SOME DETERMINANTS OF BUSINESS INTELLIGENCE ADOPTION USING THE TECHNOLOGY-ORGANISATION-ENVIRONMENT FRAMEWORK: A DEVELOPING COUNTRY PERSPECTIVE

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Abstract

The competitive environment today dictates that organisations must utilise their resources effectively and efficiently and also aim to provide their employees with the right information tools. Business Intelligence (BI) systems are known for their ability to increase organisational efficiency and effectiveness. This is achieved by providing decision makers with useful information within the necessary timeframe to support effective decision making. This makes BI systems vital to any organisation. However, BI systems require millions of dollars to develop as well as significant hardware and personnel investment. This can be a major obstacle in developing countries that want to adopt BI successfully. Information System (IS) theories on technology adoption have predominantly focused on developed countries and hence a study is required to examine how emerging technologies such as BI can successfully be adopted in a developing county such as South Africa. This research aimed to determine and describe the factors that affect the adoption of BI in South Africa. The study also attempted to identify issues pertaining to BI adoption by South African organisations.

The Technology-Organisation-Environment (TOE) Framework was used as the theoretical basis for studying BI adoption. The results of this study indicate that several factors, namely Information Technology (IT) Infrastructure, Competitive Pressure and Perceived Benefit are important determinants of BI adoption in South Africa. IT Expertise, Lack of Trading Partners and Company Size were found to be statistically insignificant in determining BI adoption decisions. From a practical standpoint, the results could provide useful pointers, both managerial and technological, to organisations in the developing world, for example South Africa, which aspires to adopt BI.

Keywords: business intelligence, BI adoption, technology-organisation-environment framework, developing country.

1.   INTRODUCTION

Business Intelligence Systems (BIS) not only require millions of dollars to develop but also significant hardware and personnel investment (Wierschem, McMillen & McBroom, 2002). These costs can be a major obstacle in a developing country despite the immense benefits that an effective BI system can bring to an organisation.

South Africa, as a developing country, is no exception to this rule. Although recent work by Dawson & Van Belle (2013) examined critical success factors for BI and Bijker & Hart (2013) identified the factors influencing pervasiveness of BI, more research is required to improve our understanding of the prerequisites of successful BI adoption in South Africa. In this paper, we draw upon concepts from Adoption Theory and use the Technology-Organisation-Environment (TOE) Framework to identify the key determinants of BI adoption in South Africa. The paper is structured as follow: in section 2 the term Business Intelligence is defined, in Section 3 the Adoption Theories are briefly discussed, in Section 4 the TOE framework is introduced, and in Section 5 the research methodology is explained. The results and findings are presented in Section 6 with a discussion in Section 7. The paper concludes with Section 8.

2.   BUSINESS INTELLIGENCE

Business Intelligence (BI) is the delivery of accurate and useful information to the appropriate decision makers within the necessary timeframe to support effective decision making (Larson, 2006:12). BI can also be viewed as a set of mathematical models and analysis methodologies that exploit available data to generate information and knowledge that is useful for complex decision-making processes Vercellis (2009:5). In today's competitive marketplace, a company that owns a BI solution possesses distinct advantages over its market rivals. The main goal of BI is to transform data into information, information into knowledge and ultimately, knowledge into wisdom. It can therefore be concluded that the main benefit of Business Intelligence adoption is the increased effectiveness of the decision-making process.

Green (2007) argues that a business has eight value drivers and that each value driver introduces key questions that align with performance. The key to capturing business information is to ask the right questions and to know what is needed to answer the questions. This primitive layer of business information then positions the business to construct intelligence. Green (2007) further argues that "Business intelligence is not a single entity; it is decomposed into business information. Cross-pollination of the value drivers identifies three major components to business intelligence within a business enterprise: relationship intelligence, competence intelligence and structure intelligence". Relationship intelligence refers to the understanding of how the interactions between knowledge workers influence the organisational performance. Competence intelligence refers to the understanding of how the abilities or proficiency of knowledge workers influences organisational performance. Finally, structure intelligence refers to the understanding of how the organisation's infrastructure environment influences its organisational performance.

3.   ADOPTION THEORIES

The decision by an individual to adopt a particular technology and the time frame involved with that decision has long been a source of research across multiple disciplines (Straub, 2009). Adoption theories, such as the Theory of Planned Behaviour (TPB) and the Technology Acceptance Model (TAM), study the individual and the choices that the individual makes in order to adopt a particular innovation (Straub, 2009). A limitation of these models is that the adoption of BI is at an organisational level instead of an individual level (Oliveira & Martins, 2011). The Technology Organisation Environment Framework (TOE) examines the acceptance and adoption of technology at an organisational level. Since the TOE Framework takes into consideration institutional and organisational effects on innovation at an organisational level, it will be used as the theoretical basis for studying BI adoption and will be discussed in the next section.

