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Critical Barriers to Business Intelligence Open Source Software Adoption

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ABSTRACT

Over the past few years, managers have been hard pressed to become more data-driven, and one of the prerequisites in doing so is through the adoption of Business Intelligence (BI) tools. However (1) the adoption of BI tools remains relatively low (2) the acquisition costs of proprietary BI tools are relatively high and (3) the level of satisfaction with these BI tools remain low. Given the potential of open source BI (OSBI) tools, there is a need for analyzing barriers that prevent organizations from adopting OSBI. Drawing a systematic review and a Qualitative Survey of BI Experts, this study proposes a framework that categorizes and structures 23 barriers to OSBI adoption by organizations including 4 that were identified by BI Experts but not explicitly found in the literature. This paper contributes to OSS and Information Systems (IS) research literature on BI adoption in general and provides specific insights to practitioners.

KEYWORDS

Adoption, Barriers, Business Intelligence (BI), Open Source, Qualitative Survey, Systematic Review

INTRODUCTION

Over the past two decades or so, business intelligence (BI) and analytics have grown into a more and more important phenomenon for both academic and business communities (Chen, Chiang, & Storey, 2012). For instance, a special issue on BI published by the last authors in the journal *Management Information Systems Quarterly* (MISQ) highlights the increasing importance of BI research in academia. Based on an 11-year survey (from 2004 to 2014) of senior IT executives from 2552 organizations located all over the world, Luftman et al. (2015) reported that, from a business perspective, analytics/business intelligence ranks first among the five most influential technologies. Another survey of over 4000 IT professionals from 93 countries and 25 industries identified business analytics as one of the four major technology trends in the 2010s (IBM, 2011). In fact, managers are hard pressed to become more data-driven (Kiron, Prentice, & Ferguson, 2014) while many scholars have underscored a broader new phenomenon qualified as "data-driven economy" (Mandel, 2012) or "analytics paradigm" (Delen & Zolbanin, 2018). In this context, the adoption and use of BI tools are considered one of the first prerequisite for organizational competitiveness that includes but is not limited to data-driven decision-making culture (McAfee, Brynjolfsson, Davenport, Patil, & Barton, 2012). In fact, apart from the fundamental data processing and analytical technologies included in BI

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and associated tools, they "include business-centric practices and methodologies that can be applied to various high-impact applications such as e-commerce, market intelligence, e-government, healthcare, and security" (Chen et al., 2012, p. 2).

However, despite the recognition of the importance of BI tools, their high potential in generating business value at both operational and strategic levels (Fink, Yogev, & Even, 2017), the rate of their adoption remains low. It is estimated that only 30% of all employees are using BI tools (Gartner, 2017a), and that penetration levels would increase to over 50% percent only "if cost, technology and other institutional challenges were not barriers to increase use" (Datamation, 2013, p. 1). The high costs associated with BI tool licenses and maintenance are echoed by Sallam, Richardson, Hagerty, and Hostmann (2011) who, in addition, underscore the complexity and low ease of use of proprietary BI tools. Another fact worth mentioning is the low level of satisfaction with BI tools and initiatives experience (Advaiya, 2017; Sallam et al., 2011).

Although most organizations have adopted proprietary BI tools that dominate the BI market, Sallam et al. (2011) reported an increasing interest in low-cost options, including open source BI tools as credible alternative solutions. A survey by Clutch revealed that 83% of business users and 88% of data scientists are likely to use open source software —as opposed to paid, proprietary solutions—in the future (Peacock, 2017).

In summary, considering (1) the struggles faced by organizations with their proprietary BI tools (Advaiya, 2017; Sallam et al., 2011) (2) the low adoption rate of BI tools (Datamation, 2013; Gartner, 2017a) (3) with the recognition of OSBI as a credible alternative to proprietary BI tools as well as the availability of OSBI tools with capabilities comparable to that of proprietary tools (Thomsen & Pedersen, 2009), there is a need to better understand the most critical barriers that prevent organizations from adopting OSBI tools.

Furthermore, a systematic review of BI studies included in this study reveals three major weaknesses in the current literature. First, the majority of studies are normative and lack empirical or theoretical foundations. Second, none of the studies focus on the perspective of BI experts. Third, as for the literature on business value creation from BI (Trieu, 2017), the body of knowledge on barriers associated with the adoption of BI tools is fragmented, thus it's lacking an all-encompassed, integrated framework. Such a framework is important, as it will facilitate knowledge accumulation (Hammersley, 2007), as well as evidence-based practices.

This study addresses the above-mentioned gaps in the literature by first providing a framework derived from a systematic review that identifies barriers to the adoption of BI tools by organizations. Building on the framework, this research – using a Qualitative Survey design – compares the barriers extracted from the academic literature with the most critical barriers elicited by open source BI experts in answering the following question: "What are the most critical barriers that prevent organizations from adopting open source BI tools?" Here barriers are defined as any factors preventing or discouraging the adoption of OSBI by organizations.

Following the introduction, the conceptual background is presented. Then the research methodology is described. The subsequent section is devoted to the presentation and discussion of the research results. Lastly, the article concludes with implications for research and practice as well as directions for future research.

BACKGROUND

Defining Business Intelligence

There is no consensus on the definition of Business Intelligence (BI). Based on Davies (2002, p. 313) the definition of intelligence is "the acquisition, interpretation, collation, assessment, and exploitation of information". Following the last author, Chung, Chen, and Nunamaker (2003, p. 1) suggest to define BI as "the acquisition, interpretation, collation, assessment, and exploitation of

information in the business domain." According to the Garner IT Glossary (2018, p. 1) Business Intelligence can be defined as "an umbrella term that includes the applications, infrastructure and tools, and the best practices that enable access to and analysis of information to improve and optimize decision making and performance". The Gartner report written by Sallam et al. (2011) identified 13 essential capabilities that define a BI platform. These capabilities are organized along three functional dimensions: integration, information delivery, and analysis: *Integration* – BI infrastructure, metadata management, development tools, and collaboration – *Information Delivery* – reporting, dashboards, ad hoc query, search based BI, and productivity suite integration – *Analysis* – OLAP, interactive visualization, scorecards, predictive modeling and data mining. Park, El Sawy, and Fiss (2017) identified seven key functionalities of BI tools: providing access to multiple data sources, rule-based exception handling, alerting managers about business events, accessing the enterprise-wide consistent database, supporting what-if analysis, presenting data visually, and extracting patterns from data. Adopting an architectural view, Chaudhuri, Dayal, and Narasayya (2011) suggest five components that define BI: data sources, data movement, streaming engines, data warehouse servers, mid-tier servers, and front-end applications.

Broadly speaking, there are three main alternatives for an organization wishing to adopt BI tools. Each one can be deployed on premises or through a cloud-based service: proprietary, custom, or open source. As indicated by Table 1, each alternative has different ratings with regard to two main differentiating characteristics of IT innovation (Wang, 2009); that is, their characteristics related to their "conceptual form" or "material form".

A survey on Business Intelligence Data Analytics conducted by Clutch (2016) revealed that the market is dominated by proprietary BI solutions. According to Apps Run The World (2011), in 2016, the top 10 analytics and BI software vendors accounted for nearly 60% of the global analytics and BI applications market, with the top five being SAP (11% of the market share) followed by SAS Institute, IBM, Oracle and Tableau. However, for the past several few years, open source business intelligence has been gaining "credence", "as more companies adopt BI and large vendors partner with open source players in an evolving BI ecosystem" (D'Souza, 2011, p. 1). The importance of the open source BI segment is illustrated by the high popularity of Hadoop (Stackowiak, Licht, Mantha, & Nagode, 2015), and a number of key takeovers such as the acquisition of Jaspersoft by TIBCO in April 2014 (TIBCO, 2014) and the acquisition of Pentaho by Hitachi Vantara in June 2015 (Hitachi, 2015).

Adoption of Open Source Business Intelligence Tools by Organizations

According to Gartner (2017b), open source is now an essential part of the modern IT industry, and they call for every CIO to secure the most developed strategies so as to manage specific risk, as well as rewards in order to take the maximum advantage from this powerful phenomenon. In fact, started decades ago within the infrastructure software in horizontal domains, the open source phenomenon has expanded beyond IS business applications in vertical domains (Fitzgerald, 2006), and has since reached the domain of mission-critical and strategic packaged application software, such as enterprise resource planning (ERP), Electronic Health Record (HER), and BI software. According to Thomsen & Pedersen (2009), although open source business intelligence tools are popular in some industries, their adoption by organizations is still limited. The author underscores that there are available mature OSBI tools when considering capabilities related to Extraction-Transfer-Load (ETL) tools, as well as Database Management Systems (DBMs) and On-Line Analytical Processing (OLAP) servers, and OLAP clients. Thus, there is a need to understand the barriers that prevent organizations from adopting OSBI tools.

