for example).

Successful "case-studies" of BAI implementation and value represent the major improvements that firms may experience when deciding to implement these systems (see for example, [11, 12]). Nevertheless, implementing BAI is not a task that is free of risks, nor does it automatically achieve improved performance. Successful firms such as Continental Airlines [11] or First American Corporation [12] achieved up to 1000% return on investments from BAI initiatives, while others have incurred sizable losses [13]. For these reasons practitioners and researchers need to understand the drivers of BAI adoption to ensure the success of this promising, yet risky and costly, technological innovation.

Adoption Models´ Literature

To fully understand the BAI adoption process, we need to view the issue through the lenses which have already proved to be effective in explaining many other technological innovations in the past. The literature on organizational innovativeness has seen significant advances in recent years, as authors have combined multiple theories into integrated new models to gain better insights into technological innovativeness, subsequently testing them with data. Three of the most popular ones are the Diffusion of Innovations [2], the Technological, Organization, and Environment Framework (TOE), and the Institutional Theory [4].

Diffusion of Innovation (DOI)

Diffusion of Innovation theory (DOI) is one of the most prominent adoption models used in IS research [14]. DOI provides a thorough analysis of innovation diffusion drivers and constraints along with insights into the process of adopting, or not, an innovation

(technological or non-technological), both for individual and firm levels. Considering that innovations are new ideas, they introduce an element of social change and risk, which brings uncertainty to the adoption-decision. Hence, diffusion of innovations is a complex phenomenon that depends on multiple factors. Rogers [2] lists five perceived attributes of the innovations that explain "between 49% and 87%" of an innovation´s rate of adoption, i.e. the relative speed with which an innovation is adopted by members of a social system [2] (page 221). These five characteristics of each innovation are the relative advantage, compatibility, complexity, trialability and observability [2] (pages 222-259). As mentioned, these attributes of the innovations will define its rate of adoption. Considering that the adoption of innovations in firms is a much more complex process than the adoption of individuals [2, 14], some characteristics of the firms are also found to be important in explaining its innovativeness [2] (page 411). Rogers reports three aspects of the firms´ context that have the potential to influence its innovativeness. These are the individual (leader) characteristics, the internal characteristics of organizational structure, and external characteristics of the organization. Each one involves the measure of distinct items.

Technological, Organizational and Environmental (TOE) Framework

The TOE framework was developed in 1990 [3]. It comprises three elements of a firm's context that influence the process by which it adopts a technological innovation: technological, organizational, and environmental contexts. The technological context describes both the internal and external technologies relevant to the firm, including technologies existing inside and outside the firm [3] (page 153). Tornatzky et al. argue that these technologies should be in a separate context to focus attention on how the capabilities (attributes) of the technology itself can influence its adoption decision. Organizational context comprises several features of the organization, such as its size, centralization, linking structures, and others [3] (page 153). Finally, the environment context is "the arena" in which an organization conducts its business, including its industry, competitors, suppliers, and governmental entities [3].

Hence, much overlapping exists between TOE and DOI. Although different, these two theories are consistent with each another. When Tornatzky et al. [3] posit that technological features influence the adoption and implementation processes, it implies the same reasoning of Rogers when he includes the perceived benefits of the technological innovations as important in explaining its adoption rates. Moreover, the DOI´s internal and external organizational characteristics are approximately the same measures as the TOE´s organizational context [15]. There are, however, important differences between these two theories. The TOE´s environmental context is an addition to Rogers´ DOI. On the other hand, DOI includes an important factor that is not mentioned in TOE, which is the individual (leader) characteristics, commonly known as top-management support. Hence, DOI is better able to explain intra-firm technological innovation adoptions, while TOE´s is better suited for inter-organizational ones [14, 15].