4.   TECHNOLOGICAL ORGANISATIONAL ENVIRONMENT FRAMEWORK

Tornatzky, Fleischer & Chakrabarti (1990:237) presented the TOE framework (see figure 1) identifying three key aspects that influence technology adoption by firms, namely: technological context, organisational context and environmental context.
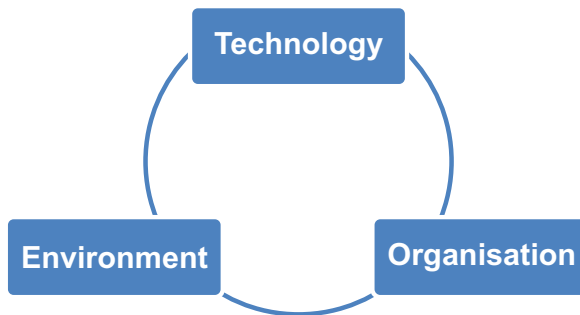

Figure 1: TOE Framework (Tornatzky et al., 1990: 237)

Tornatzky et al. (1990:238) argued that the technological context includes the internal and external technologies that are relevant to the firm and that technologies may include both equipment and processes. Tornatzky et al. (1990:238) further argued that the organisational context refers to the characteristics and resources of the firm, including the firm's size, degree of centralisation, degree of formalisation, managerial structure, human resources, amount of slack resources, and linkages among employees. The environmental context includes the size and structure of the industry, the firm's competitors, the macroeconomic context and the regulatory environment.

4.1.   TOE framework research

Oliveira & Martins (2011) pointed out that the TOE framework was applied by several researchers to explain the adoption of different IT systems by organisations. Examples of various research studies that have applied this theoretical lens in the information systems domain are as follows: electronic data interchange (Kuan & Chau, 2001); web sites (Oliveira & Martins, 2008); e-commerce (Liu, 2008; Martins & Oliveira, 2009); enterprise resource planning (Pan & Jang, 2008); business to business (B2B) e-commerce (Teo, Ranganathan & Dhaliwal, 2006) and knowledge management systems (Wang, Lee & Lim, 2009). However, the aim of this study is to adapt the TOE framework to the BI domain, thus providing a conceptual guideline for explaining some of the important determinants of BI adoption in South Africa.

4.2.   Technology Context

Organisations depend on their information systems for day-to-day operations. The technology context represents the total pool of technologies available for the organisation's adoption of Business Intelligence. Tornatzky et al. (1990: 238) divided the technology context into two factors, namely IT expertise and IT infrastructure. In existing literature, technology resources have been consistently demonstrated as an important factor for successful IS adoption (Chau & Tam, 1997). Racherla & Hu (2008) argue that the technological benefits perceived by the firm prior to the adoption have to be achieved within the allotted resources available to the firm. They add that a firm's capabilities in turn enhance the effectiveness and productivity of the resources that the firm deploys in achieving its business goals. In the context of Customer Relationship Management (CRM), organisational resources such as operational skills and the availability of sufficient financial resources should be directed towards a successful adoption effort. IT expertise includes employees' skills of using and developing BI solutions. IT expertise is essential for firms to develop successful IT applications. The presence of skilled labour in a firm increases its ability to absorb and make use of an IT innovation, and therefore it is an important determinant of IT adoption. The successful implementation of a new IT application requires complex skills and it is to be expected that firms with better educated workers are more likely to have more advanced BI users. The extent of efforts to introduce an IT innovation also depends on existing IT infrastructure since firms that are already familiar with IT appear to have a positive attitude towards further IT adoption. According to Racherla & Hu (2008), previous research indicated that financial and technical resources are the two most important factors that impact the adoption of innovative technologies, and that no number of sophisticated technologies can replace the role played by the organisation's human resources.