A first systematic review was performed on a research published prior and up to July 5th 2017 in five major research databases: ABI inform Global, Springerlink, Business source Complete, Emerald and Scopus. At this stage, it is important to remember that the inclusion of systematic review in the research theoretical background has been done in previous research (e.g. Poba-Nzaou, Lemieux, Beaupré, and Uwizeyemungu (2016)).

Table 1. BI alternatives and associated ranking

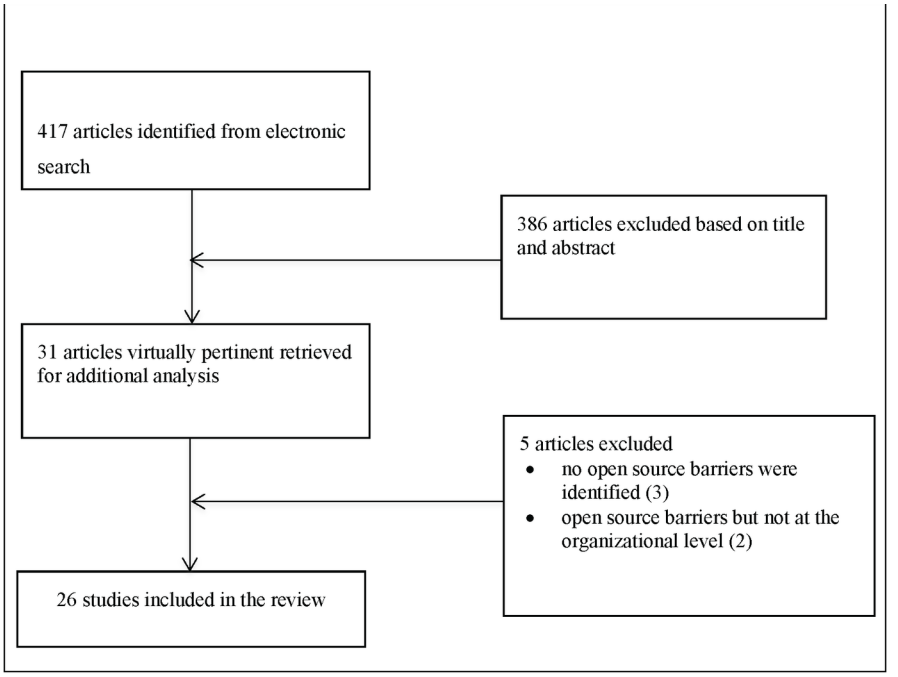
BI solution alternative BI attribute	Proprietary software	Custom development	Open source software
Conceptual form			
Governance metaphor	Chapel	Cathedral	Bazaar
Ability to access and modify the source code (Olsen & Saetre, 2007)	–	+	+
Ability to try out the software at a very low cost (Dedrick & West, 2004)	–	–	+
Independence (Olsen & Saetre, 2007)	–	+	+
High level of maintainability (Bonaccorsi, Piscitello, Merito, & Rossi, 2006)	–	+	+
Low acquisition and possession costs (Olsen & Saetre, 2007)	–	+/–	+
Sharing of development costs (Sledgianowski, Tafti, & Kierstead, 2008)	–	+/–	+
Material form			
Property of source code (Olsen & Saetre, 2007)	–	+	+
Rare need to invest in specific servers (Sledgianowski et al., 2008)	–	+	+
Based on most recognized software standards, middleware or languages such as XML and JBoss (Smets-Solanes, 2003)	+/–	+	+
+ the BI solution alternative is highly rated on the BI attribute - the BI solution alternative is lowly rated on the BI attribute +/- the BI solution alternative is moderately rated on the BI attribute			

Adapted from Poba-Nzaou, Raymond, and Fabi (2014, p. 483)

To be eligible for the systematic review, studies had to fulfill two inclusion criteria: (1) be a peer-reviewed article published in English (2) report on barriers to the adoption of open source BI tools. This first research used combinations of three key words: "Business intelligence" and "Open source", combined with one of the following key words: obstacle, barrier, challenge. The research led to the identification of 137 articles, among which 107 were excluded after the reading of the abstracts, leading to 30 articles to be read in full. However, after reading all the articles in full, none was relevant to the themes of the study: 12 were not about open source, 10 were not about adoption and 4 did not mention any barrier or obstacle or challenge.

Given that the first systematic review was unsuccessful, the second systematic review was performed in three major research databases with a broader scope; that is, not restricted to BI but extended to open source in general: ABI/INFORM Global, Business Source Complete and Scopus. To be eligible, studies had to fulfill two inclusion criteria: (1) be a peer-reviewed article published in English (2) report on the adoption of open source software. Given that research on open source business intelligence is relatively young, the research team decided to extend the search to articles published in international peer-reviewed conferences. An additional search was thus performed in the Association for Information Systems' (AIS) digital library, which is the major central repository

Figure 1. Flow chart of study selection process



for research papers, including conference proceedings and journal articles related to information systems. Starting with 441 articles, 24 were excluded because of redundancy. The remaining 417 articles were processed as indicated by the flow chart (see figure 1).

The previous research on information systems suggests that the adoption and implementation of technological innovation are influenced by technological, organizational, and environmental factors (e.g. Poba-Nzaou and Raymond (2011); Poba-Nzaou et al. (2016)). This research uses the technology-organization-environmental (TOE) framework (Depietro, Wiarda, & Fleischer, 1990) which is one of the most widely used frameworks for studying the adoption of technological innovation (Venkatesh & Bala, 2012). Through the scheme of TOE, the technological context describes internal as well as external technologies that are relevant to the organization. It comprises of factors such as availability of current and new technological innovations. Organizational context covers the characteristics of the organization, for instance, firm size, and the extent of resources available within the organization. Alongside other resources, *slack resources* designate resources that are in surplus in comparison to the regular operating of the organization. Environmental context represents the industry or in a broad sense, the "field" in which the firm operates (DiMaggio & Powell, 1983). Table 2 presents the synthesis of the 23 barriers found in the 26 studies of the systematic review; the barriers are organized according to the TOE framework.

Broadly speaking, the systematic review reveals that: (1) the majority of studies are normative and lack empirical or theoretical foundations (2) none of the studies focus on the perspective of BI experts (3) the related body of knowledge is scattered; thus, it is lacking an all-encompassed, integrated framework. It is important to remember that the last observation is consistent with the results of a recent review of research on "getting value from BI" conducted by Trieu (2017, p. 1).

Research Design - Qualitative Survey

According to Jansen (2010, p. 1), whereas "the statistical survey analyzes frequencies in member characteristics in a population the qualitative survey analyzes the diversity of member characteristics within a population. The diversity of member characteristics may either be predefined or developed in open coding". Fink (2003) recommended the use of qualitative survey analysis for researches aimed at exploring meanings and experiences which is the case for the current study. Other previous studies have adopted the Qualitative Survey method to elicit experts' knowledge (e.g. Felix, Rauschnabel, & Hinsch, 2017).

Data Collection and Analysis

As for most qualitative studies, we adopted a purposeful sampling strategy combined with a snowball sampling strategy (Patton, 1990). Experts' selection was based on five criteria: (1) occupy a position in information technology and communication (ICT) domain within an organization (2) have a minimum of five years of professional experience in ICT (3) have a minimum of three years of experience with open source technologies (4) have a minimum of five years of professional experience with enterprise systems (e.g. ERP, CRM, SCM), and (5) show a strong interest in BI technologies. Initially 52 potential respondents were identified from three sources: (1) researchers' professional networks (2) a professional social network and (3) internet searches. All the profiles were recorded in a database. After a screening of the profiles, only 20 met the inclusion criteria, but the research team was not able to identify the correct email address or telephone of seven of them. Thus, a formal invitation to participate in the study was sent by email to 13 respondents, along with a brief description of the research project and the expected commitment, as well as a request to recommend potential respondents. Overall, 8 experts agreed to participate; five were unable to commit to the study due to time constraints. Of note is the fact that an additional set of six experts were recommended by those contacted directly by the research team. However, three were not able to actually commit to the study due to time constraints, and among them, two suggested interview appointments beyond the deadline set by the researchers. At that stage, it is important to underscore that it was initially decided to start the interviews with the selected 11 experts, while remaining ready to recruit new experts if theoretical saturation was not reached (Lincoln & Guba, 1985). Theoretical saturation is the point at which the qualitative analyst does not see new information in the data related to the codes or themes (Guest, Bunce, & Johnson, 2006). However, the point of saturation was reached after nine interviews were conducted.

