Open Source Alternatives for Business Intelligence: Critical Success Factors for Adoption

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ABSTRACT

The purpose of this research is to identify critical factors that affect the adoption of Open Source Business Intelligence (OPBI) tools and to compare the differences between OPBI and Proprietary Business Intelligence (PBI) tools. Based on the Technology Acceptance Model, an organizational adoption model was designed to analyze four cases of organizations that have adopted Business Intelligence (BI) tools. The cases were documented using a tested protocol and a set of interviews. The analysis of the cases shows that organizations with fewer resources and simpler IT selection processes tend to adopt OPBI. The most cited reason for using OPBI software is cost savings. The results also reveal that for most users OPBI does not require sophisticated BI specialists and offers as many useful features as PBI tools. These findings are important to BI vendors, users, developers, and organizations interested in adopting BI technologies.

Keywords

Business Intelligence, Open Source, Technology Adoptions, Success Factors.

INTRODUCTION

Organizations are experiencing increased data storage requirements due to increased data creation and the need to share more data and applications with a growing number of end users. The challenge for organizations is not only to scale up to support these dramatic increases, but to maximize performance at minimal costs. In general, Business Intelligence (BI) tools help organizations to gather, store, analyze, and provide access to data, enabling users to make more informed business decisions (Ranjan, 2009). BI tools deliver the insight needed to make strategic forecasts, optimize business processes, and lower operational costs. BI is becoming increasingly important to businesses as they need to obtain information from the abundance of data they collect every day. BI continues to evolve, and some recent developments are attracting public interests. Current trends include real-time BI, business performance management, and pervasive BI.

BI tools can be categorized as Open Source BI (OPBI) and Proprietary BI (PBI). Today PBI is a self-sustaining technology given that a number of large BI vendors such as IBM, SAP, Microsoft, and Oracle have invested intensively on their products. Their offers include technical support, consulting services, software integration, and readily available applications. However, PBI is significantly expensive and lacks licensing transparency, which turns adoption decisions challenging to make. OPBI is categorized as community OPBI and commercial OPBI and can be obtained free of charge or on a service-fee basis by Actuate BIRT, JasperSoft, Jedox, Pentaho, and SpagoBI (Sallam, 2010). Like other open source software, OPBI allows access to its source code and offers ease of integration into existing systems. However, OPBI has disadvantages. First, OPBI tools are far from perfect and issues with security, stability, dependability, support, and lack of capabilities have prevented its full market adoption (Hagerty, Sallam, Richardson, 2012). Second, organizations planning to adopt BI tools are not aware of the differences between PBI and OPBI and find requirements for successful adoption unclear. Consequently, firms are not adopting OPBI at the same rate as proprietary BI software, which in many cases can translate into an over spending on technology (Nagy, Yassin and Bhattacherjee, 2010).
In this research study we identify critical factors (i.e., organizational, provider, system, and project) that affect the adoption of OPBI tools and we compare perceived differences between OPBI and PBI. Our research strategy is designed to investigate

how OPBI tools are used, how they are adopted and how external factors affect the use and adoption of OPBI in organizations. The findings of this study are important to BI vendors, users, developers, and companies that are interested in adopting or promoting BI technologies. The findings can also be useful guidelines for organizations that need to choose the best suitable BI solution to their business problem.

LITERATURE REVIEW

BI includes an effective data warehouse design and a reactive component capable of monitoring the time critical operational processes to allow tactical and operational decision-makers to tune their actions according to the company strategy (Ranjan, 2009). BI can help to make business decisions at the operational, tactical and strategic levels. BI consists of a data warehouse, OLAP (On-Line Analytical Processing), data visualization, data mining and data integration.

Organizations need timely information to make decisions and take improvement actions that will allow them to remain competitive. The information necessary for decision-making and process management must be obtained from various data resources related to customers, suppliers, orders, inventory, and daily transaction. Collecting this information often requires complex queries of different databases, which result in high level of dependency of IT specialists. The remark that organizations are rich in data but poor in information seems appropriate. The challenge of modern organizations is how to transform the abundance of data into useful information (Carver and Ritacco, 2006).

BI is described as process that includes two primary activities: getting data in and getting data out (Watson and Wixom, 2007). Getting data in, traditionally referred to as data warehousing, involves moving data from a set of source systems into an integrated data warehouse (Watson and Wixom, 2007). This activity entails to extract, clean, model, transform, transfer, and load transaction data from one or more operational systems into the data warehouse. Getting data out, commonly referred to as BI, involves business users and applications. Users can view report as a static documents, filter report by relevant criteria, or navigate reports to change views or levels of detail on demand (Eckerson, 2003).

Proprietary BI vs. Open Source BI

Proprietary BI is a self-sustaining technology which concentrates on existing customer needs, and which may, ultimately, smooth innovation (ElegantJ BI, 2010). Today, a number of large independent BI vendors have invested intensively in their BI products, though many niche players continue to stream into the space (Hagerty, Sallam, Richardson, 2012). Advantages of PBI include availability of technical support, consulting and software installation services, and readily available application with more 'solid' deliverables, and standard features. Table 1 lists advantages and disadvantages of PBI.