4.3.   Organisational Context

Organisational context refers to the effect of organisational characteristics on the decision to adopt BI and it moreover represents all the structures, processes and attitudes that constrain or facilitate the adoption of technology (Tornatzky et al., 1990:239). Company size is an important organisational factor for technology adoption. Racherla & Hu (2008) argue that the organisation's structural characteristics play a role in IT systems adoption by organisations. Larger organisations tend to adopt more innovations mainly as a result of their greater flexibility and ability to absorb risks. Racherla & Hu (2008) noted that there are many reasons why larger firms adopt advanced IT systems. Firstly, they have better access to resources and are able to take greater risks than smaller firms. Secondly, the implementation of IT systems needs the support of technically skilled personnel who tend to be abundant in larger organisations. Finally, larger firms have a breadth of products and services which tend to benefit from the adoption of IT systems. Research on IT adoption and implementation suggests that when the technology is complex, as is the case for BI, perceived obstacles are particularly relevant because the adoption process may be complicated and costly, as is the case with BI adoption. Perceived benefits refer to the degree to which new technologies provide more benefits than the old technologies did. Firm scope, another common organisational factor, is defined as the geographical extent of the organisation's operations. In the context of BI, an organisation that has operations in several geographic areas with numerous business partners will benefit more through the use of a standardised technology than an organisation with narrow scope.

4.4.   Environmental Context

The environmental context represents the environment in which the organisation operates. Tornatzky et al. (1990:238) pointed out that the environmental context is divided into competitive pressure and consumers' readiness. Tornatzky et al. (1990:238) defined competitive pressure as pressure resulting from a threat of losing competitive advantage, forcing firms to adopt and use BI solutions. It is therefore assumed that BI solutions are implemented and operated most successfully in highly competitive environments. Chau & Tam (1997) argued that a firm will adopt a technology due to the influences exerted by its business partners and competitors, and this influence sometimes does not relate to the technological and organisational factors.

5.   RESEARCH METHODOLOGY

The main aim of this research is to identify the key determinants of BI adoption by South African organisations. This will be of use to South African IS managers, Chief Information Officers (CIOs) and IS practitioners and other policy makers as it will help in directing their efforts in identifying the key factors that facilitate or inhibit the adoption of BI.

Since developing countries differ culturally from developed countries, it is important to identify the factors which motivate individuals and organisations in those countries to adopt and use new technologies. This study will therefore provide a South African perspective on the adoption of Information Systems (IS) and consequently provide IS practitioners with knowledge on key adoption factors, how they impact organisational performance and how they can be managed. Finally, this study contributes to the IT adoption literature in the following ways: firstly, by enhancing our knowledge of the pattern of SA companies' adoption of BI systems and secondly, by improving our understanding of the adoption and use of technology innovation in general.

With reference to section 4, this study investigated the following key adoption factors (see table 1):

Table 1: Summary of key adoption factors to be investigated

Technology Context	Are firms with higher levels of IT expertise more likely to adopt Business Intelligence?
	Is IT infrastructure positively associated with Business Intelligence adoption?
Organisational Context	Are larger firms more likely to adopt Business Intelligence?
	Is a perceived benefit positively related to Business Intelligence adoption?
Environmental Context	Are firms facing higher levels of competitive pressure more likely to adopt Business Intelligence?
	Are firms facing a lack of Trading Partner Readiness less likely to adopt Business Intelligence?

Instrument design

All research involves collecting some sort of data and Information Systems research is no exception. Drawing on the TOE model, this research study used a qualitative research design as the philosophical lens. To empirically test the factors identified in literature, an online questionnaire research instrument was used to gather information from participants. Approximately 100 emails containing and explaining the objectives of the questionnaire were sent to a random sample comprising large to medium sized companies based in South Africa. The selection of the respondents is critical for obtaining quality data in survey studies. The authors were interested in identifying the factors that affect BI adoption.

Thus the respondents had to be managers such as Chief Information Officers (CIO), Information System (IS) managers, Information Technology (IT) managers and Head of Departments, responsible for the delivery of IT services in their respective organisations. The respondents were selected across different business sectors.

The questionnaire was composed of two sections. The first section consisted of five questions designed to collect information regarding the respondents' level of BI knowledge and general data about their companies. The second section was the major focus of the questionnaire and consisted of twenty-four (24) five-point Likert-type scale questions to measure the technological context, organisational content and environmental context. All research data was collected over a period of approximately 8 weeks.

6.   RESULTS

Questionnaires with incomplete answers were excluded and a total of 58 completed questionnaires from the 100 that were distributed, were entered on an Excel spreadsheet. The Statistical Package for the Social Sciences (SPSS) computer program was used for the statistical analysis.