Table 3 presents the demographic profile of the study panel of 11 Canadian BI experts.

To achieve an appropriate level of internal validity, two sources of evidences were used, semi-structured interviews, and field notes. The interviews lasted one hour and thirty minutes on average, using the same interview guide for all respondents in order to facilitate comparative analysis (Miles & Huberman, 1994). The content of the interview guide was based on the TOE framework that was also used to classify the barriers extracted from the literature. It contained initial information gathering on the respondent characteristics including education, position, and professional experience. Critical barriers that may impede the adoption of open source BI were then discussed. Based on the framework, specific questions were asked about the identification of the most critical barriers related to open source BI specific characteristics, those related to the characteristics of the adopting organizations, those related to the characteristics of the environment in which the adopting organization operates. Then, respondents were asked to identify barriers that don't match any of the three categories. All interviews were tape-recorded and transcribed verbatim for a total of 50 pages.

The data analysis began immediately after the first interview and it essentially followed the principles of interpretative research suggested by Klein and Myers (1999). In the same manner as Poba-Nzaou et al. (2016, p. 4013), first, "one of the research team members' read and reread the verbatim transcript starting in run-of-river mode, to develop a deep understanding of the material". Then the researcher performed a semantic analysis of the transcript following three steps (Tanner

Table 2. Barriers to the Adoption of BI Tools

TOE dimensions	Barrier description	Support in the literature
Technological OSS specific	Fear, Uncertainty and Doubt (FUD) with regard to open source product characteristics (sustainability, reliability, quality, variability, functionalities, usability, security, privacy, maturity, interoperability, intellectual property, etc.)	(Côté & Egelstaff, 2007; Gallego, Luna, & Bueno, 2008a; Nagy, Yassin, & Bhattacherjee, 2010; Palanisamy & Mukerji, 2012; Poba-Nzaou & Uwizeyemungu, 2013; Safadi, Chan, Dawes, Roper, & Faraj, 2015; Stol, Babar, Avgeriou, & Fitzgerald, 2011; Williams van Rooij, 2007)
	Fear, Uncertainty and Doubt (FUD) with regard to open source service provider characteristics (longevity, service quality, etc.) and services availability.	(Poba-Nzaou & Uwizeyemungu, 2013)
	Fear, Uncertainty and Doubt (FUD) with regard to open source product governance (e.g. strategy on intellectual property, development community organization, relationship with users, release schedules and speed)	(Gallego et al., 2008a; Gallego, Luna, & Bueno, 2008b; Goode, 2014; Gwebu & Wang, 2010; Palanisamy & Mukerji, 2012; Paré, Wybo, & Delannoy, 2009; Poba-Nzaou & Uwizeyemungu, 2013; Safadi et al., 2015; Vanmeulebrouk, Rivett, Ricketts, & Loudon, 2008; Weilbach & Byrne, 2013)
	Complexity of the open source software ecosystem (e.g. high number of license types, high number of fork projects, etc.)	(Palanisamy & Mukerji, 2012; Stol et al., 2011)
	Complexity of open source products (e.g. long learning curve, complex configuration, etc.)	(Crowston & Wade, 2010; Foll & Foil, 2008; Gallego et al., 2008a; Hauge, Ayala, & Conradi, 2010; Macredie & Mijinyawa, 2011; Paré et al., 2009; Poba-Nzaou & Uwizeyemungu, 2013; Stol et al., 2011)
	Low level of integrability (functional, technical) and interoperability with existing organizations' legacy information systems	(Gallego et al., 2008a; Harris et al., 2016; Mutula & Kalaote, 2010; Nagy et al., 2010; Safadi et al., 2015; Stol et al., 2011)
	Lack of training courses and reliable information or documentation on open source products in the market	(Buchan, 2011; Buchana & Naicker, 2014; Côté & Egelstaff, 2007; Grodzinsky, Miller, & Wolf, 2003; Hauge et al., 2010; Palanisamy & Mukerji, 2012; Paré et al., 2009; Stol et al., 2011)
	Lack of responsible third party engagement	(Paré et al., 2009; Poba-Nzaou & Uwizeyemungu, 2013)
	Hidden costs	(Buchan, 2011; Gallego et al., 2008a; Gwebu & Wang, 2010; Hauge et al., 2010; Mutula & Kalaote, 2010; Nagy et al., 2010; Palanisamy & Mukerji, 2012; Paré et al., 2009; Safadi et al., 2015; Stol et al., 2011)
	Insufficient visibility in the market and lack of marketing actions	(Poba-Nzaou & Uwizeyemungu, 2013)
	Shortage of enterprises providing integrated services including support, training, installation, maintenance, etc.	(Côté & Egelstaff, 2007; Foll & Foil, 2008; Grodzinsky et al., 2003; Gwebu & Wang, 2010; Mutula & Kalaote, 2010; Palanisamy & Mukerji, 2012; Safadi et al., 2015; Stol et al., 2011; Williams van Rooij, 2007; H. Wu & Cao, 2009; J. Wu, Goh, Li, Luo, & Zheng, 2016)
Organizational	Stereotype, prejudice, misunderstanding over open source business models	(Grodzinsky et al., 2003; Palanisamy & Mukerji, 2012; Poba-Nzaou & Uwizeyemungu, 2013)
	Internal inertia (political pressure, conservative attitudes and practices of IT managers and executives, etc.)	(Gallego et al., 2008a; Paré et al., 2009; Poba-Nzaou & Uwizeyemungu, 2013)
	Cultural and structural obstacles (e.g. disadvantageous tender/procurement processes vis-à-vis open source solution, unfavorable quality assessment approach, etc.)	(Gallego et al., 2008a; Paré et al., 2009; Poba-Nzaou & Uwizeyemungu, 2013)
	Lack or insufficiency of internal resources (technical and functional skills, knowledge, infrastructure, guiding policies, etc.)	(Foll & Foil, 2008; Gallego et al., 2008a; Hauge et al., 2010; Mutula & Kalaote, 2010; Nagy et al., 2010; Palanisamy & Mukerji, 2012; Paré et al., 2009; Tomazin & Gradišar, 2007; Vanmeulebrouk et al., 2008; Weilbach & Byrne, 2013)
	Fear of users' resistance or rejection	(Côté & Egelstaff, 2007; Gallego et al., 2008a; Kim, Chan, & Lee, 2014; Safadi et al., 2015)
	Strong dependence on proprietary software and providers (lock-in)	(Mutula & Kalaote, 2010)
Environmental	Lack of government and policy makers' awareness and support	(Macredie & Mijinyawa, 2011; Mutula & Kalaote, 2010; Poba-Nzaou & Uwizeyemungu, 2013)
	External political pressure	(Paré et al., 2009; Poba-Nzaou & Uwizeyemungu, 2013; Safadi et al., 2015)
	Effect of fashion phenomenon trends in the market	(Gallego et al., 2008a)
	Insufficient visibility and legitimacy in the market	(Gallego et al., 2008a; Poba-Nzaou & Uwizeyemungu, 2013)
	Insufficient dissemination of knowledge concerning open source software in higher education institutions	(Poba-Nzaou & Uwizeyemungu, 2013)
	Shortage of skilled labor with OS expertise including combination of technical and functional competencies on open source products	(Poba-Nzaou & Uwizeyemungu, 2013)

Table 3. Demographic profile of respondents

Gender	Male	82%
	Female	18%
Age(years)	50-59	18%
	40-49	45%
	30-39	27%
	<59	9%
Highest education degree	High school diploma	9%
	Bachelor or other undergraduate degree	18%
	M.Sc.	27%
	Doctorate	45%
Professional experience with BI (years)	<10	82%
	>=10	18%
Role	Expert	45%
	Vice-president	9%
	Director	36%
	Researcher	9%
Industry sector	Public sector administration	9%
	Media industry	9%
	Consulting services	55%
	Transportation	9%
	Higher education	18%
Size of organization	Large (>=500)	27%
	Medium (100-499)	36%
	Small (<=100)	9%
Annual revenue (Million $ CAN)	0.15-1	9%
	<1.6 - 5	18%
	6 - 15	27%
	250-450	18%
	Undisclosed	27%
Use of BI tools	Yes	91%
	No	9%

& Stone, 1998). During the first step, statements were extracted from each interview's transcript and copied in different rows on a table. Thereafter, statements conveying the same meaning were combined. By doing so, the researcher created categories. Lastly, a label was assigned to each set of statements. Afterwards, relying on TOE framework dimensions as vehicles, the researcher derived abstraction and connected experts' statements with theoretical categories in accordance with the "principle of abstraction and generalization" by moving back and forth within and between experts' statements and the TOE framework dimensions, following the "hermeneutic circle principle" (Klein & Myers, 1999). The processes ended up with a final list of 18 barriers after eliminating duplicates

and combining all statements that conveyed the same meaning. A researcher familiar with BI literature critically reviewed the combined list of barriers for clarity in regard to the statements extracted from the verbatim transcript. Based on this review, minor adjustments were made to the list of barriers in order to enhance the clarity of the categories that were created. Table 4 shows the revised framework based on the results of the Qualitative Survey.