Advantages	Disadvantages
Availability of help desk, technical support, and consultant (ElegantJ BI, 2010)	High total cost of ownership (TCO) (Madsen, 2010)
Ease of use, less training required (ElegantJ BI, 2010)	Do not support the prototype, must sign contract before full evaluation of solutions (Pentaho , 2006)
A sophisticated, stabilized tested application. Significant capabilities and more dependability for various industries (ElegantJ BI, 2010)	Lack of transparency with bundling, editions, components, user types and environments (Madsen, 2010)
More flexibility with different technologies (ElegantJ BI, 2010)	Vendor lock-in to paying for unneeded features and functions (Ventana Research, 2008)
Standardized technical and user documentation of solutions (ElegantJ BI, 2010)	Difficult or impossible for customers and to extend the system (Pentaho, 2006)

Table 1. Advantages and Disadvantages of Proprietary BI

OPBI software is available under an open source license. The market for OPBI is proliferating with major open source players like Actuate BIRT, JasperSoft, Jedox, Pentaho, and SpagoBI. Their software is built on open source licensed code, and in general these vendors offer software on a subscription-based model, which is less expensive compared to fees for technical support, upgrading, and troubleshooting (Ventana Research, 2008). Table 2 lists advantages and disadvantages of OPBI.

Advantages	Disadvantages
Reduced total cost of ownership (TCO) (Madsen, 2010)	Poor support, limited access to consultants, knowledge, and training (ElegantJ BI, 2010)
Availability and accessibility of source code, right to modify the code at will. Re-usable BI components, and fully customization of user interfaces (ElegantJ BI, 2010; Pentaho, 2006)	There is no administrative body or person to restrict how and where the software is used (ElegantJ BI, 2010)
Ease of integration into an existing application (Pentaho, 2006)	There is always a possibility of creating an alternative code (ElegantJ BI, 2010)
Prototyping can be done without significant financial expenditure (Pentaho, 2006)	External developed modules are not properly or fully tested (ElegantJ BI, 2010)
Many open source software products use a subscription model that enables organizations pay for only needed features and adjust their subscription costs (Ventana Research, 2008)	Exposure to Intellectual Property theft issues (ElegantJ BI, 2010)
Recognized standards which make it compatible with other third-party tools and portable skills (Pentaho, 2006).	There is uncertainty over the future of open source tools and protection for vendors and users that invest these tools (ElegantJ BI, 2010).
Flexibility to evaluate the tool before buying (Tayal, 2009).	Lack of capabilities / features catering to all industries (MAIA Intelligence, 2010).
Higher quality code (Tayal, 2009).	Absence of adequate, accurate functional and technical documentation (ElegantJ BI, 2010).

Table 2. Advantages and Disadvantages of OPBI

METHODOLOGY

The research strategy follows a case study design with four steps: 1) literature review of the evolution of BI tools, 2) analysis of BI and OPBI characteristics and design of the research framework, 3) documentation of four BI adoption cases guided by the project research framework, and 4) case analysis using the research framework to test the study propositions. Figure 1 presents the research strategy. Cases 1 and 2 represent PBI adoptions, while cases 3 and 4 represent OPBI adoptions.

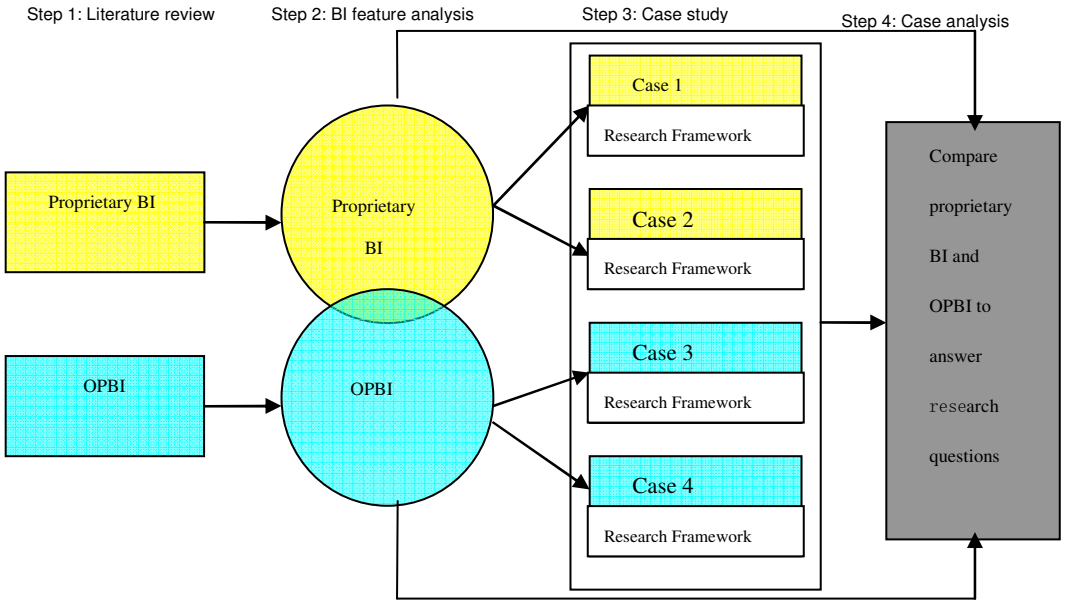

Figure 1. Research Strategy

Research Questions

The research strategy allowed us to analyze successful OPBI adoptions and identify perception differences between PBI and OPBI tools. Specifically, the study aimed to answer the following questions:

RQ 1: What factors affect the adoption of OPBI tools?

