User Acceptance of Business Intelligence (BI) Application: Technology, Individual Difference, Social Influence, and Situational Constraints

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Abstract

Business intelligence (BI) applications have gained significant attention as a viable option to address the challenges of complex business decisions. While several studies examined key determinants of BI adoption at the organizational level, individual-level factors influencing the adoption of BI applications have received less attention. Drawing upon various theories and adoption literature, this research-in progress study attempts to identify factors that affect an individual's decision to adopt BI application. The initial survey was conducted, and we present preliminary data analysis result.

1. Introduction

Firms generate enormous amounts of operational data that may contain patterns, relationships, clusters, and other information. In seeking improvements in decision-making process, more and more organizations are turning to data-driven decision making. Business intelligence (BI) applications have gained significant attention as a viable option to address the challenges of complex business decisions [1-3].

Business intelligence applications are innovative tools for data analysis, query, and reporting that support organizational decision-making. It enables interactive access and manipulation of data in order to gain valuable insights and to support management decision making process across a broad range of business activities [4, 5]. According to the Gartner survey [6], business intelligence and analytics is CIO's top technology priority in 2012 and 2013. The importance attached to business intelligence and analytics is mainly due to combining BI applications with other technologies to create new capabilities such as BI with supply chain management or BI with customer engagement and acquisition. As the importance of BI application is more widely accepted and substantial investment is continuing to accelerate, it is expected that global market for BI tools would reach $14 billion in 2013 [7].

The objective of this paper is to explore what factors influence user acceptance of BI application. Drawing upon various theories and adoption literature, we incorporate four different set of potential factors that influence an individual's decision to adopt BI application.

Our research provides the contribution to IS literature. First of all, several studies examined factors influencing organizational adoption of BI application [2, 3, 8], however, factors associated with individual level adoption of BI application have not received much attention. Firms seek to derive competitive advantages by adopting BI applications, but realized benefits can vary significantly depending on individuals within the firm who are the ultimate users [9, 10]. Systems that are not utilized will not provide the returns anticipated by top management. As such, it is important to understand key factors that influence an individual's decision to adopt BI application. Findings of this study can provide managers with insight into how to develop successful strategies and plans for user adoption and diffusion of BI application.

Agrawal [9] suggested that, to better understand individual acceptance of information technologies, a variety of factors including individual difference, beliefs and attitudes, social influence, managerial interventions, and situational influence should be examined. However, as shown in Appendix 1, prior adoption studies did not consider all those sets of factors. In addition, prior studies focused primarily on the technological characteristics and individual differences. Therefore, this study provides a more comprehensive view on the user acceptance of information systems by incorporating different set of potential determinants (technology, individual difference, social influence, and situational constraints). Subsequent sections elaborate on each construct and relationship of the overall framework in greater detail.

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2. Theoretical model and hypotheses

2.1. Technological factor

Diffusion of Innovation Theory (DOI) [11, 12] serves as a fundamental theoretical base of innovation adoption research in many disciplines, including sociology, communications, marketing, education, etc. [13-15]. According to Jeyaraj et al. [16], DOI is one of the dominant theories used to examine adoption of IT innovation over the prior two decades.

DOI argues that innovation characteristics, such as relative advantage, compatibility, complexity, trialability, and observability influence an individual's decision whether to accept or reject IT innovation [12]. A meta–analysis by Tornatzky and Klein [15] identified other innovation characteristics: costs, communicability, divisibility, profitability and social approval. Moore and Benbasat [17] suggested that it is a useful theory for studying a variety of IT innovations. Many studies used DOI theory to study the impact of IT innovation characteristics on the individual adoption of IT innovation [16]. In addition, DOI theory received consistent empirical support from prior studies on the individual adoption of IT innovation [18, 19].

A meta–analysis by Tornatzky and Klein [15] reveals that compatibility, relative advantage and complexity are consistently found to be significant in the prior studies they reviewed. Therefore, this study focuses on those three innovation characteristics. In addition, those same three attributes are consistently identified as critical adoption factors in IS research [16, 20]. While compatibility and relative advantage are positively related to adoption, complexity is negatively related to adoption.

Relative Advantage is defined as the degree to which the innovation is perceived as better than the idea it supersedes [11, 12]. Relative advantage is comparable to perceived usefulness in Technology Acceptance Model (TAM), and often used interchangeably in the literature. Several studies have shown that perceived advantage of an innovation over existing or alternative products/processes is positively associated with information system adoption [18, 21]. For example, Agarwal and Prasad [18] indicated that relative advantage is positively related to the adoption of a knowledge-based system. In the context of business intelligence, Ramamurthy et al. [8] examined key determinants of data warehouse (DW) adoption, and found that relative advantage has a significant positive effect on DW adoption.