The majority of respondents were from Financial Services representing 38% of the sample, and followed by the Manufacturing Sector (26%). Figure 2 summarises the respondents categorised by Industry Type.
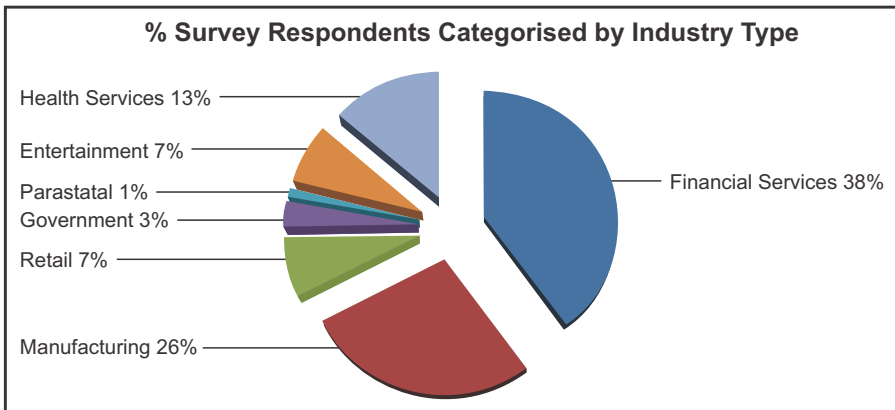

Figure 2: Survey Respondents Categorised by Industry Type

The majority of respondents (n=49, 84%) had more than 2 years' BI experience. Only one (1.7%) respondent had less than 6 months' BI experience, while seven (12%) had between seven and twelve months' BI experience.

The majority of the respondents (n=31, 53.45%) were IS/IT Managers in their companies. There were no CIOs in the respondents and only four (n=4, 6.9%) respondents identified themselves as IS/IT Directors. The remainder (n=23, 39%) was classified as other, which included project managers and team leaders.

The majority of respondents (n=33, 56.9%) worked in organisations with less than 500 employees while the remaining 25 respondents (43.1%) worked in large organisations with more than 500 employees.

Table 2 summarises the survey results that will now be discussed in detail.

Table 2: Survey Respondent Results

Adoption Factor	Agree Strongly	Agree	Disagree	Strongly Disagree
IT Expertise	10.34	17.24	34.48	25.86
IT Infrastructure	51.72	25.86	8.60	5.17
Perceived Benefit	25.86	43.10	10.34	6.90
Competitive Pressure	25.86	60.34	1.72	1.72
Trading Partner Readiness	6.90	13.79	37.93	6.90

Adoption Factor: Higher levels of IT expertise

A total of 34.48% of the respondents (n=20) disagreed that the existence of IT expertise is an important factor in the decision to adopt BI. In total, 25.86% of the respondents (n=15) strongly disagreed that IT expertise is an important factor in the decision to adopt BI. Only 17.24% of the respondents (5 responses) agreed that IT expertise is an important factor in the decision to adopt BI, while 10.34% of the respondents (3 responses) strongly agreed that IT expertise is a factor in the decision to adopt BI. Based on the above analysis, 60.34% (strongly disagreed + disagreed) of the respondents therefore believed that IT expertise is not a critical factor influencing BI adoption.

Adoption Factor: IT infrastructure

A total of 50% of the respondents (n=30) strongly agreed that the existence of IT infrastructure is an important factor. Also, 25.86% of the respondents (n=15) agreed that this factor as a very important factor in the decision to adopt BI.

A total of 8.62% of the respondents (n=5) disagreed that IT infrastructure is an important factor in the decision to adopt BI, while 5.17% of the respondents (n=3) strongly disagreed that IT infrastructure is a factor in the decision to adopt BI. Based on the above analysis, 77.58% (strongly agreed + agreed) of the respondents believed that the existence of IT infrastructure is a critical factor influencing BI adoption.

Adoption Factor: Higher levels of competitive

Approximately 60.34% of the respondents (n=20) agreed that the existence of competitive pressure influences the decision to adopt BI while 25.86 % of the respondents (n=15) strongly agreed that competitive pressure is an important factor in the decision to adopt BI. Only 1.72 % of the respondents (n=1) disagreed that pressure is an important factor in the decision to adopt BI, while 1.72 % of the respondents (n=1) strongly disagreed that pressure is a factor in the decision to adopt BI. Based on the above analysis, 86.2% (strongly agreed + agreed) of the respondents believed that competitive pressure is a critical factor influencing BI adoption.

