Assimilation of Business Intelligence Systems: The Mediating Role of Organizational Knowledge Culture

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Abstract. This study examined the assimilation of business intelligence (BI) systems in firms. Based on the innovation assimilation concepts from information systems (IS) studies and considering the resource-based theory (RBT) as the theoretical underpinning, an initial research model was developed. The model was then validated with survey data that we collected from 153 managers and executives from Malaysia. The collected data were analyzed by partial-least-squares (PLS) methods. The results show that the assimilation stages (i.e., implementation and routinization) are not sequential (in other words, successful implementation does not ensure routinized use of BI systems); rather, implementation of BI systems enhances organizational knowledge culture, which in turn drives routinized use of BI systems. Data analyses also find that implementation of BI systems is dependent on three factors: quality of the BI system itself, quality of its users, and the governance of BI systems in firms. Our results offer new insights to theory and practice.

Keywords: Business Intelligence (BI); Assimilation; Implementation; Routinization; Organizational knowledge culture; Resource-based Theory (RBT)

1 Introduction

Business intelligence (BI) systems are considered as information technology (IT)-based tools that assist firms to achieve competitive advantage through improved knowledge and decision-making. BI system can be defined as “an organized and systematic process by which organizations acquire, analyze, and disseminate information from both internal and external information sources significant for their business activities and for decision making” [1, p. 32]. Studies [e.g., 2] demonstrated that BI provide firms the ability to analyze business data and information; such ability supports and improves organizational decision making across various departments in a range of business activities. Organizations employ BI in various functions including marketing research, competitor analysis, and customer relationship management. A wide variety of industries including logistics, manufacturing, retail, financial institutions, telecommunication, marketing, utilities have been using BI systems. The interest on BI systems has even been increasing with the progression of 'big data' [3, 4].

The deployment of BI applications in today's firms is increasing and the demand for BI is stronger than ever before. Gartner report predicts that the worldwide spending on BI system would reach US$18.3 billion in 2018. However, other recent reports [e.g., 5] 'terrify' companies by identifying that 70-80% BI system projects fail [6]. Tapadinhas [7] warns that, even if corporates achieve a successful implementation of a BI system, many users eventually disengage themselves from using it. But, in order to realize the most out of any BI system, it is essential that firms use it regularly in decision-making operations [4].

Numerous information systems (IS) studies agree that many innovations are initially accepted by firms, which really are not used to their full potential [e.g., 8]. IS studies also established that the migration from initial deployment to 'full utilization' is complex. Unlike general concept-based innovations, BI systems entail considerable set-up costs and their assimilation involves complex processes. Li, Hsieh [9, p. 659] demonstrate that "after gaining first-hand usage experience in the acceptance stage, employees develop a certain level of understanding about an implemented IS, which enables them to achieve work objectives in the post-acceptance stage" by using the system in routine applications. Therefore, understanding assimilation of BI systems is important. Although a number of studies discretely examine the adoption [10] and extended use of BI systems [4], however, to the best of the authors' knowledge, an integrated effort explaining the assimilation is missing in literature. Therefore, this current study aims to develop and validate a model that explains the assimilation of BI systems in firms.

In recent years Malaysia is experiencing tremendous changes both in government services as well as corporate businesses with the application of latest IT solutions [11]. It is one of the forerunners of using various IT systems including RFID technology [12]. BI system experience no exception; various industries in Malaysia including banking and financial, communications, education, government, healthcare, manufacturing, retail, and service have adopted BIS [13]. Still, the success of BI systems is minimal [14]. Aligning this issue with our research aim, we collected survey response from the decision-makers (i.e., managers and executives) from Malaysia. We used structural equation modeling (SEM) techniques to analyze the data. Overall, data analyses found that the successful deployment of BI systems leads to routinized use only when the organization's culture is improved. This research contributes to theory by considering 'assimilation' as a process than a construct and applying it in a new context. It also offers implications to organizational decision-makers to revisit their BI systems strategies.

The rest of the paper is structured as follows. First, we discuss the theoretical perspectives that underpin the conceptual model of the study and then develop hypotheses to be empirically tested. Next, we discuss the research method followed by presenting the results and discussing our findings. Finally, we briefly discuss the theoretical and practical implications of the study as well as the limitations.