RESULTS AND DISCUSSION

Noteworthy is the fact that the list on Table 4 consists of barriers associated with each of the three dimensions of the Technology-Organization-Environment (TOE) framework. However, 4 out of the 18 barriers identified by the experts cannot be related to those derived from the systematic review of the academic literature. In the same manner, 9 out of the 23 barriers identified from the systematic review cannot be related to those mentioned by the panel of experts. It seems important to remember that understanding these gaps is important for advancing both research and practice (Avolio, 2017).

The next section follows a discussion of the four barriers mentioned by the experts but not explicitly identified in the academic literature on the adoption of open source software. The section is closed by discussing the barriers that were found from the systematic review but were not mentioned by our panel of experts.

Barriers Identified by Experts but Not Explicitly Identified in the Academic Literature

Among the four barriers mentioned by the panel of experts but not found explicitly in the literature, two are related to the characteristic of the technology, and the other two are related to the characteristics of the adopting organization. We will first discuss the two barriers related to the characteristics of the technology: obligation to share one's own specific customization and associated consequences; and fear, uncertainty and doubt (FUD) with regard to open source product business models. Then we will discuss those related to the characteristics of the adopting organization: monopolization of BI initiatives by IS departments; and risk aversion of IS managers.

Obligation to Share One's Own Specific Source Code Customization and Associated Consequences

Although seen as intriguing, several scholars stress that "source code sharing" is rooted in the history and spirit of open source software (e.g. Hauge et al., 2010; Hecker, 1999; Lerner & Tirole, 2005). The obligation of sharing the source code generally arises from the clauses defined in the licenses. Following Lerner and Tirole (2005), we consider three classes of licenses: highly restrictive (general public license (GPL)), restrictive (e.g., lesser general public license (LGPL)), and unrestrictive (e.g., the Berkeley Software Definition (BSD)-type license). Two attributes characterize GPL license: (1) the fact that "any derivative work remained subject to the same license" and (2) the prescription of "the mixing of open and closed source software in any distributed works" (Lerner & Tirole, 2005, p. 23). Among OSS licenses, GPL is the most widely used (Bonaccorsi et al., 2006; Lerner & Tirole, 2005). Compared to GPL, LGPL (lesser GPL) concedes a greater flexibility concerning the "mixing" requirement, as with this license "programs are allowed to link with (or employ) other programs or routines that are not themselves available under an open source license" (Lerner & Tirole, 2005, p. 23). The BSD-type licenses allow a greater flexibility to users. These licenses authorize the free use of the OSS and the capacity to modify the software. In addition, the BSD-type licenses allow the use of source code in proprietary software, whether modified or not. Additionally, source code created under these licenses, or derived from such code, can get "closed" and be commercialized by anyone (not just by the original developers) (Onetti & Capobianco, 2005).

Nonetheless, analyzing the implications of "source code sharing" from the perspective of the adopting organization reveals at least one tension between "companies' need for control of intellectual

Table 4. Revised framework based on the results of the Qualitative Survey

TOE dimensions	Challenge description	SRL	QLS	Rank
Technological OSS specific	Fear, Uncertainty and Doubt (FUD) with regard to open source product characteristics (durability, reliability, quality, variability, functionalities, usability, security, privacy, maturity, etc.)	✓	✓	4
	Fear, Uncertainty and Doubt (FUD) with regard to open source service provider characteristics (longevity, service quality, etc.) and services availability	✓	✓	3
	Fear, Uncertainty and Doubt (FUD) with regard to open source product governance (e.g. strategy on intellectual property, release schedules)	✓	✓	5
	Fear, Uncertainty and Doubt (FUD) with regard to open source business models	NL	✓	6
	Complexity of the open source software ecosystem (e.g. high number of license types, high number of fork projects, etc.)	✓	✓	5
	Complexity of open source products (e.g. long learning curve, complex configuration, etc.)	✓	NE	NA
	Low level of integrability (functional, technical) and interoperability with existing organizations' legacy information systems	✓	✓	4
	Lack of training courses and reliable information or documentation on open source products in the market	✓	✓	4
	Lack of third party engagement for technical support and maintenance services	✓	NE	NA
	Hidden costs	✓	✓	5
	Insufficient visibility in the market and lack of marketing actions	✓	✓	6
	Shortage of enterprises providing integrated services including support, training, installation, maintenance, etc.	✓	NE	NA
	Obligation to share own specific source code customization and associated consequences	NL	✓	5
Organizational	Stereotype, prejudice, misunderstanding over open source business models	✓	✓	2
	Internal inertia (political pressure, conservative attitudes and practices of IT managers and executives, etc.)	✓	✓	1
	Cultural and structural obstacles (e.g. disadvantageous tender/procurement processes vis-à-vis open source solution, unfavorable quality assessment approach, etc.)	✓	NE	NA
	Monopolization of BI initiatives by IS departments	NL	✓	6
	Lack or insufficiency of internal resources (technical and functional skills, knowledge, guiding policies, etc.)	✓	✓	2
	Fear of users' rejection	✓	NE	NA
	Strong dependence on proprietary software and providers (lock-in)	✓	NE	NA
	Risk aversion of IT managers	NL	✓	5
Environmental	Lack of government and policy makers' awareness and support	✓	✓	NA
	External political pressure	✓	✓	3
	Effect of fashion phenomenon trends in the market	✓	NE	NA
	Insufficient legitimacy in the market	✓	NE	NA
	Insufficient dissemination of knowledge concerning open source software in higher education institutions	✓	NE	NA
	Shortage of skilled labor with OS expertise including combination of technical and functional competencies on open source products	✓	✓	6

SRL: systematic review of the literature
QLS: qualitative survey
NL: not explicitly found in the systematic review of the literature
NE: not mentioned by experts
NA: not applicable
Rank: based on frequency of mention by experts

assets and programmers' relations to communities outside the firm." (Rolandsson, Bergquist, & Ljungberg, 2011, p. 581). Consequently, these characteristics may constitute a critical barrier for the adoption of OSBI by organizations. This is particularly true in cases where the technology allows for the generation of a business value associated with a competitive advantage.

FUD with Regard to Open Source Business Models

FUD stands for Fear, Uncertainty and Doubt, and was coined by Gene Amdahl, an ex-IBM executive who founded Amdahl Corporation in 1970 (Pfaffenberger, 2000). "FUD is a marketing strategy or technique that has been used by market-dominant firms in the computer industry to weaken competitors" (Irwin, 1998, p. 1). Generally, a FUD operation makes use of a variety of approaches, including cautioning customers about the risks of moving to an unreliable new product, as well as a storm of press releases aimed at confusing customers as regards to the merits of the new product, and biased benchmark tests (Pfaffenberger, 2000). According to Nagy et al. (2010, p. 149) "it is widely believed that proprietary software vendors often use fear, uncertainty and doubt to undermine and cut the market potential of their open source competitors".

Following (Björkdahl, 2009, p. 1470), a business model is defined as "the logic and the activities that create and appropriate economic value, and the link between them". Operationally speaking, a business model provides a heuristic logic that helps to link technical or functional potential of a technological tool with the realization of economic value (Chesbrough & Rosenbloom, 2002). According to West (2007), the business model of such an innovation as open source project has two main functions: creating value for customers and capturing value for the open source project actors. For their part, Helander and Rissanen (2005) stressed that the business model of open source project is difficult to apprehend because the value created in open source projects can often not be "owned" by a single organization, and thus the business models cannot be studied in the same way as for proprietary software. The authors maintain that the value of open source projects is created for the network, not for individual organizations or other entities or individuals. In this context, it is worth remembering that the network in question is generally composed of entities of various sizes, roles and levels of commitment, including large and well-known for-profit organizations (e.g. IBM, Google, RedHat, etc.), not-for-profit organizations (e.g. Linux foundation, Free software foundation, Universities, Government agencies, etc.), and numerous SMEs and individuals. Thus, a deep understanding of the business models of the companies involved in open source software projects requires linking them to the business models of the other network stakeholders and perhaps including some other components outside of the network (Helander & Rissanen, 2005).