BI applications can offer several benefits that include improving timeliness and quality of decision making process, providing actionable information delivered at the right time, enabling better forecasting, helping streamline operations, reducing wasted resources and labor/inventory costs, and improving customer satisfaction [1, 3, 5]. Therefore, we expect that if individuals perceive those benefits, they may be willing to adopt BI application. This leads to our first hypothesis:

H1: Relative advantage will have a significant positive effect on intention to adopt BI application

Complexity is defined as the degree to which an innovation is perceived as difficult to understand and use [11, 12]. Complexity of an innovation is considered as an inhibitor to adoption of the innovation [11]. Complexity is similar in definition to the notion of ease of use in Technology Acceptance Model (TAM). Innovations that are perceived to be complex have a lower likelihood of being accepted and used by potential users.

While BI applications get more and more user-friendly, they are still complex and hard to use. It normally requires several days of training before a user can get started using the system. According to Gartner, less than 30 percent of enterprise users who have access to BI tools actually use the technology due to the difficulty of use [22]. Another report from Gartner also indicated that ease of use was the No.1 driver of purchasing BI tools and will accelerate as a key requirement in the future [23]. With ease of use surpassing functionality as the dominant BI adoption criterion, BI applications must be intuitive and simple to use without much need for IT assistance and training. Therefore, we expect that complexity would inhibit the adoption of BI application. This leads to our second hypothesis:

H2: Complexity will have a significant negative effect on intention to adopt BI application

Compatibility is defined as the degree to which an innovation is perceived as being consistent with the existing values, experiences, and needs of potential adaptors [11, 12]. Moore and Benbasat [17] confirmed compatibility is a good predictor of technology usage behavior. In addition, Premkumar and Ramamurthy [14] reported in their research that the incompatibility of available technology with existing work procedures decreases the likelihood of adoption. Incompatibility requires major work practice changes that often require considerable learning process. As a result, an individual may perceive the technology to be not useful. On the other hand, he/she is likely to recognize the usefulness of

new system if the technology is perceived to be compatible with their existing work practices.

Similarly, it is expected that the greater the perceived compatibility of BI application with an individual's existing work practices, values, and environment, the more likely it will be adopted by the user. This leads to our third hypothesis:

H3: Compatibility will have a significant positive effect on intention to adopt BI application

2.2. Individual difference

Individual differences (i.e., motivation, cognitive style, personality, gender, education) have been found to influence individual technology acceptance. Based on the motivation theory [24-26], this study includes two types of motivation as individual difference factors: extrinsic motivation and extrinsic motivation.

Motivation theory has been used often to understand individuals' IT adoption [27-29]. Motivation theory suggests that individual behavior is determined by two fundamental types of motivation: extrinsic (utilitarian) motivation and intrinsic (hedonic) motivation. Extrinsic motivation refers to performing an activity because it is perceived to be instrumental in achieving valued outcomes that are distant from the activity itself, such as improving job performance, pay, or promotion. Intrinsic motivation refers to performing an activity for no apparent reinforcement other than the process of performing the activity per se [26, 29].

In the context of technology adoption, extrinsic motivation emphasizes an individual's personal gain associated with a technology use. Extrinsic motivation has been found as significant predictors of technology adoption [30]. Especially, extrinsic motivation plays as a dominant predictor of utilitarian technology adoption [31]. Since BI applications can be considered as utilitarian technologies that aim to provide instrumental values to users, such as improving job performance, we expect that extrinsic motivation would influence individual technology acceptance. Therefore, we propose the following hypothesis:

H4: Extrinsic motivation will have a significant positive effect on intention to adopt BI application

On the other hand, intrinsic motivation emphasizes the importance of having an enjoyable and playfulness technology experience [27, 29]. In addition to the extrinsic motivation, intrinsic motivation has been found as an important predictor of technology adoption [32]. Just like other technologies, if individuals perceive that using BI application is enjoyable and playfulness, they may be willing to adopt the BI application. Therefore, we propose the following hypothesis:

H5: Intrinsic motivation will have a significant positive effect on intention to adopt BI application

2.3. Social influence

Social influence on technology acceptance behavior has been widely acknowledged [33-36]. Prior studies suggest that the extent to which salient others view technology use as valuable has positive influence on technology acceptance behavior of an individual. Social influence has been found to emanate from a variety of sources [9, 37], including co-worker, supervisor, and friends. In working organizations, co-workers and supervisors are influential in determining technology acceptance behavior [38]. Therefore, if co-workers and/or supervisors perceive that the BI application is useful, then an individual is more willing to adopt the system. We propose the following hypothesis:

H6: Perceived social influence from referent others (co-workers & supervisors) has a significant positive influence on individual intention to adopt BI application

2.4. Situational constraint

Previous research has shown that situational constraints are important determinants of intention to use technology [39]. Typically, the concept of situational constraints has been operationalized using the perceived behaviors control construct in the theory of planned behavior [9, 40]. According to the theory of planned behavior [41], the presence or absence of requisite skills, resources necessary to perform a behavior can influence the likelihood of performing that behavior. In the context of technology adoption, individuals may not be willing to adopt a technology if they believe that they do not have skills or resources necessary to use that technology [39].