2 Theoretical Background

A convincing effort has been observed in literature examining adoption behaviour of firms towards an innovation. Studies suggest that the nature and process of adoption of an innovation is important to understand its initial acceptance; they further suggest that post-adoption process is even more important and worthy to realize the ultimate success of the innovation [8, 9]. Among a few post-adoption stages, 'assimilation' is the most popular. However, prior studies argued that 'assimilation' is rather a process that involved certain stages. For example, Thompson [15] examined 'assimilation' as a three stage process involving initiation, adoption, and implementation. Similarly, Zhu, Kraemer [8] examined it as a three staged process: initiation, adoption, and routinization. Recently, Hossain et al. [12] explained 'assimilation' as a four-stage process consisting initiation, adoption, routinization, and extension.

There are a number of studies that considered 'assimilation' as a construct; however, this current study considers 'assimilation' as a process that covers several stage (i.e., stage approach) than considering it as variable. Also, while some studies [e.g., 8] consider that 'assimilation' combines both pre-adoption and post-adoption stages, our study considers that 'assimilation' covers only the post-adoption stages given that the innovation in question is already adopted, which is consistent with prior studies [e.g., 16]. Based on prior works, this study considers that 'assimilation' of BI system in firms consists of two stages namely implementation and routinization. *Implementation* occurs when a firm puts an innovation into use [17]. Then, *routinization* happens when the innovation is 'subsumed' into the organizational activities and is practiced in operational functions in such a manner that it is not treated as a noble or foreign technology. In other words, *routinization* "describes the state in which IS use is integrated as a normal part of the employees' work processes" [9, p. 661]. *Routinization* assures continued use [16].

Over the last decades organizations are becoming keener to use technologies in business operations. Such organizational-behavior relies on the resource-based theory (RBT) [18], which postulates that unique resources that a firm possesses would bring competitive advantage. RBT focuses on identifying the value of firm resources. More specifically, it explains how firms acquire, develop, maintain, and use resources in a manner that establishes and sustains their competitive advantage. In other words, (the identification and utilization of) firm's internal resources can be the tools to be competitive and successful.

In the current context, firm's unique resources could influence the implementation of BI system, which would be the basis for sustained competitive advantage [3]. Since BI systems are knowledge-creation mechanisms, we only consider the knowledge-related resources that affect the systems. To the quest of important organizational resources for the successful implementation of BI system, studies suggest that quality of employees who will use the BI systems (i.e., the users) as the most critical. Studies also established that firm's internal governance related to BI systems that is important [19].

3 The Research Model

We propose a research model that is based on resource-based view (RBV) with the assistance from IS assimilation studies (see Fig. 1). Consistent with innovation diffusion theory [17] and IS success model [20], our model assumes that the success of a BI system can be realized if the users (i.e., employees of a firm) routinize its use in regular decision-making. In this process, based on RBV, the successful deployment of a BI system is dependent on the organizational resources including user quality and governance of BI systems (H1, H2, respectively). Also, inspired by the 'system quality' aspect from IS success model, quality of BI a system is considered as an antecedent of its successful implementation (H3). Moreover, a successful deployment of BI systems improves organization's culture, which in turn contributes to the routinized use of the system – a mediation effect (H4).

3.1 Antecedents of a successful deployment of BIS

User Quality. Regarding the human resource perspective on BI assets, skilled employees is highlighted as important factor. The recent literature review conducted by Trieu [3] suggested that humans are the primary resources for BI success. Grublješič and Jaklič [4] identified a number of important characteristics of BI system users. Quality users equipped with strong technical, business, and analytical skills are critical because values of BI system can only be tapped by the users who are capable of analyzing information and turn them into sound business decisions [21]. In addition, Strange and Hostmann [22] stated that utilization of BI tools is only part of the formula for BI success; more is related with integrating BI systems with company's requirements, priorities, and data management, which require people with unique skills. One of the reasons for the unsuccessful stories of the Malaysian firms can be the scarcity of people with the right skills in BI systems [21]. Thus, it can be inferred that that:

H_1: Quality of the users of a BI system is associated with its successful implementation.

System Governance. Challenging previous studies that claimed business governance as a constraint to its success, Matney and Larson [19] argued that BI governance is the key for the success of BI systems. Also, governance is needed to glean intelligence from data generated by BI systems. The definition of BI governance is simple – "defining and implementing an infrastructure that supports enterprise goals" [19, p. 29]. BI governance basically deals with the business process side than the technological aspects. Watson and Wixom [23] emphasized that both people and processes must be in place to manage and support BI. Recent studies [e.g., 24] found that solid BI governance – which includes controlling, directing, establishing and enforcing related BI policies – promotes resourceful thinking within an organization, and has significant impact on the successful implementation of BI systems. Therefore:

H2: BI system governance is associated with its successful implementation.