Institutional Theory

Institutional theory posits that institutional environments are significant factors in shaping organizational structure and actions [16, 17]. Hence, organizational decisions are

not driven purely by rational goals of efficiency, but also by social and cultural factors and concerns for legitimacy, which leads to isomorphic processes [14, 18], defined by DiMaggio [4] as "*a constraining process that forces one unit in a population to resemble other units that face the same set of environmental conditions*", in which firms in the same industries tend to become similar. According to him this can be caused by three distinct natures of pressures: coercive; mimetic; and normative [4, 19]. Mimetic pressures are observed when a firm adopts a new practice or innovation by imitating their competitors in the same industry [20]. Coercive pressures are a set of formal or informal forces exerted on firms by other firms upon which the former ones depend [21]. Finally, normative pressures come from dyadic relationships in which companies share some information, rules, and norms [18]. Hence, this theory is significantly different from the DOI and TOE. The institutional theory neglects some aspects of the innovations and organizations, emphasizing the role that the three types of pressures have in leading to the decisions of adopting or forgoing an innovation. We believe that some aspects of this theory may be particularly helpful in explaining the BAI's adoption.

3 Research Model

Grounded on a thorough literature review, which served as the lens through which to view technological adoptions, we develop a unifying framework for BAI combining multiple factors earlier identified by theoretical and empirical means, as being significant in explaining the adoption of other IS. The decision of aggregate different theories is since, although being similar in some points, they all have differences as well. When compared with TOE, DOI gives more attention to the innovation´s characteristics than does TOE. On the other hand, TOE emphasizes the role of organizational and environmental contexts rather than the innovation itself. We consider that both technological innovation and the firm´s contexts are equally important, and join these two theories as a result. The institutional theory is the only one that explains technological adoptions by firms from another perspective, i.e., it considers that decisions to adopt innovations are not based purely on rational arguments, in the sense of being motivated by the desire to achieve better performance.

The model (see Figure 1) comprises nine constructs: top-management support, relative advantage, compatibility, complexity, technology competence, size, slack, competitive pressure, and mimetic pressures. One might ask why some of the theories´ components described above have been excluded from our model. BAI is not testable nor observable in the same sense that Rogers´ [2] explained the concepts of observability and trialability. Moreover, the institutional theory, applied to the context of our study – BAI adoption for a wide range of industries – is suitable only for the use of mimetic pressures, excluding the normative and coercive ones. We are aware that some legislation (coercive pressures), such as the Sarbanes-Oxley Act, and industries´ norms (normative pressures) may influence, or even force, the adoption of BAI. Nevertheless, this occurs in specific contexts (for example

financial firms in the U.S.), which are beyond the scope of our study, which seeks generalization.

Considering that it is not possible to simply ask firms if they use BAI or not, due to the imprecision of the term, we use the Popovič et al. [22] measurement model, which is consistent with our view of BAI as the combination of data integration and use of analytic techniques.