- P1.1: Organizational factors have an impact on the adoption of OPBI
- P1.2: Provider factors have an impact on the adoption of OPBI
- P1.3: System factors have an impact on the adoption of OPBI
- P1.4: Project factors have an impact on the adoption of OPBI

RQ 2: What are the differences between OPBI products and PBI tools?

- P2.1: OPBI offers greater savings in total cost of ownership (TCO) compare to PBI.
- P2.2: OPBI has as many useful features as PBI for any regular organization.
- P2.3: OPBI lacks adequate, accurate functional and technical documentation.
- P2.4: OPBI requires more technology competencies than PBI.

By finding evidence to support our propositions, we expect to identify the drivers for OPBI adoption and the factors required for successful adoption of OPBI.

Research Framework

Based on the Technology Acceptance Model (TAM) (Davis, 1989), we designed an organizational technology acceptance framework (Figure 2). Given that organizations want to meet their competitive goals, they must be willing to adopt BI tools. Therefore, similar to the TAM model, we proposed that the adoption of BI tools will result from organizational use satisfaction, which will be conditioned by both organizational readiness to adopt and information needs. Last, affecting these dimensions there are several external factors grouped into four categories: Organizational, provider, system, and project variables.

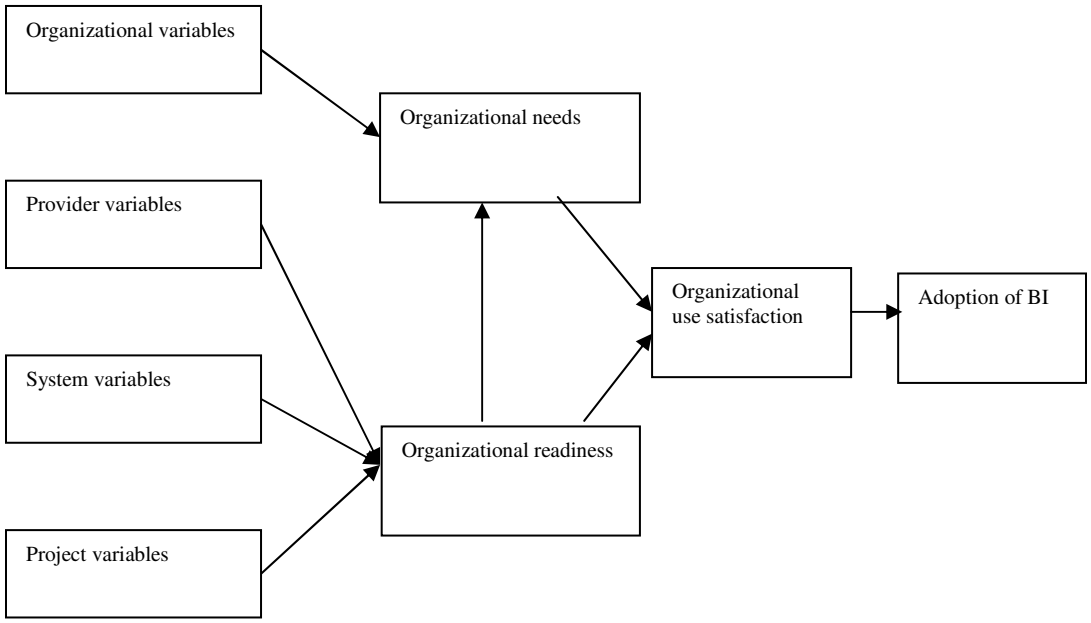

Figure 2. Research Framework

The description of the variables included in each factor of our research framework is listed in Tables 3a-d through 6.

a. Organizational Variables	
Factor	**Description**
Industry	The industry to which the organization belongs
Size	The number of employees
Resource	The technological and financial resources available
Process of selecting and implementing the IT	Complexity of process that organization selects the IT

b. Project Variables	
Factor	**Description**
Project team size Project leaders Analysts Programmers	The number of participants and their categories
Cost License cost Support cost Total cost of ownership	License cost, support cost and total cost of ownership of BI

c. Provider Variables	
Factor	**Description**
Vendor recognition	The extent to which the vendor is known as a BI vendor
Size	The number of employee.
The quality of customer support	The quality of the vendor's business/technical support offerings. Whether phone support, email support, onsite support and consulting Partnership are offered
The quality of user training	The quality of the vendor's business/technical training offerings. Whether onsite training, online classes, self-directed web-based training are offered
Offering maturity	The extent to which an offering has developed in comparison to similar offerings on the market (Datamonitor, 2007)
Administration and deployment	How is the quality of administration and deployment including security, metadata management, centralized administration and support facilities, Web-based administration facilities (Datamonitor, 2007)
Ease of evaluating capabilities	Is it easy to evaluate full capabilities before buying through documents, consulting, or free trial software

