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The diffusion stages of business intelligence & analytics (BI&A): A systematic mapping study

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Abstract

Business intelligence & analytics (BI&A) has evolved to become a foundational cornerstone of enterprise decision support. Since the way BI&A is implemented and assimilated is quite different among organizations is important to approach BI&A literature by four selected diffusion stages (adoption, implementation, use and impacts of use). The diffusion stages assume a crucial importance to track the BI&A evolution in organizations and justify the investment made. The main focus of this paper is to evidence BI&A research on its several diffusion stages. It provides an updated bibliography of BI&A articles published in the IS journal and conferences during the period of 2000 and 2013. A total of 30 articles from 11 journals and 8 conferences are reviewed. This study contributes to the BI&A research in three ways. This is the first systematic mapping study focused on BI&A diffusion stages. It contributes to see how BI&A stages have been analyzed (theories used, data collection methods, analysis methods and publication source). Finally, it observes that little attention has been given to BI&A post-adoption stages and proposes future research line on this area.

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Keywords: BI&A; business intelligence & analytics; implementation; adoption; use; impacts; benefits; systematic mapping study

1. Introduction

In the latest years, business intelligence and analytics (BI&A) has emerged as an area of decision support systems (DSS) research, with a tremendous interest among academics and researchers [1, 2]. In the era of Big Data, BI&A can help to improve organizational performance as a result of improvement on business decision making [1, 3].

BI&A born from the success of Business Intelligence (BI) in the 1990s and the introduction of Business Analytics (BA) in the 2000s, a key data analysis element in BI [3]. In the context of this paper, “business intelligence & analytics”, “business intelligence” and “business analytics” may be used as inter-changeable terms. Today’s definition of BI&A embraces all the positive attributes of BI and BA. Hence, BI&A can be defined as “the techniques, technologies, systems, practices, methodologies, and applications that analyze critical business data to help an enterprise better understand its business and market and make timely business decisions” [1]. BI&A enable firms to enhance the existing organizational applications, providing business-centric practices and methodologies that could provide competitive advantage [1, 3].

Although some literature reviews have been made about BI&A [1, 2, 4-7] none of them focus on the categorization of the different stages of BI&A diffusion: adoption, implementation, use and impacts of use. Many are the reasons that provide the motivation for this paper. First, BI&A constitute a dynamic, attractive and highly relevant field of research [8]. Second, the extended BI&A research needs to be reviewed in order to identify critical knowledge gaps and motivate researchers to close the breaches [9]. Third, a recent study called for research of BI&A diffusion stages [10]. Hence, in order for research to advance, this study analyzes the BI&A literature and then proposes an agenda for future research opportunities.

Mapping studies can make researchers save time and effort, providing baselines to support new research efforts [11]. The purpose of this study is to provide an updated review of the literature of BI&A research. A set of 30 papers published in various conferences and journals between 2000 and 2013 is analyzed. Adapted from a diffusion process approach [12], we aggregate those studies and enhanced the literature by categorize among four selected stages of BI&A. These diffusion stages were defined based on Esteves [12] process. We find this approach to be suitable since it was used in a previous study conducted by the authors [13].

The remainder of the paper is organized as follows. Section 2 describes the research method approach to the analysis of BI&A research. Next, we provide the bibliography, the overview of the articles and analysis of BI&A research. Finally, in Section 4, findings, implications and conclusions with future research opportunities are presented.

2. Background

Six review articles have been written on BI&A prior to this article. The first was made by Jourdan [4], where 167 articles published from 1997 to 2006 categorized by research strategy and BI&A category. The conclusions point to the need of BI&A researchers shift to other research strategies like survey. In the year after, Bose [5] investigate some BI&A technologies in terms of how they are used and the issues that are related to their effective implementation. A range of recently published research literature on BI&A is reviewed to explore their current state, issues and challenges learned from their practice. Later, a concept analysis from a managerial perspective made by Shollo [6] analyzed 103 articles related to BI in the period 1990 to 2010. Also, Fitriana [7] reviewed the BI&A approaches in 60 journals of business intelligence from 2000 to 2011. While half of the articles found adopt a single approach to design BI&A systems, the other half is divided by and integrated approach between BI and: Data Mining, Supply Chain Management (SCM), Customer Relationship Management (CRM), Artificial Intelligence (AI), Knowledge Management (KM), Decision Support Systems (DSS), Strategic Management, and others. Next, Chen [1] conducted a bibliometric study analyzing relevant literature, major BI&A authors, disciplines and publications, and key research topics based on the past decade (2000-2011) of related academic and industry publications. Lastly, Kowalczyk [2] conducted a literature analysis to characterize the current state of research related to BI&A systems, decision support technologies in general and their effects on decision processes.