In fact, in most open source business models, software is usually available free of charge, with or without conditions; and in most cases revenues are realized through the sale of complementary services, such as consulting, implementation, documentation, and maintenance (Hecker, 1999). For their part, based on two dimensions, that is, OSS production and OSS distribution, Watson, Boudreau, York, Greiner, and Wynn Jr (2008) identified four different business models: open community, corporate distribution, sponsored OSS, and second-generation OSS. Open community is the most well-known business model of OSS. This model relies mainly on volunteers for the development and support of the software with limited commercial interests. In contrast, with the corporate distribution model, a corporation takes advantage of an OSS product of good quality that is developed by open community model. More specifically, a corporation gets involved in the project with the aim of improving distribution methods for the OSS product, as well as providing complimentary services for adopting organizations (Watson et al., 2008). The corporate model therefore depends on the community model. RedHat and SpikeSource are two examples of such OSS model. Compared to the previous two examples, the Sponsored Open Source model portrays OSS projects that are directly sponsored by corporations or foundations or by both. Apache Web Server and Eclipse are two examples of sponsored OSS by Apache Foundation and IBM respectively. The last business model labeled Second-generation or professional open source, brings together OSS projects that are

controlled by a firm whose business model is considered hybrid, in the sense that it fits between a corporate distribution business model and a sponsored business model. One of the characteristics of this model is the control of the source code that allows the controlling firm to exploit their intimate knowledge of the code to provide higher-quality service that has the potential to compete with other service providers (Watson et al., 2008). Examples of such open source projects include MySQL and JBoss. Although other authors identified several business models of open source projects, Widenius and Nyman (2014) indicated that they can be classified in two main categories: those that require complete (or at least partial) ownership of the code by the open source project or a representative entity, and those that do not. One fact is worth mentioning here: The ownership of the source code is defined by the license, and there is a "proliferation" of OSS licenses. "Proliferation refers to the scores of open source licenses that are now in use, with more being created all the time" (Gomulkiewicz, 2009, p. 263). Indeed, there are currently 83 OSS licenses approved by the Open Source Initiative (OSI, 2008). Thus, it seems that in reality OSS business model is a complex concept that needs to be classified in a continuum from closed to open. As a result, the business model can at times not only be easily subject to FUD, but might also act as a critical barrier to OSS adoption.

At the same time, the finding of open source business model as a critical barrier is surprising. In fact, a 2008 survey by IDC of OSS vendors covering their experience in selling OSS in 2007, concluded by declaring open-source software business model as viable, on the ground that the majority of revenue from OSS (59 percent on average) was from subscriptions (Rosenberg, 2008). And since that time, the open source phenomenon has continued to be debated while OSS has continued to grow in the software industry, and now many private as well as public organizations rely on OSS applications or code (Ghapanchi, 2015).

Monopolization of BI Initiatives by IS Departments

Traditionally, the Information Systems (IS) specialists within the IS department were the only ones responsible for organizations' IS investments (Bassellier, Benbasat, & Reich, 2003; Devece, 2013). The authors maintained that since the acknowledgement of the strategic nature of IS tools, researchers and managers agree on the fact that the responsibility of Information Systems should be shared between IS and business professionals. According to Poba-Nzaou, Uwizeyemungu, and Clarke (2018, p. 2), the need for shared responsibility was later "accentuated by the popularity of Enterprise Systems (e.g. Enterprise Resource Planning (ERPs)) that are configured at the organizational level by business professionals with the help of integrators. The last authors underscored that in this regard, IS competencies held by business professionals such as finance or human resource or production managers turn into one of the prerequisites for creating business value from IS.

In this context, it is surprising that IS departments tend to monopolize BI initiatives instead of sharing the responsibility with non-IS professionals. At least one explanation and one implication can be drawn from this barrier. Given that the tendency by IS departments to monopolize IS initiatives has been observed in the past at the early stage of diffusion of major enterprise systems such as ERP, we contend that this attitude is likely to stem from the novelty of BI technologies and it may soon change. Concerning the implication, we contend that this situation may explain partially why early surveys revealed a low level of user satisfaction with BI initiatives, products and experiences. For instance, a survey conducted by LogiXML, reveals that about half of non-Technical BI users are dissatisfied with their IS departments' ability to deliver (Logi Analytics, 2011). In the same vein, Advaiya (2017) indicates that nearly two-third (67%) of the respondents are not satisfied with the BI tools that they use.

Risk Aversion of IT Managers

At an individual level, risk aversion is defined "as a preference for a sure outcome over a prospect with an equal or greater expected value" (Tversky & Fox, 1995, p. 269). Basically, it has been recognized that risk aversion of managers is one of the main barriers that impedes organizations from adopting technological innovation (Czerkawski, 2010).

It is important to remember that many organizations still view OSS as much riskier, with little or no assurance that the software will be supported in the present and in the future (Benlian & Hess, 2011). In particular, organizations tend to associate higher risk to OSS because they are attracted by the following characteristics of proprietary software (Bonaccorsi et al., 2006, p. 1086):

Licensed software is usually packaged according to industrial standard in terms of documentation, maintenance, product updating, and product responsibility clauses. These are highly appreciated by final customers, because they greatly reduce the perceived risk. … The perceived customers' risk of buying from small new entrants offering open standards is significantly higher.

In addition, managing OS BI risk can be quite different from proprietary BI. In fact, contrary to proprietary software, in the case of OSS, a client organization has no means to transfer accountability to a third party, hence it has to bear the full risk (Morgan & Finnegan, 2010). Thus, in light of the above discussion, it seems probable that IS managers with a determined risk aversion attitude may have an incentive to avoid selecting OS BI tools. It is thus not surprising that IS managers risk aversion emerges as a critical barrier to OS BI adoption by organization.

Barriers Identified from the Systematic Review of the Literature but not Mentioned by the Panel of Experts

As stated earlier, amid the 23 barriers found from the systematic review, 9 were not mentioned by our panel of experts. Among them, three are related to each one of the three dimensions of the TOE framework. The three technological barriers are: Complexity of open source products (e.g. long learning curve, complex configuration, etc.); Shortage of enterprises providing integrated services including support, training, installation, maintenance, etc.; Lack of third party engagement for technical support and maintenance services. The three organizational barriers are: Structural obstacles (e.g. disadvantageous tender/procurement processes vis-à-vis open source solution; unfavorable quality assessment approach, etc.); Fear of users' rejection; Strong dependence on proprietary software and providers (lock-in). The three environmental barriers are: Effect of fashion phenomenon trends in the market; Insufficient legitimacy in the market; Insufficient dissemination of knowledge concerning open source software in higher education institutions.

In this situation, a natural question arises: Why do none of the BI experts of our panel mention those barriers? Without pretending to provide a definitive answer to this question, a few elements are worth mentioning. At first glance, it may be argued that there were too few experts. However, given that (1) the study sample is appropriate that is, it is composed of participants who "have knowledge of the research topic" (Morse, Barrett, Mayan, Olson, & Spiers, 2002, p. 18) (2) data was saturated after nine interviews and "by definition, saturating data ensures replication in categories; replication verifies, and ensures comprehension and completeness" (Morse, Barrett, Mayan, Olson, & Spiers, 2002, p. 18) a second explanation is considered: those barriers were not mentioned by the panel of experts because none of them are perceived as being part of "critical" barriers that may impede organizations from adopting open source BI tools. A third plausible explanation is rooted in Rousseau and Fried (2001, p. 1) call for incorporating context into the research process, including interpretation and reporting. They stressed that contextualization is "more important in contemporary organizational behavior research than it has been in the past". In fact, our panel is made of Canadian BI experts from the province of Quebec. Within the province, the open-source community is well organized and enjoys a relatively high visibility. For instance, in 2009, the Quebec government clearly stated its advocacy for the use of open source software whenever it's the best choice. It also explained it will ensure that the Quebec administration will have the support they need to adopt, implement and use open source software (Gouvernement du Québec, 2009). In 2013, the government created a center of expertise dedicated to open source software (Blanchet, 2015). Furthermore, in 2015 it created a new open-source license named "Licence Libre du Québec (LiLiQ)" that was tailored to meet the needs of the administration; LiLiQ was approved by OSI in January 2016 (Gouvernement du Québec, 2018). On the business side, in 2011, in the province of Quebec, there were about 30 enterprises specializing in OSS related

services, and about 10 that can be categorized as OSS vendors (L'Association professionnelle des entreprises en logiciels libres - APELL, 2011). Of note is the fact that several governments all over the word have adopted guidelines or laws that encourage the adoption of open source software (Qu, Yang, & Wang, 2011).