d. System Variables		
Factor		**Description**
Completeness of the BI offering		The state of the BI software being complete and entire; having everything that is needed
Quality of the software code		Evaluations of customer references and performing in-house (Ventana Research, 2006)
Testing and quality of BI software		The quality of QA process, policy, and standard
Data quality and integrity		Understandability and consistency of analytic data
Interoperability and integration		The ease and extent with which a technology offering can exist, interface, combine, and work with the products, services, and solutions from other vendors (Datamonitor, 2007)
Use of industry standards		The extent to which vendors offer generally accepted protocols, methods, data structures, business principles, and programmatic interfaces (Datamonitor, 2007)
Functionality		The extent to which vendors offer the features and functionality identified out of the box without the need for additional customization. (Wise, 2010)
User community	Size	The numbers of users
	Activeness	The degree that community members involving participation
Ease of use		The extent to which BI software provides simplicity of design and interactivity. End users require the ability to create content that can be customized, redesigned, and revised without external resources required (Wise, 2010)
Documentation quality		The extent to which BI software offers user manual, technical or business documentation easy to understand and gives users a way to reference information and provides in-depth information related to the deployment and use of the system (Wise, 2010)

Table 3. External Factors for Adoption of BI

Organizational Needs		
Factor		**Description**
Tactic decision making	Effectiveness	Measurement of effectiveness and satisfaction of tactic decision making supported by BI
	Satisfaction	
Strategic decision making	Effectiveness	Measurement of effectiveness and satisfaction of strategic decision making supported by BI
	Satisfaction	
Marketing analysis	Effectiveness	Measurement of effectiveness and satisfaction of marketing analysis supported by BI
	Satisfaction	
Performance assessment	Effectiveness	Measurement of effectiveness and satisfaction of performance assessment supported by BI
	Satisfaction	
Supply chain management	Use	The adoption and usage of supply chain management for organization
	Support organization's operation	
	Use in tactic and strategic decision making	
	Use in BI	
Customer relationship management	Use	The adoption and usage of customer relationship management for organization
	Support organization's operation	
	Use in tactic and strategic decision making	
	Use in BI	

Table 4. Organizational Needs

Prior research on the OPBI supports the relevance of each factor included in our research framework (Thompson, 2008; Ventana Research, 2008; Crowston et al., 2003; Ventana Research, 2006). Research indicates the importance of cost, system and information quality, functionality, support and training in adoption of BI. As organizational factors we include industry characteristics (Kwan and West, 2005), size (Ventana Research, 2006), disposable resources, and technology competencies of IT staff. The IT selection and implementation processes are relevant to adoption (Obra and Meléndez, 2006) since top management must have a clear vision and a sound business case to meet business objectives and needs (Yeoh and Koronios, 2010). Last current deployment and use of technology within the industry the organization operates are factors considered.

As project factors research indicates that license cost, total cost of ownership, and size of the project for which BI software are relevant (Nagy, Yassin, and Bhattacherjee, 2010; Ventana Research, 2006). System quality factors include completeness of the BI solution, quality of the software code, ease of testing and quality of BI software (Ventana Research, 2006), data quality and integrity (Yeoh and Koronios, 2010), interoperability and integration, use of industry standards (Datamonitor, 2007), functionality, critical-mass user community (Ventana Research, 2008), ease of use (Thompson, 2008), and documentation quality (Crowston et al., 2003). Regarding provider factors, the framework includes vendor recognition, size of vendor, quality of customer support and training, maturity, administration and deployment (Datamonitor, 2007), and evaluation ease (Ventana Research, 2006).

Organizational Readiness	
Factor	**Description**
People	
IT staff Project leaders Analysts Programmers IT operation staffs	The number of IT staffs and their categories.
Number of computer workstations	The number of computer workstations in organization
Software and Hardware Infrastructure	
Database type	The database the organization uses (Oracle, DB2, other
Database size	The size of the organization's databases
Server Platform	The server platform the organization uses (AIX, Solaris, Windows, Linux)
Number of servers	The number of servers in organization
Enterprise Applications	
Customer relationship management (CRM) systems	CRM in place and in use
Enterprise resource planning (ERP) systems	ERP in place and in use
Supply chain management (SCM) systems	SCM in place and in use
Business performance management (BPM) system	BPM in place and in use

Table 5. Organizational Readiness

Usage of BI		
Factor		**Description**
The number of users		The number of end users who use BI software
The number of reports		The number of reports by BI software weekly, monthly and annually
The number of ad hoc reports		The number of ad hoc reports by BI software weekly, monthly and annually
Scope of BI use		The scope of BI deployment in organization
Production use	Reporting OLAP Database/DW platform Data integration and ETL Advanced analytics Embedded/application reports	The categories of tools the organization is using
Impact of BI	Performance	Whether BI improves performance of organization
	Development	Whether BI accelerates the growth of organization
	Satisfaction(product, project)	Whether BI satisfies the needs of organization

Table 6. Use of BI

The research framework also considers as drivers of BI adoption organizational needs and readiness. Organizational needs include required levels and types of decision-making i.e., tactic or strategic, marketing analysis, and performance assessment and current use of enterprise systems i.e., supply chain management and customer relationship management

In terms of organizational readiness, or the ability and willingness of to shift from the current way of operating, the framework includes IT infrastructure comprise of IT staff structure, existing software and hardware, and whether a company has the in-house capacity to built business applications.

