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ERP Sand Clock Barriers and Antecedents Model: From the Lens of Task Technology Fit Theory

Sharina Tajul Urus*
Faculty of Accountancy, University Technology MARA, Selangor, Malaysia

Tuan Zainun Tuan Mat
Faculty of Accountancy, University Technology MARA, Selangor, Malaysia

Sharifah Nazatul Faiza Syed Mustapha Nazri
Faculty of Accountancy, University Technology MARA, Selangor, Malaysia

Fadzlina Mohd Fahmi
Faculty of Accountancy, University Technology MARA, Selangor, Malaysia

Abstract

The deployment of Enterprise Resource Planning (ERP) systems worldwide has become an evidence of the unprecedented movement towards integration of information technologies. The importance of continuance usage during the post implementation stage should not be neglected as to secure an optimal advantages offered by ERP system, that is achieved through minimizing ERP system usage barriers. As such, successful implementation of an ERP system does not necessarily guarantee that the system will be comprehensively used or accepted by users of the system. ERP benefits can only be realised and sustained if users continue to have favourable experiences in using the system. While many previous studies have examined ERP system during the implementation phase, only a few have revealed barriers to ERP usage as well its antecedent factors during the post-implementation phase. The purpose of this paper is to determine ERP system usage barriers and unearth the root causes to the barriers. To achieve the aim, this research was guided by the 'soft-positivism' paradigm, a paradigm that combines elements of positivism and interpretivism. By using this paradigm, the investigator brought certain prior expectations to the data analysis which are consistent with positivist research and which also build rich explanations from the data, consistent with the interpretive assumption. Based upon the lens of Task Technology Fit theory, this study adopts a qualitative method using multiple case studies. Three Malaysian organisations that had implemented ERP were investigated by conducting 30 semi–structured interviews and reviewing archival records and documents. The interviews were guided by the research objectives. Data were analysed by using open and thematic coding.The finding indicated four major areas of ERP usage problems: system, data, and technical infrastructure and interface problems. Besides that, several antecedent factors to the problems were identified. These factors fall into four major categories: organisation, user, task and technology, and include lack of support from either external or internal expertise, lack of individual strength and limited technology affordance. The outcome of this study was encapsulated in the form of the ERP Sand Clock Barriers and Antecedents Model.The paper contributes to post-implementation ERP system literature by stressing the complex relationships between usage barriers and antecedent factors. By identifying the underlying causes of SAP usage barriers, it could become the motivating factor for individual users to undertake reflective feedback and to achieve extended use of the implemented ERP system.

Keyword: Antecedent factors; ERP system usage barriers; Task technology fit theory multiple case studies.

1. Introduction

The 21st century is illustrating its characteristic as an evolvement or reformation era in all aspects of life and this evolvement continuously running at speed as long as the world is alive. This includes education, transportation, technology, and medical and health. Apart from that, business sector is the most rapidly underwent growth along with the inevitable change of customers' demands and needs, making all businesses chose to implement and adopt the integrated and sophisticated technology that could cater their daily activities and information, and this include the institutionalization of Enterprise Resource Planning (ERP) system in an organization. The deployment of Enterprise Resource Planning (ERP) systems worldwide become an evidence of the unprecedented movement towards integration of information technologies. ERP systems present a holistic view of a business from single information and IT architecture.

However, the euphoria around ERP systems is wearing off and it has become clear that ERP systems do not automatically deliver business value. The importance of continuance usage during the post implementation stage of ERP system should not be undermined. ERP system usage is a significant element in system success, where the accomplishment of ERP is indeed dependent upon actual system use (Nwankpa and Roumani, 2014). ERP benefits

*Corresponding Author

can only be realized and sustained if users continue to have favorable experiences in using the system as to optimize the full potential benefits offered (Kwahk, 2013; Nwankpa, 2015). For instance, Kwahk (2013), argued that if users are reluctant to use the ERP system, it would hinder the expected promised benefits even though it had been developed successfully from the technical point of view.

ERP usage barriers faced by users make it difficult for them to utilize most of the system functionalities, and also distort the extended system usage (Deng and Chi, 2012). A number of previous studies had examined ERP system usage barriers (Arasanmi *et al.*, 2013; Deng and Chi, 2012; Tajul *et al.*, 2011), but most of these studies centered on the implementation phase. Limited studies have been conducted in relation to ERP usage barriers during the post-implementation stage, despite the fact that user adoption issues have also been found to be the major cause of implementation failure (Kwahk, 2013; Soja and Paliwoda-Pekosz, 2009). The study of ERP system usage barriers during the post implementation ERP phase lead to the development of an Initial Sand Clock model by Tajul *et al.* (2011). 'A Sand Clock Model of ERP Usage Problem' was initially developed to gain deeper insight on the impediment of effective use by illustrating the ERP usage problems classification.

The two critical issues discovered were data and system quality. Nevertheless, deficiency in identifying the barriers to effective ERP system usage alone lead to an urgency to unearth the root causes leading to ERP system usage barriers. This is due to the reason that the ERP usage barriers are often shaped by their numerous antecedent factors. Thus, this paper aims to investigate on *"What and how the antecedent factors (within organization, user, and technology) leading to the usage barriers?"*

Against the backdrop of the research question, the aim of this paper is to examine the root causes of ERP usage barriers. The outcome of this study was proposed in the form of a refinement model named "ERP Sand Clock Barriers and Antecedents Model". Through the lens of Task Technology Fit, this paper provides a theoretical contribution to ERP system literatures from the following perspectives. Firstly, the present effort is among the first to examine the complex relationship between ERP usage problem and their antecedents factors especially for a developing country like Malaysia. Identifying the underlying causes of SAP usage problems could become the motivating factor for individual users to undertake reflective feedback and to achieve extended use of the implemented ERP system. From the practical perspective, the end users' usage problems are the result of user, organization, technology and task issues.