3. Research methodology

In this article we have applied a systematic mapping study approach, different from the most common systematic research [14]. This approach usually aims to classify the relevant literature and aggregates studies with respect to the defined categories [11].

For conducting this systematic mapping study we used the guidelines provided by Kitchenham [11] and Webster [9]. We conducted the research in five steps: (1) definition of the research question; (2) conducting the search process; (3) screening papers; (4) classifying papers; and (5) data extraction and aggregation. One essential research question was defined:

Regarding BI&A, what are the most investigated diffusion stages?

Concerning the search process, we define the target databases and journals for the search. We searched well-established databases, namely, Web of Science, EBSCOhost, IS journals and IS conference proceedings. A period between the years 2000-2013 was selected. In order to provide further insights into the matter, a given literature base on BI&A was systematically searched with keyword queries as well as backward- and forward-searches. Several keywords were used such: “Business Intelligence & Analytics”, “Business Intelligence”, “Business Analytics”, “Diffusion stages”, among others. The main criteria used were the number citations and the impact factor of the source. A total of 30 reviewed articles related with BI&A have been selected. Following the classification guidelines [15], based on our experience of the domain [16], we classified the studies based on four BI&A diffusion stages (adoption, implementation, use and impacts of use). Although, most of the studies are related with proposed measure models, some studies are exemplifications of impacts of use BI&A technologies [17-21]. Therefore their methods should be not included on the analysis. Finally, an aggregation of the studies is made and presented on the following section.

4. Analysis of the articles

In this section we present the synopsis of present study results. The articles reviewed for each study are referred in the Appendix. Accordingly, in order to answer the main research question, we analyze the selected articles based on each diffusion stage. The review shows that the BI&A diffusion stages have been differently investigated (see Figure 1).

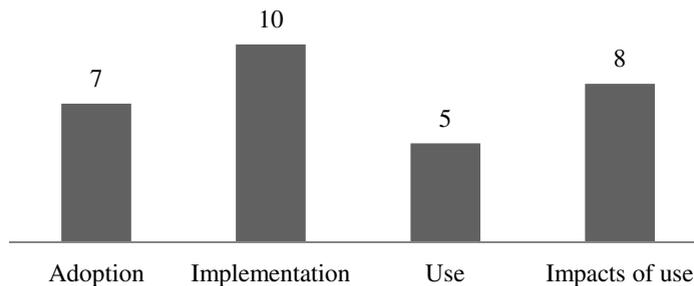


Fig. 1. Number of articles selected by BI&A diffusion stage

BI&A adoption, firms are increasingly adopting BI&A technologies like dashboards, adhoc query and interactive visualization etc. to support decision-making [1].

IS theories such Technology Acceptance Model (TAM) [22] and Technology-Organization-Environment (TOE) theory [10] have been applied to measure it. Other studies assess it using developed instruments based on literature review [23, 24]. Particularly, specific components of BI&A have been studied such as Data Warehouse (DW) (see for example [25]), CRM systems (see for example,[26]), Enterprise Resource Planning ERP systems (see for example [27]), among others. Observing Figure 1, 7 articles were found, which represents about 23% of our sample.

After adopting a set of BI&A technologies, the organization is now able to start its implementation. Regarding our study, implementation stage is the most investigated. The Figure 1 shows that a large number of articles were found (33% of the sample). The reason for this may be due to the fact that this stage is complex and fundamental to create a basis for BI&A lifecycle. Asserting that the implementation of a BI&A systems is a complex undertaking requiring considerable resources, several authors proposed critical success factors (CSF) of BI&A projects [28-30] and associate contextual elements crucial for BI&A systems implementation. They found that non-technological

problems are found to be harder and more time consuming than technological problems. Also, BI&A projects have unique CSFs and are different from IS projects in general. Successful BI&A initiatives have been qualitatively studied in major industries including: healthcare [31], airlines [32], financial services [33], telecommunications [34], and others. Nevertheless, implementing BI&A is not a task that is free of risks, nor does it automatically achieve improved performance. Some firms have incurred sizable losses on BI&A initiatives [4]. As a result, especially to manage volatile environments, some factors that affect implementation, have been explored such: BI&A capabilities [35] and agility [36, 37].

The realization of business benefits of BI&A depends on sustaining effective use of BI&A systems [38]. BI&A use involves creating new insights through analyzing data and information from a diversity of sources and using them to achieve competitive differentiation [3]. In practice, BI&A use has been quantitatively studied using IS theories like DeLone & McLean Model [38, 39] or DOI theory [40]. While some authors [40] explored the link of use to organizational performance in a specific component of BI&A (ERP), others [38] demonstrated that higher levels of BI&A systems usage lead to a better individual performance. Others analyze this dimension based on multiple case studies [41] or developed instruments based on literature to analyze specific areas like budgeting [42]. Comparing the stage of effective use with others, we can observe in Figure 1 this stage has the lowest representation in our sample (about 17% of total sample).