In addition to the factors included in the framework, our data collection included factors that would indicate the state adoption and us of BI. These factors include the depth and width of utilization of BI system, the effectiveness and satisfaction with the BI project, the number of users of BI tools and the number of reports generated with this tools, the scope of use of BI

tool, the products the organization has implemented, and the impact the BI system brought to the organization. Table 6 lists these indicative factors.

Research Procedure

We tested our research framework in four case studies of organizations, two having adopted PBI and two having adopted OPBI. For each organization, we identified factors that affected the adoption of BI tools. For each case, we interviewed business managers and BI project leaders. Interviews were initiated with a formal email invitation, and later conducted by IP phone. During the interviews, first, we asked each participant to provide general information of the BI project and how BI tools were used. Next, we asked participants to relate the organizational needs and readiness to adopt BI. Each interviewee provided information related to the BI project in their current organization. Findings were coded and summarized, and later presented to each interviewee for their validation and approval.

CASE STUDIES

Case I Online Publishing Company

The organization is the premier source of special interest media in the United States. It offers more than 70 publications, 90 Web sites, 400 branded products, and TV and radio programs. This company is the largest provider of content to communities of enthusiast of automotive and action sports. This organization utilizes existing content to build leading online destinations. With more severe competition in the online publishing industry in addition to all merger and acquisition activity, the company needed to expand its operating platform and enlarge its market share on a long-term path of sustainable growth. The BI capabilities of this organization were being built into and across various Microsoft's products including SQL Server, SharePoint, and Office Suite. SQL Server incorporated reporting, extraction, transformation and loading (ETL), and OLAP and data mining functionalities. The dashboards, scorecards and social software enterprise-search capabilities were deployed using SharePoint 2010. Excel ad hoc analysis and PowerPivot were in place to allow users the capacity to gather data from various sources and analyze it on their desktop. The Microsoft-centered BI platform facilitated production reporting with a cost of $40,000 for licensing and $110,000 for annual support.

Case I Bank

The organization was founded in 1884 from the merger of two banks. The bank has 1,700 branches with 28,759 employees. The company through its subsidiaries provides financial services, including savings accounts, revolving loans, personal loans, credit cards, travelers' checks, checking accounts, electronic money transfers, and ATM services. The purpose of the BI project was to implement a management model based on the Balanced Scorecard methodology that would help to monitor the performance of the organization and provide relevant and timely information on the attainment of strategic objectives to facilitate decision-making and improvement actions. The BI system was built on Hyperion System 9 BI platform**.** The BI solution development was outsourced to a BI vendor. The vendor created a strategic map with performance indicators and associated initiatives for each area: Distribution Networks, Business Development, and Sales Support. The vendor provided the methodology for defining, aligning, and prioritizing strategic initiatives; however, the implementation of the initiatives was the responsibility of the organization.

Case III Government Agency

The organization is a city government incorporated in 1877 that employs approximately 900 people. In 2007, the city had a total population of 92,000. Its mission is to provide essential services to residents while minimizing taxpayer's burden. The police department of this city needed to get timely and accurate reporting from their computer aided dispatch and police report applications. The organization wanted to use free open source tools from the start. They decided to adopt OPBI which offered a full range of BI products, without paying any licensing fee. They only paid for support for the first three months of the project. After that they have relied on the open support of the user community. The BI system involves 50 end users with thee staff members: one for support, one for maintenance, and one for development.

Case IV Publishing Company

The organization is the number one publisher in the Netherlands founded in 1868 with almost 3000 employees. It has a dominant position in the Dutch market and is the most successful publishing house in the Netherlands. They merged with three other companies and they needed to integrate the information of the three organizations into the existing data

warehouse. The goal was to bring the existing data warehouse to a more mature level and benefit from BI applications. The company was working on a back-end Oracle platform. Even though they thought OPBI was cheaper and covered the functionality they needed, the organization already had a long-term contract with a PBI vendor and decided to stay with this vendor since it was a safer choice. However, they also adopted OPBI and took advantage of both open source and proprietary offers. The BI system involved 300 users supported by seven staff members. The company used various BI tools including reporting, OLAP, database and data warehouse, data integration, and ETL. Their reports were built of information contained in the data warehouse and in multidimensional databases or cubes. Reporting tools and multidimensional analysis were used the most.

RESULTS

Tables 7 through 10 summarize the findings of the application of our research framework to the four case studies. The first column presents the factors included in the research framework. The other four columns represent each of the four cases. Cases I and II represent the PBI adoption cases while Cases III and IV represent the OPBI adoption cases.