BI system quality. IS success model [20] considers *system quality* as an important determinant of the successful implementation of a system. A number of proponents of IS success model evidenced that this relationship in many contexts; BI systems domain has no exception. For example, [4] found that BI system quality is a strong determinant of BI use. Generally, higher system quality is expected to lead to higher use of a system [20]. In fact, Yeoh and Popovicˇ [25] suggest that *system quality* is one of the success factors of BI system implementation. It is sensible that a reliable BI system with higher usability, consistent user interface, and easier to use and learn will be more-successfully implemented in a firm. Therefore, organizations that acquire a high quality BI system are more likely to be successful in implementing it.

H3: BI system quality is associated with its successful implementation.

3.2 Mediating Effect of Organizational knowledge culture

Extant literature on BI agrees that technology cannot increase employee productivity unless it is used effectively [3]. *Organizational culture* refers to a system of shared meaning held by the members of an organization that distinguishes the organization from others [26]. Organizational culture, in general, has been considered as an important driver for the success of knowledge-related initiatives. Creating a culture of ‘learning organization’ has become an important strategic objective for many firms that hinges on the acquisition of information. Prior studies [e.g., 27] evidenced that a large percentage of BI applications fail not because of technology but for a dysfunctional organizational knowledge culture where the knowledge generated from the knowledge-systems are not shared properly. A functional *organizational knowledge culture* encourages employees to create and share knowledge within a firm [28]. Studies indicate that, in order to realize their full potential, BI systems have to be integrated in organizations regular decision-making so that the BI systems are considered as an integral practice of business operations/activities and not as ‘foreign’ tools to the organizational operations [29]. Based on the prior works, our proposed model argues that:

H4: Organizational knowledge culture has a mediating effect between implementation and routinized use of a BI system.

4 Research method

This research adopted quantitative method. A survey was administered to a sample of 1,000 executives through contact persons. To increase the response, the study administered follow-up phone calls and reminders. 166 questionnaires were eventually obtained but 13 were with missing values, resulted 153 usable responses. The demographics have been representative of the population (*see* Table 1). For example, around 37% of the respondents were female, where World Bank data (www.data.worldbank.org) says the contribution of female in Malaysian labour force was 38.1% in 2016.

Table 1. The demographics of the respondents

Gender		Job position	
Male	63.2%	Director and above	9.9%
Female	36.8%	Dept. Manager	14.4%
		Operation Manager	24.2%
		Operation Officer	51.6%
Age		Industry	
20-30 year	13.1%	Manufacturing	26.2%
31-40 year	39.2%	Retail	23.6%
41-50	35.3%	Logistics	15.2%
51 and over	12.4%	Financial institutions	11.1%
		Telecommunication	10.8%
		Marketing & others	13.1%

The measurement items were based on previous works from BI literature. The instrument items were based on Likert scale, ranging from ‘strongly disagree’ to ‘strongly agree’; a six-point Likert scale was employed in this study with the rationale that most Asian respondents has the tendency of selecting the middle point [30]. All constructs were operationalized as reflective. Specifically, *user quality* was measured by using the instruments from [21]. BI *system quality* was measured using the items in [20] and *BI system governance* was measured by the scales in [19]. The instruments for *organization knowledge culture* and *system implementation* were adopted from [29], and *routinized use* was from [31]. The items for each construct are presented in Table 2. Data were analyzed by partial least squares (PLS)-based SEM.

5 Results

5.1 Evaluating the Measurement Model

The assessment of the measurement model was established by examining convergent validity, reliability, and discriminant validity. First, convergent validity was assessed with the outer loadings of the indicators and the average variance extracted (AVE) of the constructs. The bold values shown in Table 2 represent item loading of the respective construct; all item loadings were greater than the threshold of 0.70 [32]. Similarly, all construct’s AVE was well above of 0.5 (see Table 3). Then, internal consistency was assessed with composite reliability (CR) values. As Table 3 shows, all CR values satisfied the 0.7 threshold [32]. Finally, we assessed discriminant validity with two measures. As the first approach to assess the discriminant validity of the indicators, we checked cross-loadings. Table 2 shows that the indicator’s loading on the associated construct is greater than any of its cross-loadings (i.e., its correlation) on other constructs [32]. The second approach to assess discriminant validity was checking Fornell-Larcker criterion, which compares the square root of the AVE values with the latent variable correlations. Table 3 shows that the square root of each construct’s AVE is greater than its highest correlation with any other construct. Thus, our indicators and constructs passed the discriminant tests.