Situational constraints have been widely studied in the training literature. In addition to the requisite skills and resource, the training literature suggests that organizational learning climate could be considered as a situational constraint that can influence behavior [42, 43]. If an organization encourages employees for learning and development, employees are more willing to learn new things and apply them to their work [44]. Therefore, we propose the following hypothesis:

H7: Situational constraints (requisite skills and resources & organizational learning climate) have a significant positive influence on individual intention to adopt BI application

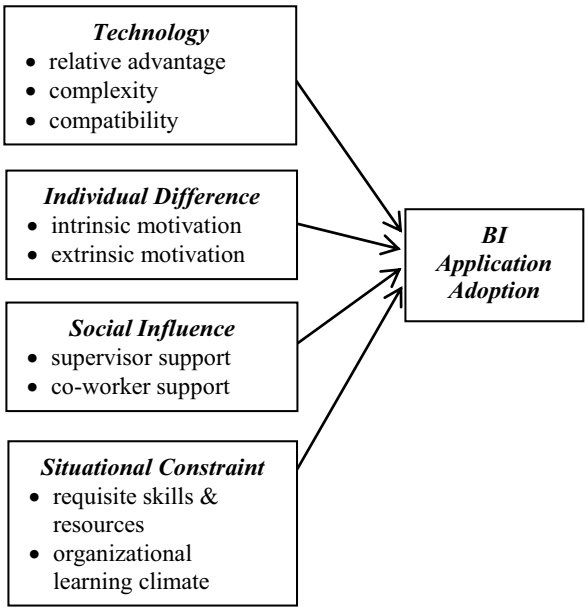

Figure 1. Proposed model

3. Research methodology

A literature review was conducted to identify past operational measures of the constructs, and existing measures proven to be reliable and valid were adapted. Some measures were modified to fit the Business Intelligence context. Each question was measured on a five-point Likert scale, ranging from (1) strongly agree to (5) strongly disagree. All constructs were measured with multiple items. Table 1 presents each construct with the corresponding references. The final survey consisted of 31 measurement items and 6 demographic questions.

Construct	Items
Relative Advantage [45, 46]	1. Using BI application will enhance my efficiency in gathering information 2. Using BI application will make it easier to gather information 3. Using BI application will increase my effectiveness to gather information 4. Using BI application will increase the quality of information that I gather
Compatibility [45]	1. Using BI application will fit with the way I like to gather information at work 2. Using BI application will be incompatible with how I like to do things in my work 3. Using BI application will fit well with the way I like to interact with the system
Complexity [46]	1. There is a clear and understandable process regarding how to use BI application 2. Using BI application will require a lot of effort 3. Using BI application will be difficult for me
Situational Constraints (requisite skills and resources & organizational learning climate) [42]	1. I will have the time necessary to strengthen my skills using BI application 2. I have so much work, that it is difficult to apply newly acquired skills and knowledge about BI application 3. My employer provides sufficient recourses needed to try and use BI application 4. My present job requires me to develop my skills and abilities of using BI application 5. My company's policies and work rules allow me to participate in training 6. My company values employee learning and development activities 7. My company emphasizes the need for learning to their employees
Social Influence (supervisor & co-worker) [42, 47, 48]	1. My manager views using BI application as an important aspect of his/her job 2. My manager is supportive of efforts to apply newly acquired skills and knowledge about BI application 3. My manager supports using BI application 4. My co-workers value using BI application 5. My co-workers encourage my efforts to use BI application on the job 6. My co-workers help me to further develop the skills to use BI application
Intrinsic Motivation [30]	1. I found using BI application to be enjoyable 2. The actual process of using the BI application is pleasant 3. I have fun with using BI application
Extrinsic Motivation [30]	1. Using BI application will improve my job performance 2. Using BI application will enhance my job effectiveness 3. Using the BI application to be useful for my job
Adoption Intention [46]	1. Assuming I have continued access to BI application, I intend to adopt it in my work 2. Assuming I have continued access to BI application, I am willing to change my

	work activities to use the tool in my work

Table 1. Construct measurement

The survey was performed using a paper survey at a local SAP user group meeting. The sample was drawn from the attendees of a workshop offered at the meeting on the SAP Business Objects tool and represents a convenience sample. One of the authors introduced the survey, and invited the attendees to take some time to complete the survey at the end of the workshop. Participation was entirely voluntary and the respondents were asked to indicate their assessment of the magnitude for each item.