External Factors					
Variables		**I**	**II**	**III**	**IV**
Organization					
Industry		Online publisher	Finance	Government	Publisher
Size		M	L	M	L
Resource		H	H	M	M
The culture of the organization		Passive	Proactive	Passive	Passive
Complexity of process of selecting and implementing the IT		M	H	LO	LO
Project					
Project team size		3	8	5	9
Project leaders		1	1	1	1
Analysts		0	2	0	2
Programmers		2	2	0	3
Support staffs		2	N/A	4	3
Cost (thousand US dollar)	License cost	40	25	0	183
	Support cost	120	0	5	137
	Total cost of ownership	160	107.720	5	400
Provider					
Vendor recognition		H	H	H	H
Size		L	S	M	M
The quality of customer support		H	M	H	H
The quality of user training		H	H	M	H
Offering maturity		H	H	M	H
Administration and deployment		H	M	M	LO
Ease of evaluating capabilities		M	M	M	M
Case number		I	II	III	IV
System variables					
Completeness of the BI offering		H	H	M	LO
Quality of the software code		H	H	M	LO
Testing and quality of BI software		H	H	M	M
Data quality and integrity		H	M	M	H
Interoperability and integration		H	H	M	LO
Use of industry standards		H	H	H	M
Functionality		H	M	M	H
User community	Size	S	S	L	M
	Activeness	M	LO	H	M
Ease of use		H	H	M	M
Documentation quality		H	H	LO	M

Table 7. Findings for External Factors BI

Organizational Needs						
Variable			**I**	**II**	**III**	**IV**
Tactic decision making	Effectiveness	Before adoption of BI	N/A	LO	H	LO
		After adoption of BI	H	H	H	H
	Satisfaction	Before adoption of BI	N/A	LO	H	M
		After adoption of BI	H	H	H	M
Strategic decision making	Effectiveness	Before adoption of BI	N/A	LO	LO	LO
		After adoption of BI	H	H	H	H
	Satisfaction	Before adoption of BI	N/A	LO	LO	LO
		After adoption of BI	H	H	H	H
Marketing analysis	Effectiveness	Before adoption of BI	N/A	M	N/A	LO
		After adoption of BI	M	H	N/A	H
	Satisfaction	Before adoption of BI	N/A	M	N/A	LO
		After adoption of BI	M	H	N/A	H
Performance assessment	Effectiveness	Before adoption of BI	N/A	LO	M	LO
		After adoption of BI	H	H	H	H
	Satisfaction	Before adoption of BI	N/A	LO	LO	LO
		After adoption of BI	H	H	H	H
Supply chain management	Use		N/A	N/A	N/A	Y
	Support organization's operation		N/A	N/A	N/A	Y
	Use in tactic and strategic decision making		N/A	N/A	N/A	Y
	Use in BI		N/A	N/A	N/A	Y
Customer relationship management	Use		N/A	Y	N/A	Y
	Support organization's operation		N/A	Y	N/A	Y
	Use in tactic and strategic decision making		N/A	Y	N/A	Y
	Use in BI		N/A	Y	N/A	Y

Table 8. Findings for Organizational Needs

Organizational Readiness				
Variable	**I**	**II**	**III**	**IV**
People				
IT staff				
Project leaders	10	5	2	1
Analysts	2	20	6	2
Programmers	75	20	0	6
IT operation staffs	7	120	30	12
Number of workstations	250	500	700	1000
Software/hardware				
Database type	SQL Server	Oracle, DB2	SQL Server, MySQL	Oracle
Database size	2.5 Terabytes	80 Gigabytes	N/A	1Terabyte
Server platform	Windows and Linux	Solaris, Windows	Windows	AIX
Number of servers	40	N/A	N/A	N/A
Application				
Customer relationship management (CRM)	N/A	Y	N/A	Y
Enterprise resource planning (ERP)	N/A	Y	Y	Y
Supply chain management (SCM)	N/A	N/A	N/A	Y
Business performance management (BPM)	N/A	Y	N/A	N

Table 9. Findings for Organizational Readiness

Usage of BI					
Variable		**I**	**II**	**III**	**IV**
Number of end users		30	30	50	300
Number of reports -Monthly - Annually		 150 1800	 150 1800	 320 4000	 300 3600
Number of ad hoc reports -Monthly - Annually		 20 240	 50 600	 160 2000	 30 360
Scope of BI use		Enterprise-wide	Enterprise-wide	Enterprise-wide	Enterprise-wide
Production use	Reporting	Y	Y		Y
	OLAC	Y	Y	Y	Y
	Database/DW platform	N	Y	Y	Y
	Data integration and ETL	N	N	Y	Y
	Advanced analytic	Y	Y	N	Y
	Embedded/application reports	Y	Y	N	Y
Impact of BI					
The degree in which BI improves organizational performance		H	H	H	H
The degree in which BI accelerates organizational growth		H	M	N/A	H
Satisfaction with the BI solution		H	H	H	H
Satisfaction with the BI project		H	H	H	M

Table 10. Findings for Usage of BI

ANALYSIS OF RESULTS

Two dimensions indicate the state of BI adoption in organizations: the impact on organizational needs and the current use of BI tools. Table 8 documents the organization's objectives and the degree of support of organizational needs. It also compares effectiveness and satisfaction during operational processes and procedures before and after adoption of BI. Table 10 lists frequency of use and volume of use by users as well as the impact BI has in the four organizations studied. These tables show factors in common among the four cases:

- Organizations had experienced inefficient decision making prior to BI adoption.
- Organizations perceived improvement of efficiency of both tactic and strategic decision-making after BI adoption.
- Top management is highly satisfied with the value BI adds to the organization.
- The adoption of BI improved the performance of organizations and accelerated the growth of organizations.
- BI tools were used across the company.