About impacts of BI&A usage authors [40, 43-46] applied theories such absorptive capacity theory or resource-based-view (RBV) to measure the performance effects of BI&A use at organizational levels. Also, in an organizational perspective other authors [39] proposed an interrelation model of how several dimensions affect BI&A use. Recent studies provide an exemplification of BI&A positive impact on organizations in the most different areas and applications. In market intelligence, several authors [18, 19, 47] reported some of the benefits such increased sales and customer satisfaction. Also, BI&A systems are able to support strategic decisions in mergers and acquisitions [17]. In banking, the monitoring and mitigating of contagious bank failures is possible using BI&A technologies [19]. In order to detect fraud, analytical capabilities are used to discover fraud patterns [21]. Lastly, BI&A technologies create the possibility of collaborating filter, personalizing recommendations for user preferences [20]. Although a considerable number of articles related were found (27%), only 10% focus on studying the effect of use in performance. The remaining articles are exemplifications of how the use of BI&A technologies can bring benefits to the organizations.

5. Discussion

An effective literature review uncovers areas where research is needed [9]. The sample of articles that constitute this systematic mapping study show a baseline for empirical research of various kinds. Huge attentions have been given to implementation stage but few authors have tried to assess this stage by conducting quantitative studies theoretically grounded. In opposite to its previous stage, adoption has been researched essentially using quantitative methods. In this particular stage, we observe that BI&A is generally studied in specific components (e.g., ERP, CRM, DW).

After a successful adoption of BI&A, the interest moves further to the most efficient use of the technology. Typically it has been approached using data for only one country. For that reason cross-sectional studies could bring a contribution for academia. Also, this stage has been theorized using only IS success theory (DeLone & McLean) [38, 39] or DOI [38]. Given the unique characteristics of BI&A, it would be an opportunity to apply other theories which are able to explain their specificities. In addition, a recent study [10] also refers that factors that affect BI&A use deserve a closer look. Therefore, we conclude it is important to explore the factors that affect BI&A use grounded in other theories.

Moreover, the impacts of use have been essentially presented in BI&A field through exemplifications which indirectly demonstrate the potential benefits of BI&A. Few studies tried to statistically measure the benefits that BI&A technologies can bring to organizations. Theories such absorptive capacity or resource-based-view theory of the firm were used to theorize those benefits only in specific components of BI&A (ERP, Management Control System (MCS)). It remains unclear how can we measure the benefits offered by the umbrella of BI&A technologies.

In general, although BI&A is a popular concept, it has not yet been properly theoretically grounded or holistically studied. Through our systematic research process based on relevant information sources, few studies analyze BI&A post-adoption stages and none of them explores the panoply of BI&A technologies in an

organizational perspective. Also, none of them empirically studied the holistic BI&A use based on IS theories.

For these reasons practitioners and researchers need to deeply understand the drivers of BI&A use and its consequence on organizations in order to ensure the success of this promising, yet risky and costly, technological innovation. Once factors of use and its impacts are identified firms may act accordingly and develop better programs in order to achieve their objectives.

6. Conclusions

In today's world of global hyper-competition, organizations want to see demonstrable results from their use of information technology [31]. Since BI&A has significant impact on the data used in a large number of technological innovations [1, 10], we considered to be relevant to focus on it. Also, since BI&A evolves a significant investment to organizations, it is important to have some rigorous research able to support the measurement of its tangible and intangible benefits (impacts of use). It helps to improve the existing organizational applications, practices and methodologies [1, 3], which has a transversal function on any organization.

The study is expected to improve rigor and define emergent issues in BI&A research. To reinforce BI&A research, we call for greater theorizing of BI&A diffusion stages and statistically measure BI&A as a transversal concept. Particularly, the post adoption stages such as use and value of BI&A need to be structurally explored based on robust IS theories. After a systematic mapping study on BI&A and its stages (adoption, implementation, use and impacts of use), it becomes clear that the phenomenon of BI&A from an organizational perspective deserves a closer look in order to identify which factors in BI&A post-adoption stages. While BI&A usage refers to the production stage of system usage among firms actually using BI&A in their daily business activities, BI&A value can be seen as the firm ability to effectively use in order to create unique capabilities which have a positive impact on their performance [48, 49]. Despite a long-standing research tradition investigating the role of IS in decision-making, there is little understanding of how BI&A systems may effectively used and create positive impacts on the organization. A deeper insight into theory-based research is required to better understand the underlying motivators and barriers that will lead users to or inhibit them from using BI&A and acquire the benefits offered by this technology.