Adoption Factor: Lack of trading partner

A total of 37.93% of the respondents (n=20) disagreed that Trading partner readiness influences the decision to adopt BI. A total of 6.90% of the respondents (n=1) strongly disagreed that Trading partner readiness is an important factor in the decision to adopt BI. Only 6.90% of the respondents (n=1) strongly agreed that Trading partner readiness is an important factor in the decision to adopt BI while 13.79% of the respondents (n=2) agreed that Trading partner readiness is a factor in the decision to adopt BI. Based on the above analysis, 44.83% (strongly disagree + disagree) of the respondents believed that Trading partner readiness is not a critical factor influencing BI adoption.

Adoption Factor: Perceived benefit

More than 43.1% of the respondents (n=20) agreed that a perceived benefit influences the decision to adopt BI, while 25.86% of the respondents (n=15) strongly agreed that a perceived benefit is an important factor in the decision to adopt BI. In total 10.34% of the respondents disagreed that perceived benefit is an important factor in the decision to adopt BI. Only 6.90% of the respondents strongly disagreed that perceived benefit is a factor in the decision to adopt BI. Based on the above analysis, 68.96% (strongly agreed + agreed) of the respondents believed that a perceived benefit is a critical factor influencing BI adoption.

Adoption Factor: Larger firm size

In order to statistically assess whether the size of an organisation affects its decision to adopt BI, tests were performed on all the previous results. The following table (see table 3) shows the results of Multiple Regression Analysis tests that were conducted on the data.

Table 3: Organisational Size versus Adoption Factor

Size	IT Infrastructure	Competitive Pressure	Perceived Benefit
Small	18	15	5
Large	12	5	15
Total	**30**	**20**	**20**

It could be argued that only large organisations are able to adopt BI. According to Zhu, Kraemer & Xu (2003), firm size has been consistently recognised as an adoption facilitator. With regard to e-business adoption, larger firms have several advantages over small firms. Larger firms (1) tend to have more slack resources to facilitate adoption; (2) are more likely to achieve economies of scale, an important concern due to the substantial investment required for e-business projects; (3) are more capable of bearing high risks associated with early stage investment in e-business; and (4) possess more power to urge trading partners to adopt technology with network externalities (Zhu et al., 2003).

Surprisingly, this study has indicated that this is not the case (F=152.26, p < 0) as large and small organisations are equally adopting BI. Smaller companies identified IT Infrastructure and competitive pressure as adoption drivers. Out of a total of 30 companies that identified IT Infrastructure as an adoption driver, 18 were small companies. Out of a total of 20 companies that identified competitive pressure as an adoption driver, 15 were small companies. This could be as a result of external pressure to adopt BI.

7. DISCUSSION

This study examined the relationships between Technological, Organisational and Environmental factors in a BI context. The aim of the study was concerned with establishing a relationship between Technological-Organisation Environment (TOE) factors and the intent to adopt BI. The results of the analysis of the data gathered from the questionnaires provide good insight into the determinants of the adoption of BI in South African organisations. See table 4 for a summary of these results:

Table 4: Summary of results

Adoption Factor	Supported
Firms with higher levels of IT expertise are more likely to adopt Business Intelligence.	No
IT infrastructure is positively associated with Business Intelligence adoption.	Yes
Larger firms are more likely to adopt Business Intelligence.	No
A perceived benefit is positively related to Business Intelligence adoption.	Yes
Firms facing higher levels of competitive pressure are more likely to adopt Business Intelligence.	Yes
Firms facing a lack of Trading Partner Readiness are less likely to adopt Business Intelligence.	No

This study shows that the internal IT expertise in the company is not a key determinant of BI adoption. The reason for this finding could be that most companies utilise external consultants to implement BI solutions. IT Infrastructure, perceived benefit and competitive pressure are key determinants of the implementation success of BI. Moreover, this study found that trading partner readiness and company size have no significant influence on a company's BI adoption.

8.   CONCLUSION

This study set out to determine and describe the factors that affect the adoption of BI in South Africa (as a developing country case) using the Technology-Organisation Environment model. Most of the previous work on adoption of technology was carried out in developed countries. This study determined the factors relevant to BI adoption from the perspective of a developing country.

This survey based empirical study examined BI adoption in 58 companies in South Africa. It found that IT infrastructure, competitive pressure and perceived benefit are important determinants of BI adoption in South Africa. IT expertise, lack of trading partners and company size were found to be statistically insignificant in determining BI adoption decisions. By leveraging on existing IS literature and examining IS adoption theories in the IS context, this research has added to the body of knowledge on the factors that influence BI adoption in a developing country context.

As BI gains wider acceptance among businesses in developing countries, research that accurately characterises and measures BI will become increasingly important. Through our study, we have offered useful insights into some of the factors that influence and drive BI adoption.

9. ACKNOWLEDGMENTS

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