When managers and employees make business decisions, they are often unable to locate important information. A recent survey found that the top pressure driving midsized organizations to adopt BI is improving operational efficiency (Sage, 2011).

In terms of scope of use, a survey indicates that small organizations are more likely than medium and large to do company-wide deployments, and large organizations are more likely to do smaller deployments (Madsen, 2009). In this study, all the organizations used BI across the organization which contrasts with prior research. This difference may be due to the limited number of cases, thus further study is needed.

Factors Affecting BI Adoption

Type of industry is considered a determinant in the adoption of BI (Kwan and West, 2005). Our findings are consistent with finding of prior research. The first two cases, online publishing and finance, had a larger number of transactions and were more concerned with competition and security, so they considered PBI a safer choice. For government, as a non-profit organization, the industry is relatively stable. Although OPBI was challenging, the government agency was willing to take the risk. The last case, traditional publishing, has adopted both proprietary BI and OPBI. Although they had more faith in proprietary BI, OPBI also offered comparative features, so they decided that a hybrid solution was best for them.

In terms of organizational readiness, the cases differed in IT infrastructure, software and hardware, and enterprise applications. Case I and Case II had larger IT teams. Case I particularly had a very large number of programmers. Conversely, Case III had no programmers. Case IV had a small IT team because the company often hired external IT specialists. Regarding their software and hardware infrastructures, Case I had Microsoft-centric infrastructure, while the IT structure of Case II and Case IV was built on Oracle, and Case III used Window as OS and MySQL as database. Regarding the application, Case I had not adopted any enterprise application, Case II used CRM, ERP, and BPM systems, Case III had adopted an ERP system, and Case IV used CRM, SCM and ERP systems. Thus, another important factor is the kind of enterprise applications and infrastructure they have in place. In the two PBI cases, the companies had a large number of database licenses, so they received data warehouse building and reporting services free of charge from the proprietary vendors. In the hybrid BI case they still had a long-term contract with a PBI vendor, in addition, they got some services free of charge. Thus, they did not fully adopt OPBI. In the other OPBI case, the company had been using free database and open source tools. Therefore, they were in solid ground to utilize OPBI. This findings support our proposition P1.1; organizational factors have an impact on the adoption of OPBI tools.

Provider Factors

IT vendors were different in their levels of social recognition, size, quality of customer support, quality of user training, administration and deployment, and ease of evaluating capabilities. These factors are mentioned in some research as important criteria for vendor assessment (Datamonitor, 2007). Findings indicate that provider selection was uniformly based on the BI vendor's social recognition. In the four cases, the vendors have a high social recognition due to their leading position in the BI industry. The vendors in the cases all offer maturity, quality of customer support, and quality of user training. PBI is better in administration and deployment compared to OPBI. Because the high license fees customers pay these vendors have sufficient resources to coordinate the administrative, database, analytical and web-delivered aspects of BI. In terms of ease of evaluating capabilities, both PBI and OPBI have the same medium level, since they all offer free trial versions for customers to evaluate. However, all interviewees responded that evaluation was not easy, and that too much time was needed to identify the advantages of each tool. These findings support our proposition P1.2; provider factors have an impact on the adoption of OPBI tools.

System Factors

System factors include completeness of the BI offer, quality of the software code, testing and quality of BI software (Ventana Research, 2006), data quality and integrity (Yeoh and Koronios, 2010)**,** interoperability and integration, use of industry standards (Datamonitor., 2007), functionality, user community (Ventana Research, 2008), ease of use (Thompson, 2008*)*. Our findings show that PBI is more complete and has better quality of code, testing and quality of software, and interoperability and integration. PBI is also better than OPBI in ease of use and documentation quality. In terms of data quality, integrity, and use of industry standards, both perform almost the same. However, OPBI has a larger and more active user community since OPBI users rely heavily on support forums. Our findings are almost consistent with prior research. Nevertheless, in some studies, OPBI is said to be more reliable because of higher quality code and better interoperability (Tayal, 2009), which differs from our findings. Our findings do not support our proposition P1.3; system factors do not have an impact on the adoption of OPBI tools.

Project Factors

Size and cost are the main project factors. The top reason for the use of OPBI software is cost savings. Cost is reported as a contributive factor by many researchers (Madsen, 2010; ElegantJ BI, 2010). The third case that used OPBI only purchased three months of support. There was no license fee added. For the last case, the company downloaded OPBI tools for free without purchasing any support. The fact is that the open source software can be little to a lot less expensive depending on the number of users. In many open source models the price model is not based on number of users.