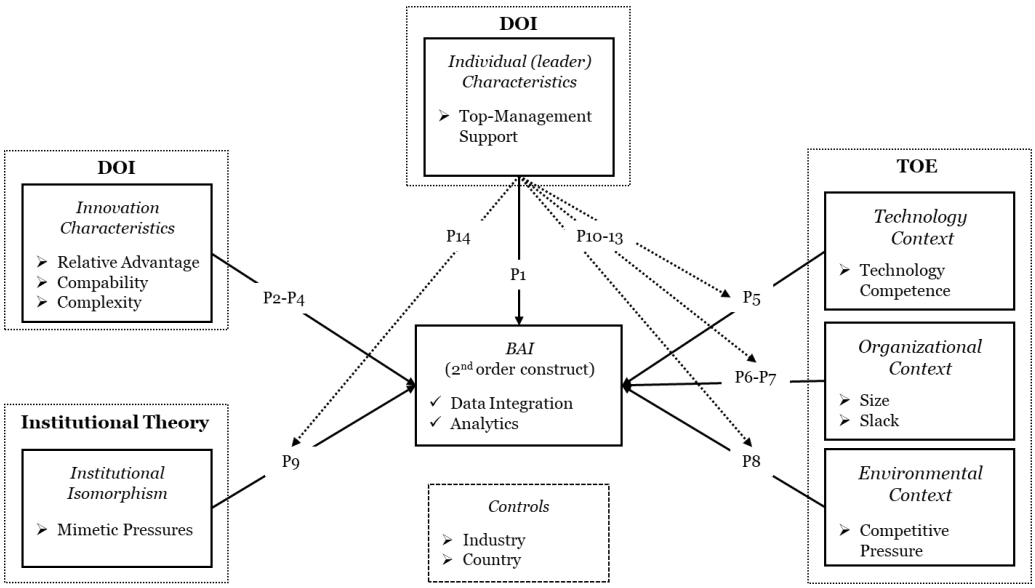

Fig 1. Proposed adoption model for BAI

Top-Management Support

The innovation literature suggests that top-management support is positively related to the adoption of technological innovations in firms [2, 23]. Due to its unique characteristics such as the high financial costs and complexity, BAI may be especially dependent on top-management support [24]. Hence, we posit,

P1: Top management support will positively influence BAI adoption.

Relative Advantage

Relative advantage has been widely identified as a significant factor driving firms´ adoption of technological innovations [2, 23, 25]. Rogers [2] (page 233) posits that "relative advantage is one of the strongest predictors of an innovation´s rate of adoption", which is fully consistent with our view of BAI. As some of its main advantages are, but not limited to, data quality improvement; operating-costs reduction; increased sales, or increase customer retention rates. Hence, we posit,

P2: Relative advantage will positively influence BAI adoption.

Compatibility

Compatibility is generally described as a driver for technological innovativeness [2, 26]. The degree to which a technological innovation is compatible with the firm intending to adopt it involves several dimensions. Compatibility can be related to the firm´s existing values, culture, needs, or work practices [25, 27]. Considering that implementing BAI implies profound transformation in the way a firm conducts its business and in its decision-making processes, BAI must be perceived as being compatible with the firm´s values and needs. Hence, we posit,

P3: Perceived compatibility of BAI with the firm´s processes and culture will positively influence its adoption.

Technology Competence

Technology competence is an important predictor for IS adoption [28]. IT infrastructure is the physical and technological assets on which BAI is built and operates as it requires a wide range of hardware and software, such as servers, computers, specific software applications, networks, etc. It also requires a certain expertise from its human resources to take advantage of its possibilities. These requirements of BAI in terms of infrastructure and human resources lead us to consider the technological competence of a firm to engage BAI as a combination of physical and intangible resources.

P5: Higher levels of technology competence will positively influence BAI adoption.

Size

There is no consensus in the innovation diffusion literature about the effect of firms´ size in the role of innovativeness adoption [15]. Several authors, such as Rogers [2] (page 412), argue that a firm´s size positively affects its innovativeness, probably because larger firms tend to have greater financial and technical resources, which facilitate the adoption of technologies. Against this, several other studies (see for example, [29]) point in the opposite direction, i.e., argue that size has a negative effect on technological innovativeness, considering that larger firms are more bureaucratic, which leads to inertia - a constraint to innovativeness. We argue that these two opposite arguments can both be right, depending on the context. Hence, the effect of size in innovativeness probably depends on the technological innovation itself. Considering that BAI is a demanding process in terms of financial and human resources, we argue that:

P6: Firm size will positively influence BAI adoption.

Slack Resources

According to Rogers [2] (page 411), slack resources, or organizational slack, refers to "*the degree to which an organization has more resources than those required for its ongoing operations*", and it is described by Rogers as having a positive influence on innovativeness. Considering that the availability of slack resources is related entirely to the organizational context, we include it within the TOE in our conceptual model. Although the existence of slack resources is not one of the most popular aspects to understand technological innovation´s adoption, we find it particularly interesting in the context of BAI because of its demands in terms of costs and uncommitted human resources. Thus,

P7: The availability of slack resources will positively influence BAI adoption.