Participants consisted of different functional responsibilities ranging from sales/marketing, IT, logistic, accounting, finance, service, production, HR and in different levels: operational, managerial, strategic, and executive. Among the six demographic questions, their years of job experience, BI application usage experience, job title and their industry of work were asked. The respondents represented different business functions in different industries, such as insurance, logistics, manufacturing, energy, and healthcare. A total of 47 completed surveys (out of approximately 60 surveys distributed) were collected and analyzed for this study.

4. Preliminary data analysis

Principal component analysis with varimax rotation was used to test the initial survey items' loading on the different factors. The criterion used in the analysis was a factor loading greater than 0.5, and Eigen values greater than 1.0 [49].

Most items loaded on their respective theorized constructs, but there was one cross-loading instance. The four items measuring relative advantage and two items measuring compatibility were loaded on a single factor. To determine whether they are single or multiple constructs, we examined both the theoretical conceptualization as well as the empirical validation for the constructs of relative advantage and compatibility used in prior IS research [50]. An independent factor analysis of the items measuring these two constructs showed that they loaded on one factor. Furthermore, prior studies suggested that relative advantage and compatibility may be conceptually different, but they are being viewed identically by respondents [17, 51]. Therefore, we decided to combine relative advantage and compatibility into a single construct. The results of the factor analysis are shown in Table 2.

Construct	Item	1	2	3	4	5	6
Relative Advantage	RA1	.91					
	RA2	.89					
	RA3	.81					
	RA4	.61					
Compati-bility	COM1	.85					
	COM3	.52					
Complexity	COMP2		.91				
	COMP3		.67				
Social Influence	S_SUP1			.84			
	S_SUP2			.70			
	P_SUP1			.79			
	P_SUP2			.90			
	P_SUP3			.91			
Intrinsic Motivation	IMT1				.88		
	IMT2				.92		
	IMT3				.86		
Extrinsic Motivation	EMT2					.88	
	EMT3					.92	
Situational Constraint	CLI1						.84
	CLI2						.92
	CLI3						.88
	SITU3						.70
	SITU4						.72

Table 2. Results of principal component factor analysis [1]

5. Conclusion

BI applications have gained significant attention as a viable option to address the challenges of dynamic business processes and real-time decision making scenarios. The focus of this paper is to model and study the individual-level factors that influence the adoption of BI application. The premise is that while the decision to adopt BI applications may be taken at the organizational level, the effective use and ultimate success of BI applications inside the firm's business process is influenced by several individual factors.

Based on prior research, these individual factors fall into four categories: technology, motivation, social influence and situational constraints. The paper builds an empirical model based on a multi-theoretic approach and using prior literature to study the factors on BI application adoption. A multi-item survey has been developed and the constructs that we propose have been validated using a pilot study. The next steps are to conduct the final survey in the Fall

[1] One item in the compatibility (COM2), complexity (COMP1), social support (S_SUP3), extrinsic motivation (EMT1) and two items in the situational constraint (SITU1 and SITU2) were dropped since the factor loadings were less than 0.5 or loaded in multiple constructs.

2013 user group meeting (in October 2013) among SAP BI users, and then test the hypotheses.

There are several limitations of the study that should be recognized. First, preliminary data analysis that we presented is based on the sample size of 47 which is too small. Therefore, the proposed model should further be validated in order to provide useful insights. It would also be useful to conduct a panel expert review on questionnaires to increase content validity. Lastly, survey participants in this study are the users of one particular BI tool. Therefore, caution must be applied as findings may not be generalized to broader BI application adoption.

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Author	Factors considered in the study								
	Technology			Individual Difference		Social Influence		Situational Constraint	
	Relative Advantage	Compatibility	Complexity	Intrinsic Motivation	Extrinsic Motivation	Supervisor Support	Co-worker Support	Requisite Skills & Resources	Organizational Learning Climate
Moore and Benbasat (1991) [17]	•	•	•						
Davis et al. (1992) [29]				•	•				
Chin and Gopal (1995) [52]	•	•	•	•					
Agrawal and Prasad (1998) [18]	•	•	•						
Venkatesh (2000) [53]	•		•	•					
Moon and Kim (2001) [54]				•	•				
Tharenou (2001) [42]						•	•	•	•
Van Der Heijden (2004) [27]				•	•				
Avlonitis and Panagopoulos (2005) [55]	•		•			•	•		
Wu and Wang (2005) [56]	•	•	•						
Schillewaert et al. (2005) [57]	•		•			•	•		
Karahanna et al. (2006) [35]	•	•	•						
Schepers et al. (2008) [58]	•		•			•	•		
Puschel and Mazzon (2010) [59]	•	•	•			•	•	•	
Lin and Lu (2011) [60]				•	•				
Our study	•	•	•	•	•	•	•	•	•

Appendix 1. Selected Literature on user acceptance of information systems