Size of project was small for all the cases. However, Case I lacked analysts and Case III lacked analysts and programmers. Furthermore, Case I and Case IV consisted of both internal and external staffs. The results show that PBI projects usually include BI vendor staff since these organizations had paid for the support. The two OPBI cases had similar project sizes. It seems that no additional IT competencies are required for OPBI to those necessary for PBI. OPBI requires specialists with the right knowledge of the tools and platforms being used. Our findings support our proposition P1.4; project factors, cost but not project size, have an impact on the adoption of OPBI.

Differences between OPBI and PIB

The cases show that OPBI can eliminate license fees and decrease support fees drastically to reduce cost-of-entry into BI,

especially if the organization represents a large size deployment environment, since the price model of OPBI is not based on number of users. However, savings will vary depending on factors such as the hardware and software in use and the vendor being considered. Consequently, our proposition P2.1 cannot be fully supported; OPBI does not necessarily achieve greater savings in total cost of ownership compared to PBI.

The analysis of the cases indicates that organizations currently using OPBI are satisfied with the features OPBI offers. One project manager interviewed stated that "although OPBI is still not complete and mature as PBI, in general, open source tools are 20% of the cost versus 80% of functionality but has all the features we need." This finding is aligned to some research studies that report that OPBI alternatives offer enough functionality to meet regular organizational needs (Ventana Research, 2006). Our findings support our proposition P2.2; OPBI has as many necessary features as PBI for the majority of regular users.

Many researches argue that PBI has standardized technical and user documentation of solutions while OPBI lacks adequate, accurate, functional, and technical documentation (ElegantJ BI, 2010). The analysis of the cases corroborates this perception, so our proposition P2.2 is supported; OPBI lacks adequate, accurate functional and technical documentation.

No prior research found that OPBI requires more technology competencies than PBI. The case studies had similar technology competencies in terms of staff and project structures. The findings demonstrate that no additional specialists are required for OPBI to those required by PBI. OPBI requires specialists with the right knowledge of the tools and platform being used. Both OPBI and PBI required a strong IT team. These findings do not support our proposition P2.4; OPBI tools do not require more technological capabilities than those required by PBI.

CONCLUSIONS

Our study revealed that organizational, provider, system, and project factors have a strong influence on the decision to adopt PBI or OPBI. This answers our RQ1. Larger firms with sufficient financial and technical resources are more likely to use PBI. Besides cost, the most important factor for a decision is the kind of IT infrastructure and tools organizations already have in place. In addition, social recognition and processing have an impact on the decision. The results suggest that organizations using either PBI or OPBI heavily focus on provider maturity, completeness of the BI offering, functionality, and ease of use. However, organizations using PBI put more emphasis on customer support, user training, quality of the software code, testing and quality of BI software, interoperability and integration, use of industry standards, and documentation quality. These companies are willing to pay a premium in order to get professional support, simplified installation and deployment processes, and standardized documentation. In contrast, organizations using OPBI have more interest in administration and deployment processes, and access to a support user community. Given that organizations that adopt OPBI do not pay license fees, they rely exclusively on their competencies and that of the open user community.

Our study identified the differences between two kinds of BI software. These answer our RQ2. On one hand, OPBI tools are less expensive than PBI tools and have a larger, more active user community. On the other hand, PBI tools are comparatively more complete, easier to use and conform to industry standards. In addition, PBI tools have better quality of software code, testing, interoperability and integration, and documentation.

Implications for Organizations and BI Providers

Organizations usually have negative perception of OPBI tools believing that because of their low cost, the tools have poor performance and a high occurrence of faults. However, the cost of OPBI is 20% of the cost of PBI; OPBI functionality can reach 80% of proprietary BI functionality. In most cases, OPBI fully offers the needed functionality. Besides cost, the most important factor for a decision is the kind of tools the organizations already have in place. In our opinion, a better solution will include both types of BI tools: they would have the benefits of PBI and at a minimal cost all the benefits of OPBI tools. PBI offers would be more attractive if they would lower license and support fees and increase access to a user support communities. In the case of OPBI providers, for large companies, the emphasis is not on cost savings but on the functionality, ease of use, and support. If OPBI providers can enhance these aspects, OPBI can attract the attention of more organizations, be more marketable, and acquire a larger market share.

Implications for Researchers

An additional contribution of this study is the research framework that lists the factors that are relevant to the study organizational adoption of BI. Based on TAM, this research framework succeeds in representing the success factors for BI

adoption. Future research in the area of IT adoption can use this framework to forecast the success or failure of adopting a given technology by an organization.

Limitations

BI solutions demand large investment of time, money, and efforts that involve different technologies. First, the study was conducted around certain vendors and specific BI products. Thus, our findings may not represent the complete BI industry. Second, being a case study research this study is descriptive in nature and no conclusions about cause-and-effect relationships should be attempted. The number of cases in this study is a small sample of organizations adopting BI and may not be representative of all organizations. Last, findings are based on perceptions of individuals involved in BI adoption projects. These perceptions may be biased given that interviewees may have different perspectives based on their level of involvement and responsibilities in the projects.

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