Lastly, additional insights are generated by comparing these barriers with those found by Poba-Nzaou and Uwizeyemungu (2013). In fact, 5 out of 9 barriers not mentioned by the current study panel were among the 10 most important barriers to the adoption of open source mission critical application by organizations in the province of Quebec, found by Poba-Nzaou and Uwizeyemungu (2013). This finding seems to indicate that the open source phenomenon has evolved to the point where those barriers are no longer considered "critical" to the adoption of open source BI in the context of Quebec, Canada. This means that, in summary, the open source BI phenomenon may have reached a certain level of maturity, at least in Quebec.

RESEARCH CONTRIBUTIONS AND LIMITATIONS

It is important to remember that, from a business executive's perspective, business intelligence (BI) emerges as one of the most promising technologies in recent years in terms of business value creation (Kappelman, McLean, Luftman, & Johnson, 2013). However, the study of the adoption of open source BI by organizations is in its infancy (Trieu, 2017), despite the empirical evidence of their growing presence in the business environment in firms worldwide. This research focuses on the identification of critical barriers that may inhibit organizations from adopting open source business intelligence tools, and which may also prevent them from developing needed capabilities required for securing strategic organizational outcomes. This exploratory study is an initial step toward a deeper understanding of factors that inhibit organizations from adopting open source business intelligence tools.

A systematic review of the literature resulted in the identification of 23 barriers. To understand these barriers in the context of organizational settings, their classification was done according to three categories derived from TOE framework (Technology-Organization-Environment)(Depietro et al., 1990). This was subsequently compared with a list of 18 barriers derived from a qualitative survey of 11 Canadian BI experts.

This study contributes to the nascent body of knowledge on the adoption of BI tools in general, and to open source BI tools in particular in two ways. First, it provides an initial foundation for understanding these barriers from BI experts' perspectives. Findings from the systematic review by the authors of this study reveal that this is one of the first endeavors to focus on barriers associated with the adoption of BI tools, from the perspectives of BI experts and the first investigation of Canadian BI experts' views on open source BI adoption.

From a practical standpoint, this research provides IS managers, as well as open source BI providers and consultants with an initial structured lens to better understand the most important barriers that prevent organizations from adopting open source BI tools. These barriers require further consideration by all stakeholders interested in the adoption or deployment of open source BI.

From a methodological standpoint, following Poba-Nzaou et al. (2016), this research provides one main contribution that is a rigorous analysis of Qualitative Survey data, based on two principles of interpretive research (Klein & Myers, 1999): the fundamental principle of Hermeneutic Circle, and the principle of Abstraction and Generalization.

To conclude, the authors acknowledge some areas of limitations, and call for further studies of open source business intelligence to be conducted. First, though it is adequate for a qualitative survey and methodologically sufficient, the size of the panel was small. Second, it could be interesting to compare these barriers with those preventing organizations from adopting open source software in areas where they are very popular (such as web server, operating systems, etc.). Third, since this exploratory study focuses on BI experts in only one country, Canada, the authors also recommend future studies investigating the views of BI experts in other countries and involving other BI stakeholders (e.g. users,

executives, etc.), as such studies can increase the validity of the findings from this study. Fourth, as this initial study focuses solely on barriers, the authors also recommend that future studies, including the identification of strategies that may be initiated by relevant stakeholders in dealing with the identified barriers. Lastly, future researches may benefit from adopting other research methods as well, such as case study, surveys or experiments, as they may provide richer insights than the qualitative survey adopted in this study.

REFERENCES

Advaiya. (2017). *BI and Analytics Adoption and Usage Report*. Retrieved from https://www.advaiya.com/thanks-bi-adoption-report/

Apps Run The World. (2011). *Human Capital Management. Enterprise Applications Market Report 2010-2015*. Retrieved from https://www.appsruntheworld.com/wp-content/uploads/2015/09/Human-Capital-Management-Applications-Market-2010-2015.pdf

Avolio, B. J. (2017). The practice and science connection: Let's not obsess over minding the gap. *Industrial and Organizational Psychology: Perspectives on Science and Practice*, *10*(4), 558–569. doi:10.1017/iop.2017.56

Bassellier, G., Benbasat, I., & Reich, B. H. (2003). The influence of business managers' IT competence on championing IT. *Information Systems Research*, *14*(4), 317–336. doi:10.1287/isre.14.4.317.24899

Benlian, A., & Hess, T. (2011). Opportunities and risks of software-as-a-service: Findings from a survey of IT executives. *Decision Support Systems*, *52*(1), 232–246. doi:10.1016/j.dss.2011.07.007

Björkdahl, J. (2009). Technology cross-fertilization and the business model: The case of integrating ICTs in mechanical engineering products. *Research Policy*, *38*(9), 1468–1477. doi:10.1016/j.respol.2009.07.006

Blanchet, J.N. (2015). Le centre du libre éclate. Retrieved from http://www.journaldemontreal.com/2015/10/16/le-centre-du-libre-eclate

Bonaccorsi, A., Piscitello, L., Merito, M., & Rossi, C. (2006) How is it possible to profit from innovation in the absence of any appropriability? In IFIP International Federation for Information Processing (pp. 333-334).

Buchan, J. (2011). Developing a dynamic and responsive online learning environment: A case study of a large Australian university. In Free and Open Source Software for E-Learning: Issues, Successes and Challenges (pp. 92-109). Hershey, PA: IGI Global.

Buchana, Y., & Naicker, V. (2014). The effect of mobile BI on organisational managerial decision-making. *Journal of Applied Business Research*, *30*(4), 1003–1018. doi:10.19030/jabr.v30i4.8649

Chaudhuri, S., Dayal, U., & Narasayya, V. (2011). An overview of business intelligence technology. *Communications of the ACM*, *54*(8), 88–98. doi:10.1145/1978542.1978562

Chen, H., Chiang, R. H., & Storey, V. C. (2012). Business intelligence and analytics: From big data to big impact. *Management Information Systems Quarterly*, *36*(4), 1165–1188. doi:10.2307/41703503

Chesbrough, H., & Rosenbloom, R. S. (2002). The role of the business model in capturing value from innovation: Evidence from Xerox Corporation's technology spin-off companies. *Industrial and Corporate Change*, *11*(3), 529–555. doi:10.1093/icc/11.3.529

Chung, W., Chen, H., & Nunamaker, J. F. (2003). Business intelligence explorer: a knowledge map framework for discovering business intelligence on the Web. *Paper presented at the 36th Annual Hawaii International Conference on System Sciences*.

Clutch. (2016). 2016 Business Intelligence Data Analytics Survey. Retrieved from https://clutch.co/analytics#survey

Côté, J., & Egelstaff, J. (2007). Supporting Not-For-Profits. *The Open Source Business Resource*, 11.

Crowston, K., & Wade, M. (2010). Introduction to JAIS special issue on empirical research on free/libre open source software. *Journal of the Association for Information Systems*, *11*(11), I–V. doi:10.17705/1jais.00246

Czerkawski, B. Ö. (2010). Free and Open Source Software for E-Learning: Issues, Successes and Challenges: Issues, Successes and Challenges. Hershey, PA: IGI Global.

D'Souza, S. (2011). Open source business intelligence: The next big thing? Retrieved from https://www.computerweekly.com/news/2240035963/Open-source-business-intelligence-The-next-big-thing

Datamation. (2013). Business Intelligence Adoption: Gaining Ground. Retrieved from https://www.datamation.com/applications/business-intelligence-adoption-gaining-ground.html

Davies, P. H. (2002). Intelligence, information technology, and information warfare. *Annual Review of Information Science & Technology*, *36*(1), 312–352. doi:10.1002/aris.1440360108

Dedrick, J., & West, J. (2004). An exploratory study into open source platform adoption. *Paper presented at the 37th Annual Hawaii International Conference on System Sciences*. doi:10.1109/HICSS.2004.1265633

Delen, D., & Zolbanin, H. M. (2018). The analytics paradigm in business research. *Journal of Business Research*, *90*, 186–195. doi:10.1016/j.jbusres.2018.05.013

Depietro, R., Wiarda, E., & Fleischer, M. (1990). The context for change: organization, technology and environment. In T. LG & F. M (Eds.), The Processes of Technological Innovation (pp. 151-175). Lexington, MA: Lexington Books.