Competitive Pressure

Competitive pressure is recognized in the innovation adoption literature as an important driver in the adoption of innovation [30, 31]. BAI can be easily seen as a path to overcome competition [9]. By making use of BAI, firms can put their customers in the center of the business [32], relating with them in a personal way, getting to know their preferences and behaviors. Moreover, by means of analytics and modeling, they can identify those customers with more propensities to churn, which is naturally greater in the most competitive markets. Acting on this and other insights, firms may be tempted to engage in BAI in order to reduce these churns and even gain more customers by increasing sales with cross- and up-selling campaigns.

P8: Higher levels of competitive pressure will positively influence BAI adoption.

Mimetic Pressures

As mentioned above, including the institutional theory in our model allows us to address the adoption of BAI with motivations other than rational goals of efficiency [14]. Hence, the proposition we include in our model is based on neither the perceived technological characteristics of BAI nor the firm´s organization, but rather on the perceived success of BAI in competitors of the same industry, which has been demonstrated to be a valid driver for technological innovativeness in earlier research [21]. Note that we are not measuring the competition a firm experience – that was hypothesized earlier – in which BAI can appear as a solution to overcome it. We are interested in measuring the perception of BAI´s successful rate of adoption from competitors within the same industry. We find this to be particularly relevant to BAI because of the popularity these systems have, which makes them especially vulnerable to mimetic pressures.

Proposition 9: Higher levels of perceived success in competitors´ usage of BAI will positively influence its adoption.

Top-Management Support as Moderator

Top-management support, we hypothesize, serve as a catalyst, i.e., moderator, for some of the previously mentioned BAI's would-be drivers.

P10-14: The higher the top management support, the higher the effect of technology competence, size, slack, competitive and mimetic pressures on BAI adoption.

4 Perspective Implications of the Proposed Model

Understanding BAI adoption is an issue of special importance considering that during recent decades these technologies have emerged as one of the critical applications in firms to provide useful insight, support decision-making, and drive organizational performance [5, 6, 33-35]. BAI is thriving in almost every industry, including retail, financial services, manufacturing, utilities, and telecommunications services. This increasing popularity is

related to the potential of BAI to deliver what is today recognized as a critical success factor for firms – the ability to make accurate, timely and effective decision-making – at all hierarchical levels, thereby remaining competitive in a global economy [36, 37]. Due to BAI's complexity, given its ability to completely (re)shape the way a firm conducts its business, thus presenting simultaneously significant risks and opportunities, we combined specific attributes of some of the most popular and widely tested adoption models, to propose a new one especially "tailored" to BAI adoption.

Our proposed model intends to help researchers and practitioners to better understand BAI's adoption, in order to mitigate its implementation's risks and, at the same time, improve the adoption process. From the empirical validation of our model, and its hypotheses, we expect practitioners and managers, may know a priori what are the most relevant drivers, and inhibitors, of BAI's adoption. If we can do so, then a smoother and most effective adoption may take place. For researchers, the perspective implications of our work lie in shed some light on the adoption process of one of the most innovative and relevant technologies for firms.

5 Conclusions and Future Work

We developed a new conceptual model that combines the Diffusion of Innovations, the Technology, Organizational, and Environmental Framework and the Institutional Theory, to understand BAI adoption by firms. Our conceptual model comprises specific attributes of these three theories that, based on the literature review, the authors believe are suitable in the specific context of BAI. Overall, we developed 14 propositions, in which nine are hypothesized as direct determinants of BAI adoption, whereas five are in respect to the moderator effect top-management support is hypothesized to have with the other determinants.

The model will be empirically tested using Structural Equation Modelling (SEM), more specifically, Partial Least Squares (PLS) using data collected in the Portuguese context.

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