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Appendix A. Published articles on BI&A diffusion stages between 2000 and 2013

Categorization	Innovation	Theory	Data and context	Data collection Methods	Data Analysis Techniques	Year	Author	Published in
Implementation	BI	NA	First American Corporation	Case studies	Qualitative methods	2000	[33]	Journal (JMIS)
Adoption	ERP	DOI	51 American companies	Survey	Regression analysis	2003	[27]	Journal (JAIS)
Implementation	DW/BI	NA	American company Continental airlines	Case studies	Qualitative methods	2004	[32]	Journal (JMISQ)
Implementation	BI	NA	American company Cardinal Healthcare	Case study	NA	2005	[31]	Journal (JMISQ)
Adoption	DW	DOI	196 American companies	Survey	Logistic regression	2008	[25]	Journal (DSS)
Impacts of use on performance	BI - MCS	Absorptive Capacity	419 companies	Survey	PLS	2008	[46]	Conference (ECAIS)
Implementation	BIS	NA	15 BI systems experts EAMOS	Delphi Method	Qualitative methods	2008	[30]	Journal (IJEIS)
Use	BI	Developed instrument	121 Australasian companies	Survey	Analysis of variance (ANOVA)	2008	[42]	Conference (ACIS)
Adoption	BI	TAM	NA	NA	NA	2009	[22]	Conference (ISECS)
Adoption	BI	NA	214 German SMEs in the state of Saxony	Survey	Cluster Analysis	2010	[23]	Conference (ECIS)
Implementation	BI	NA	15 interviews CEO and Vice President Chinese firms	Case studies	Qualitative methods	2010	[34]	Journal (IJM)
Adoption	CI/BI	NA	1200 Portuguese companies	Survey	Mixed logit model	2011	[24]	Journal (BPMJ)
Adoption	CRM	NA	30 SMEs in the UK	Multiple case studies	Qualitative methods	2011	[26]	Journal (JIMM)
Implementation	BI	Delone & McLean Model	68 polish firms Poland	Survey	PLS	2011	[29]	Journal (JISB)
Impact of use (exemplification)	BI&A 1.0 and 2.0	Porter Model	Chinese companies	NA	Sentiment and impact analysis	2012	[17]	Journal (MISQ)
Impact of use (exemplification)	BI&A 1.0 & 2.0	Social networks and homophily theory	Korean mobile telecommunications service companies	Survey	Prediction analysis	2012	[18]	Journal (MISQ)
Impact of use (exemplification)	BI&A 1.0	NA	Real-world data from the Federal Deposit Insurance Corporation	NA	Simulation techniques	2012	[19]	Journal (MISQ)
Impact of use (exemplification)	BI&A 1.0	NA	Bankruptcydata.com	NA	Sensitivity analysis	2012	[21]	Journal (MISQ)
Impact of use (exemplification)	BI&A 1.0	NA	Corporate blog network	NA	Sensitivity analysis	2012	[20]	Journal (MISQ)
Impact of use on performance	BA	Developed instrument	788 companies of USA, Europe, Canada, Brazil and China	Survey	Regression Analysis	2012	[43]	Journal (JESA)
Implementation	BI	NA	1st round - 37 experts 2nd round - 27 experts	Delphi Method	Cluster Analysis	2012	[28]	Conference (HICSS)
Use	BI&A 2.0	NA	Website (xanga.com)	Case studies	Qualitative methods & Cluster Analysis	2012	[47]	Journal (MISQ)
Use	BI	Delone & McLean	330 Taiwan companies	Survey	SEM	2012	[38]	Journal (IJM)
Use	BI	Delone & McLean	181 medium and large companies	Survey	PLS	2012	[39]	Journal (DSS)
Use and impact on performance	ERP	DOI RBV	883 Scandinavian and Iberian SMEs	Survey	PLS	2013	[45]	Journal (JGIM)
Adoption	BI&A	TOE	229 north American companies	Survey	Logistic regression	2013	[10]	Conference (AMCIS)
Implementation	BI	NA	German firms	Interviews and case studies	Qualitative methods	2013	[37]	Conference (ECIS)
Implementation	BI	NA	NA	NA	NA	2013	[36]	Conference (ECIS)
Implementation	BI	NA	116 American companies	Survey	PLS	2013	[35]	Journal (I&M)
Use	BI	NA	7 leading companies in Thailand	Multiple case studies	NA	2013	[41]	Conference (ECIS)