Devece, C. (2013). The value of business managers' 'Information Technology' competence. *Service Industries Journal*, *33*(7-8), 720–733. doi:10.1080/02642069.2013.740463

DiMaggio, P., & Powell, W. W. (1983). The iron cage revisited: Collective rationality and institutional isomorphism in organizational fields. *American Sociological Review*, *48*(2), 147–160. doi:10.2307/2095101

Felix, R., Rauschnabel, P. A., & Hinsch, C. (2017). Elements of strategic social media marketing: A holistic framework. *Journal of Business Research*, *70*, 118–126. doi:10.1016/j.jbusres.2016.05.001

Fink, A. (2003). *The survey handbook* (Vol. 1). Sage. doi:10.4135/9781412986328

Fink, L., Yogev, N., & Even, A. (2017). Business intelligence and organizational learning: An empirical investigation of value creation processes. *Information & Management*, *54*(1), 38–56. doi:10.1016/j.im.2016.03.009

Fitzgerald, B. (2006). The transformation of open source software. *Management Information Systems Quarterly*, *30*(3), 587–598. doi:10.2307/25148740

Foll, D. L., & Foil, F. A. (2008). Open source software in telcosa gentle tsunami. *Journal of the Institute of Telecommunications Professionals*, *2*(2), 7–11.

Gallego, M. D., Luna, P., & Bueno, S. (2008a). Designing a forecasting analysis to understand the diffusion of open source software in the year 2010. *Technological Forecasting and Social Change*, *75*(5), 672–686. doi:10.1016/j.techfore.2007.02.002

Gallego, M. D., Luna, P., & Bueno, S. (2008b). User acceptance model of open source software. *Computers in Human Behavior*, *24*(5), 2199–2216. doi:10.1016/j.chb.2007.10.006

Gartner. (2017a). Survey Analysis: Why BI and Analytics Adoption Remains Low and How to Expand Its Reach. Retrieved from https://www.gartner.com/doc/3753469/survey-analysis-bi-analytics

Gartner. (2017b). *What Every CIO Must Know About Open-Source Software*. Retrieved from https://www.gartner.com/doc/3660617/cio-know-opensource-software

Gartner. (2018). IT Glossary. Retrieved from https://www.gartner.com/it-glossary/

Ghapanchi, A. H. (2015). Predicting software future sustainability: A longitudinal perspective. *Information Systems*, *49*, 40–51. doi:10.1016/j.is.2014.10.005

Gomulkiewicz, R. W. (2009). Open source license proliferation: Helpful diversity or hopeless confusion. *Wash. UJL & Pol'y*, *30*, 261.

Goode, S. (2014). Exploring organizational information sharing in adopters and non-adopters of open source software: Evidence from six case studies. *Knowledge and Process Management*, *21*(1), 78–89. doi:10.1002/kpm.1430

Gouvernement du Québec. (2009). Les logiciels libres. Retrieved from https://www.tresor.gouv.qc.ca/ressources-informationnelles/logiciels-libres/

Gouvernement du Québec. (2018). Forge gouvernementale. Retrieved from https://forge.gouv.qc.ca/licence/

Grodzinsky, F. S., Miller, K., & Wolf, M. J. (2003). Ethical issues in open source software. *Journal of Information. Communication and Ethics in Society*, *1*(4), 193–205. doi:10.1108/14779960380000235

Guest, G., Bunce, A., & Johnson, L. (2006). How many interviews are enough? An experiment with data saturation and variability. *Field Methods*, *18*(1), 59–82. doi:10.1177/1525822X05279903

Gwebu, K. L., & Wang, J. (2010). Seeing eye to eye? An exploratory study of free open source software users' perceptions. *Journal of Systems and Software*, *83*(11), 2287–2296. doi:10.1016/j.jss.2010.07.011

Hammersley, M. (2007). The issue of quality in qualitative research. *International Journal of Research & Method in Education*, *30*(3), 287–305. doi:10.1080/17437270701614782

Harris, N. L., Cock, P. J. A., Lapp, H., Chapman, B., Davey, R., Fields, C., & Munoz-Torres, M. et al. (2016). The 2015 Bioinformatics Open Source Conference (BOSC 2015). *PLoS Computational Biology*, *12*(2). doi:10.1371/journal.pcbi.1004691

Hauge, Ø., Ayala, C., & Conradi, R. (2010). Adoption of open source software in software-intensive organizations–A systematic literature review. *Information and Software Technology*, *52*(11), 1133–1154. doi:10.1016/j.infsof.2010.05.008

Hecker, F. (1999). Setting up shop: The business of open-source software. *IEEE Software*, *16*(1), 45–51. doi:10.1109/52.744568

Helander, N., & Rissanen, T. (2005). Value-creating networks approach to open source software business models. *Frontiers of E-Business Research*, *2005*, 840–854.

Hitachi. (2015). Hitachi Data Systems Completes Pentaho Acquisition. Retrieved from https://www.hitachivantara.com/en-us/news-resources/press-releases/2015/gl150604.html

IBM. (2011). 2011 IBM Tech Trends Report. Retrieved from https://www.ibm.com/developerworks/community/blogs/ff67b471-79df-4bef-9593-4802def4013d/entry/2011_ibm_tech_trends_report_the_clouds_are_rolling_in_is_your_business_ready5?lang=en

Irwin. (1998). What is FUD? Retrieved from http://www.cavcomp.demon.co.uk/halloween/fuddef.html

Jansen, H. (2010). The logic of qualitative survey research and its position in the field of social research methods. *Paper presented at the Forum Qualitative Sozialforschung/Forum: Qualitative Social Research*.

Kappelman, L., McLean, E., Luftman, J., & Johnson, V. (2013). Key Issues of IT Organizations and Their Leadership: The 2013 SIM IT Trends Study. *MIS Quarterly Executive*, *12*(4).

Kim, H. W., Chan, H. C., & Lee, S. H. (2014). User resistance to software migration: The case on Linux. *Journal of Database Management*, *25*(1), 59–79. doi:10.4018/jdm.2014010103

Kiron, D., Prentice, P. K., & Ferguson, R. B. (2014). The analytics mandate. *MIT Sloan Management Review*, *55*(4), 1.

Klein, H. K., & Myers, M. D. (1999). A set of principles for conducting and evaluating interpretive field studies in information systems. *Management Information Systems Quarterly*, *23*(1), 67–93. doi:10.2307/249410

L'Association professionnelle des entreprises en logiciels libres - APELL. (2011). *L'industrie du logiciel libre québécoise*. Retrieved from www.agirs.org

Lerner, J., & Tirole, J. (2005). The scope of open source licensing. *Journal of Law Economics and Organization*, *21*(1), 20–56. doi:10.1093/jleo/ewi002

Lincoln, Y., & Guba, E. (1985). *Naturalistic inquiry. Newburry Park*. Newbury Park, CA: Sage.

Logi Analytics. (2011). Half of Non-Technical Business Intelligence Users Dissatisfied with IT's Ability to Deliver, Survey Shows. Retrieved from https://www.logianalytics.com/news/half-of-non-technical-business-intelligence-users-dissatisfied-with-its-ability-to-deliver-survey-shows/

Luftman, J., Derksen, B., Dwivedi, R., Santana, M., Zadeh, H. S., & Rigoni, E. (2015). Influential IT management trends: An international study. *Journal of Information Technology*, *30*(3), 293–305. doi:10.1057/jit.2015.18

Macredie, R., & Mijinyawa, K. (2011). A theory-grounded framework of Open Source Software adoption in SMEs. *European Journal of Information Systems*, *20*(2), 237–250. doi:10.1057/ejis.2010.60

Mandel, M. (2012). Beyond goods and services: The (unmeasured) rise of the data-driven economy. Progressive Policy Institute.

McAfee, A., Brynjolfsson, E., Davenport, T. H., Patil, D., & Barton, D. (2012). Big data: The management revolution. *Harvard Business Review*, *90*(10), 60–68. PMID:23074865

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook*: sage.

Morgan, L., & Finnegan, P. (2010). Open Innovation in Secondary Software Firms: An Exploration of Managers' Perceptions of Open Source Software. *The Data Base for Advances in Information Systems*, *41*(1), 76–95. doi:10.1145/1719051.1719056

Morse, J. M., Barrett, M., Mayan, M., Olson, K., & Spiers, J. (2002). Verification strategies for establishing reliability and validity in qualitative research. *International Journal of Qualitative Methods*, *1*(2), 13–22. doi:10.1177/160940690200100202

Mutula, S., & Kalaote, T. (2010). Open source software deployment in the public sector: A review of Botswana and South Africa. *Library Hi Tech*, *28*(1), 63–80. doi:10.1108/07378831011026698

Nagy, D., Yassin, A. M., & Bhattacherjee, A. (2010). Organizational adoption of open source software: Barriers and remedies. *Communications of the ACM*, *53*(3), 148–151. doi:10.1145/1666420.1666457

Olsen, K. A., & Saetre, P. (2007). IT for niche companies: Is an ERP system the solution? *Information Systems Journal*, *17*(1), 37–58. doi:10.1111/j.1365-2575.2006.00229.x

Onetti, A., & Capobianco, F. (2005). Open source and business model innovation. the funambol case. *Paper presented at the first International Conference on Open source Systems*.