Table 2. The cross-loading matrix

	Items	UQ	SG	SQ	OC	SI	SR
UQ1	Technical skill	**0.776**	0.365	0.394	0.342	0.368	0.354
UQ2	Analytical skill	**0.749**	0.421	0.496	0.316	0.307	0.405
UQ3	Competence	**0.790**	0.514	0.515	0.359	0.394	0.397
UQ4	Understand requirements	**0.775**	0.440	0.476	0.317	0.345	0.327
UQ5	Ability to use data	**0.835**	0.481	0.504	0.505	0.459	0.422
SG1	Management support	0.407	**0.712**	0.427	0.216	0.360	0.128
SG2	Necessary training provided	0.537	**0.772**	0.514	0.419	0.491	0.387
SG3	Policy in place	0.423	**0.844**	0.680	0.453	0.502	0.407
SG4	Manage implementation	0.475	**0.829**	0.533	0.418	0.504	0.356
SG5	Enforce top-down directive	0.420	**0.831**	0.611	0.368	0.463	0.29
SQ1	Usability	0.503	0.602	**0.865**	0.458	0.416	0.445
SQ2	Adaptability	0.432	0.581	**0.815**	0.341	0.380	0.324
SQ3	Reliability	0.500	0.611	**0.800**	0.428	0.448	0.370
SQ4	Response time	0.425	0.532	**0.829**	0.411	0.372	0.358
SQ5	Availability	0.597	0.548	**0.811**	0.587	0.525	0.512
OKC1	Knowledge is shared	0.364	0.398	0.464	**0.872**	0.509	0.523
OKC2	Knowledge sharing is encouraged	0.454	0.445	0.497	**0.860**	0.573	0.598
OKC3	Incentive to share knowledge	0.387	0.364	0.461	**0.837**	0.410	0.554
OKC4	Policy for knowledge sharing	0.391	0.323	0.403	**0.862**	0.410	0.550
OKC5	knowledge portals are available	0.383	0.469	0.471	**0.721**	0.462	0.397
SI1	System in use in all units	0.352	0.424	0.380	0.401	**0.753**	0.323
SI2	Data are integrated in BI system	0.296	0.401	0.319	0.381	**0.760**	0.236
SI3	Rely on it to take decision	0.480	0.522	0.468	0.576	**0.857**	0.410
SI4	Comprehensive business alignment	0.410	0.535	0.518	0.465	**0.866**	0.367
SR1	Incorporated into regular schedule	0.420	0.461	0.463	0.563	0.385	**0.827**
SR2	Part of normal work routine	0.400	0.295	0.434	0.557	0.368	**0.911**
SR3	BI is a normal part of my work	0.452	0.301	0.402	0.542	0.349	**0.879**

Note: UQ, User Quality; SG, (BI) System Governance; SQ, (BI) System Quality; OKC, Organizational Knowledge Culture; SI, (BI) System Implementation; SR, (BI) System Routinization

Table 3. Construct reliability and discriminant validity tests

				Fornell-Larcker discriminant criterion					
	Alpha	CR	AVE	UQ	SG	SQ	OKC	SI	SR
UQ	0.846	0.890	0.617	**0.786**					
SG	0.858	0.898	0.638	0.567	**0.799**				
SQ	0.883	0.914	0.680	0.606	0.698	**0.825**			
OKC	0.888	0.918	0.693	0.477	0.479	0.552	**0.832**		
SI	0.826	0.884	0.657	0.484	0.587	0.529	0.572	**0.811**	
SR	0.843	0.906	0.763	0.486	0.405	0.497	0.635	0.421	**0.873**

Note. Alpha, Cronbach’s alpha; CR, Composite Reliability; AVE, Average Variance Extracted

5.2 Testing the Structural Model and Hypotheses

The structural model deals with testing the hypothesized relationships. A bootstrapping procedure was used to establish the significance of the path coefficients; the values are summarized in Table 4. It is observed that the hypotheses leading to BI systems deployment (H1, H2, H3) were supported. Also, the R^2 value of SI (38.9%) and SR (40.2%) indicate that the model successfully explains the current phenomenon.

To begin the mediation analysis, first we tested the indirect effect. The indirect effect (i.e., 0.334) from BI system implementation (SI) via organizational knowledge culture (OKC) to routinized use (SU) is the product of path coefficients from SI to OKC and from OKC to SU (i.e., 0.572*0.586). To test the significance of these path coefficients' products, we ran the bootstrapping routine with default values. We found that the indirect effect is significant since neither of the 95% confidence intervals includes zero. The empirical *t* value of the indirect effect (0.334) for the OKC to SR relationship is 4.869, yielding a *p* value of 0.000. Next, the direct relationship from SI to SR is weak (0.086) and statistically nonsignificant (t=0.978, p=0.328). Hence, we conclude that OKC does have a *full* mediation effect between (SI) and routinized use (SR); thus H4 is accepted.