OSI. (2008). Licenses by Name. Retrieved from https://opensource.org/licenses/alphabetical

Palanisamy, R., & Mukerji, B. (2012). Adoption Of Open Source Software For Enhancing Customer Satisfaction: A Case Study From Canadian Educational Sector. *Journal of Services Research*, *12*(2).

Paré, G., Wybo, M. D., & Delannoy, C. (2009). Barriers to open source software adoption in Quebec's health care organizations. *Journal of Medical Systems*, *33*(1), 1–7. doi:10.1007/s10916-008-9158-4 PMID:19238891

Park, Y., El Sawy, O. A., & Fiss, P. C. (2017). The Role of Business Intelligence and Communication Technologies in Organizational Agility: A Configurational Approach. *Journal of the Association for Information Systems*, *18*(9), 648–686. doi:10.17705/1jais.00001

Patton, M. Q. (1990). *Qualitative evaluation and research methods*. Newbury Park, CA: SAGE Publications, inc.

Peacock, A. (2017). Business Intelligence Survey 2017: Mobility and Access. Retrieved from https://clutch.co/analytics/resources/business-intelligence-survey-mobility-access

Pfaffenberger, B. (2000). The rhetoric of dread: Fear, uncertainty, and doubt (FUD) in information technology marketing. *Knowledge, Technology & Policy*, *13*(3), 78–92. doi:10.1007/s12130-000-1022-x

Poba-Nzaou, P., Lemieux, N., Beaupré, D., & Uwizeyemungu, S. (2016). Critical challenges associated with the adoption of social media: A Delphi of a panel of Canadian human resources managers. *Journal of Business Research*, *69*(10), 4011–4019. doi:10.1016/j.jbusres.2016.06.006

Poba-Nzaou, P., & Raymond, L. (2011). Managing ERP system risk in SMEs: A multiple case study. *Journal of Information Technology*, *26*(3), 170–192. doi:10.1057/jit.2010.34

Poba-Nzaou, P., Raymond, L., & Fabi, B. (2014). Risk of adopting mission-critical OSS applications: An interpretive case study. *International Journal of Operations & Production Management*, *34*(4), 477–512. doi:10.1108/IJOPM-03-2012-0117

Poba-Nzaou, P., & Uwizeyemungu, S. (2013). Barriers to Mission-Critical Open Source Software Adoption by Organizations: A Provider Perspective. *Paper presented at the the 19th Americas conference on information systems (AMCIS 2013)*, Chicago, IL.

Poba-Nzaou, P., Uwizeyemungu, S., & Clarke, C. (2018). Patterns underlying required HR and IT competencies: A content and cluster analysis of advertisements of HR manager positions. *International Journal of Human Resource Management*, 1–24. doi:10.1080/09585192.2018.1424019

Qu, W. G., Yang, Z., & Wang, Z. (2011). Multi-level framework of open source software adoption. *Journal of Business Research*, *64*(9), 997–1003. doi:10.1016/j.jbusres.2010.11.023

Rolandsson, B., Bergquist, M., & Ljungberg, J. (2011). Open source in the firm: Opening up professional practices of software development. *Research Policy*, *40*(4), 576–587. doi:10.1016/j.respol.2010.11.003

Rosenberg, D. (2008). IDC survey proves opensource software as viable business model. Retrieved from https://www.cnet.com/news/idc-survey-proves-open-source-software-as-viable-business-model/

Rousseau, D. M., & Fried, Y. (2001). Location, location, location: Contextualizing organizational research. *Journal of Organizational Behavior: The International Journal of Industrial. Occupational and Organizational Psychology and Behavior*, *22*(1), 1–13. doi:10.1002/job.78

Safadi, H., Chan, D., Dawes, M., Roper, M., & Faraj, S. (2015). Open-source health information technology: A case study of electronic medical records. *Health Policy and Technology*, *4*(1), 14–28. doi:10.1016/j.hlpt.2014.10.011

Sallam, R. L., Richardson, J., Hagerty, J., & Hostmann, B. (2011). *Magic quadrant for business intelligence platforms*. Stamford, CT: Gartner Group.

Sledgianowski, D., Tafti, M. H., & Kierstead, J. (2008). SME ERP system sourcing strategies: A case study. *Industrial Management & Data Systems*, *108*(4), 421–436. doi:10.1108/02635570810868317

Smets-Solanes, J.-P., & de Carvalho, R. A. (2003). ERP5: A next-generation, open-source ERP architecture. *IT Professional*, *5*(4), 38–44. doi:10.1109/MITP.2003.1216231

Stackowiak, R., Licht, A., Mantha, V., & Nagode, L. (2015). *Big Data and the Internet of Things: Enterprise Information Architecture for a New Age*. Apress. doi:10.1007/978-1-4842-0986-8

Stol, K.-J., Babar, M. A., Avgeriou, P., & Fitzgerald, B. (2011). A comparative study of challenges in integrating Open Source Software and Inner Source Software. *Information and Software Technology*, *53*(12), 1319–1336. doi:10.1016/j.infsof.2011.06.007

Tanner, C. K., & Stone, C. D. (1998). School Improvement Policy--Site-Based Management. *education policy analysis archives, 6*, 6.

Thomsen, C., & Pedersen, T. B. (2009). A survey of open source tools for business intelligence. *International Journal of Data Warehousing and Mining*, *5*(3), 56–75. doi:10.4018/jdwm.2009070103

TIBCO. (2014). TIBCO Software Acquires Jaspersoft. Retrieved from https://www.tibco.com/press-releases/2014/tibco-software-acquires-jaspersoft

Tomazin, M., & Gradišar, M. (2007). Introducing open source software into Slovenian primary and secondary schools. *Informatica, 31*(1).

Trieu, V. H. (2017). Getting value from Business Intelligence systems: A review and research agenda. *Decision Support Systems*, *93*, 111–124. doi:10.1016/j.dss.2016.09.019

Tversky, A., & Fox, C. R. (1995). Weighing risk and uncertainty. *Psychological Review*, *102*(2), 269–283. doi:10.1037/0033-295X.102.2.269

Vanmeulebrouk, B., Rivett, U., Ricketts, A., & Loudon, M. (2008). Open source GIS for HIV/AIDS management. *International Journal of Health Geographics*, *7*(1), 53. doi:10.1186/1476-072X-7-53 PMID:18945338

Venkatesh, V., & Bala, H. (2012). Adoption and impacts of interorganizational business process standards: Role of partnering synergy. *Information Systems Research*, *23*(4), 1131–1157. doi:10.1287/isre.1110.0404

Wang, P. (2009). Popular concepts beyond organizations: Exploring new dimensions of information technology innovations. *Journal of the Association for Information Systems*, *10*(1), 2. doi:10.17705/1jais.00182

Watson, R. T., Boudreau, M.-C., York, P. T., Greiner, M. E., & Wynn, D. Jr. (2008). The business of open source. *Communications of the ACM*, *51*(4), 41–46. doi:10.1145/1330311.1330321

Weilbach, L., & Byrne, E. (2013). Implementing open source software to conform to national policy. *Journal of Systems and Information Technology*, *15*(1), 78–96. doi:10.1108/13287261311322594

West, J. (2007). Value capture and value networks in open source vendor strategies. *Paper presented at the 40th Annual Hawaii International Conference on System Sciences HICSS 2007*.

Widenius, M. M., & Nyman, L. (2014). The business of open source software: A primer. *Technology Innovation Management Review*, *4*(1), 4. doi:10.22215/timreview/756

Williams van Rooij, S. (2007). Perceptions of open source versus commercial software: Is higher education still on the fence? *Journal of Research on Technology in Education*, *39*(4), 433–453. doi:10.1080/15391523.2007.10782491

Wu, H., & Cao, L. (2009). Community collaboration for ERP implementation. *IEEE Software*, *26*(6), 48–55. doi:10.1109/MS.2009.171

Wu, J., Goh, K. Y., Li, H., Luo, C., & Zheng, H. (2016). The effects of communication patterns on the success of open source software projects: An empirical analysis from social network perspectives. *Journal of Global Information Management*, *24*(4), 22–44. doi:10.4018/JGIM.2016100102

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