Table 4. Structural properties of the model

	β value	SE	*t* value	*p* value
UQ to SI (H1)	0.172*	0.083	2.082	0.037
SG to SI (H2)	0.375**	0.087	4.303	0.000
SQ to SI (H3)	0.172*	0.078	2.095	0.036

SE, Standard error; Significance level *p<0.05, **p<0.001; ns: not significant

6 Discussion and Implications

This study managed to reiterate the reason for relatively low implementation success rate and the relatively low satisfaction from BI projects. The reasons identified from our study include user skill-related issues, BI system issues (e.g., technical complexity, inflexibility), and lack of governance. Our finding is consistent with current literature [e.g., 3] that suggests that sophisticated BI system and high quality human resources are favorable for 'BI assets' which are recognized as necessary conditions for the success of BI systems.

As hypothesized in this study, firm's internal resources are found to have an influence on the successful implementation of BI systems. Among the two resource variables, first, it is found that *user quality* is important. It is intuitive that the main actors of the BI system (i.e., the users) determine the success of BI. They need to possess certain skills (including technical, analytical) to use BI systems as well as to interpret and use the outputs of BI systems. Therefore, firms have to arrange regular training sessions, workshops and interactive sessions to upgrade the users. Next, the hypothesis related to the role of BI system governance in stimulating implementation of BI systems had significant statistical evidence. In fact, among the three antecedents of BI implementation, *BI governance* has come up as the strongest. Effective BI governance may include strong management support that provides sufficient funding, infrastructure, staffing, and appropriate policies regarding BI. Having good BI governance in place (in terms of providing supportive infrastructure including resource allocation and training) is a prerequisite for BI systems' success in firms. In order to ensure continuous support and sponsor the successful implementation of BI systems, it is prescribed by this study that BI steering committee should comprise of high-level executives. As a consequence, executives may want to look into their existing BI governance in their firms and focus on developing supportive BI governance.

Our results show that the higher quality of BI systems, higher the likelihood of their successful implementation. It is found that, in the past, many BI systems could not be successful because of the quality in terms of mainly usability [20]. Therefore, BI systems should possess critical technical features such as reliability, consistent user interface, quick response time, and quality of documentation. Also, a BI system should be customizable based on firm requirements, user ergonomics, and business processes. Also, the system should be easy to use and easy to learn. It should also mimic the way the users perform a business process and take decision so that the users do not consider it as an alien, which needs significant effort and involves learning curve.

The results of the mediation test suggest that a successful implantation of a BI system has positive influence on improving organizational knowledge culture. BI systems are knowledge-acquiring and knowledge-generating engine; upon their implementation, organizational knowledge culture – the way a firm generate and share knowledge – has to be changed. A supportive organizational culture is vital in encouraging staff to create and share knowledge within a firm. This finding suggests that BI systems should change organization culture than building the systems to fit firm's culture – McDermott and O'Dell [33] provided examples supporting our claim.

The mediation results also show that successful implementation of a BI system can develop good culture of knowledge sharing within a firm, which in turn decides the success of the system by routinizing its use in decision-making processes (e.g., to generating new products, improving business operations and customer service). Hence, managers should make endeavors to create a knowledge-intensive culture for staff to believe that knowledge sharing actively reward them as well as the firm. Also, firms need to be transformed into learning organizations which facilitates learning for all employees. If they successfully create a supportive knowledge culture, there will be good chance that the BI systems will be successfully routinized. Hence, organizations should put more emphasize on promoting and building appropriate knowledge culture.

7 Limitations and Future Works

Despite contributing new and valuable insights to BI systems literature, this study has been faced with some limitations that may inform future research. First, realizing the Cloud BI systems as essential in recent times, companies are moving towards Cloud BI systems (e.g., Amazon AWS, Microsoft Azure, Google Cloud, and IBM Bluemix). Forbes find that the adoption of Cloud BI systems in 2018 is almost doubled from

2016 [34]. Our study examined the traditional enterprise-wide BI systems; future studies could test the model in the Cloud context. Second, we used a self-reported survey that may have resulted in self-selection bias particularly to measure 'routinized use'. Although the CMV tests did not expose any concerns, it is still not possible to claim definitively that the data are free from self-reported bias. Future research could use actual (objective) usage data from BI system users. Third, we collected data from one country at a given point of time. Future studies could investigate this model in different cultures and use longitudinal data. Finally, we relied on Elbashir et al.'s [2] study which suggests that *firm size* does not affect organizational use of BI systems; still large organizations may exploit BI's potential better than smaller organizations. Therefore, the effect of firm size is worthy to investigate in a future study.

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