The remaining sections of this paper are organized into four major sections. Next, the theoretical background and literature on ERP usage barriers and possible antecedent factors during the post implementation phase are presented. Following that, the research method will be illustrated and the analyses and findings from the 3 Malaysian cases will then be discussed. Subsequently, the discussion of findings will be reflected on the refinement model of ERP Sand Clock Barriers and Antecedents Factors. This is done by highlighting causal factors leading to ERP System usage barriers. The last section offers the concluding thought.

2. Literature Review

2.1. Theoretical Foundation of ERP System Usage Barriers

The extent of ERP Literature proposes several theories in investigating ERP system usage barriers either during the implementation or post implementation stages. Amongst the common theories used for implementation phase are the DeLone and McLean IS Success Model, the Theory Acceptance Model (TAM) and the Grounded Theory Approach (Arasanmi *et al.*, 2013; Soja and Paliwoda-Pekosz, 2009). While for the post implementation phase evidence some of the notable theories used were the Task Technology Fit Theory, Absorptive Capacity Theory, DeLone and McLean IS Success Model (Lin, 2010; Markus *et al.*, 2000; Nwankpa, 2015). Table 1 depicts a summary of some of the theories used pertaining to the studies on ERP system usage barriers.

Table-1. A Summary of Theories Used For the Literature of ERP System Usage Barriers

Reference	Research Method	Theoretical Framework	Domain of Literature
Post Implementation Phase			
Nwankpa (2015)	Survey Instrument	Absorption Capacity theory	ERP
Deng and Chi (2012)	Combined Method	A multi-user view and dynamic perspectives	IS (Post Adoption)
Lin (2010)	Survey Instrument	DeLone & McLean IS Success Model	ERP
Markus *et al.* (2000)	Case Study & Experimental Design	ERP Experience Cycle	ERP
Implementation Phase			
Arasanmi *et al.* (2013)	Literature Review	Technology Acceptance Model (TAM)	E-Commerce & ERP
Lv and Chen (2010)	Literature Review	Return of Investment (ROI)	ERP
Elbertsen *et al.* (2006)	Survey	Diffusion of Innovations Theory	ERP
Xu *et al.* (2002)	Case Study	DQ Framework	ERP

2.2. Task Technology Fit

Goodhue and Thompson (1995), developed the Task-Technology Fit (TTF) theory to provide a conceptual basis for user evaluation instruments. Based on a task model of managerial decision making, the core constructs of the TTF theory represents the ability of information technology (IT) to support a task (Goodhue and Thompson, 1995). As defined by the similar authors, TTF theory is refers to "the degree to which an information system or systems environment assists an individual in performing his or her portfolio of tasks" (Goodhue and Thompson, 1995). In compliance with TTF, if an information technology is to be effective, that technology must fit the task performed by the individual who uses the technology. When there is a correspondence between IS functionalities and task requirement, then the information technology system (information systems, policies and staff) has a positive impact on performance. This will result in task-technology fit (dimension of TTF) and subsequently help to improve the organization performance. On the other hand, when the gap between the requirements of a task and the functionalities of a technology widens, performance will drop (Goodhue and Thompson, 1995). Thus, systems with higher TTF will lead to better performance at any given level of usage, since they are more likely to meet the task needs of individuals.

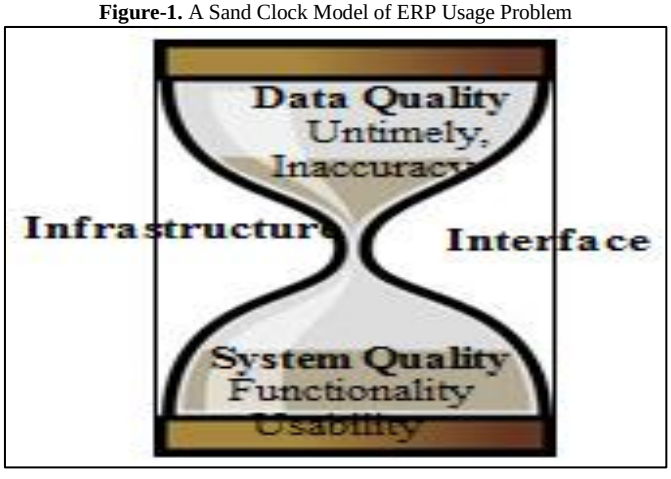
This is also in line with Palvia and Chervany (1995) who suggested that users use technologies like ERP system to complete their tasks, only if the functions available fit their task activities. Nevertheless, users tend to disregard the system if it failed to provide them the required benefits. For instance, the functionalities constraint found in the ERP system (technology) may hinder ERP system usage. Applying this concept from TTF theory, it is anticipated that for an ERP system to be fully utilized, its functionalities should match the users' task requirements. Conversely, problems of task-technology misfit occur when an ERP system is unable to cater for some of the requirements of the various tasks. As suggested by previous studies that success of ERP system implementation is depending upon resolving those misfits' issues (Soh *et al.*, 2000). This misfit can be related to data format, operating procedures and/or output, and forces companies to customize the ERP (Soh *et al.*, 2000).

2.3. An Initial Sand Clock Model

Tajul *et al.* (2011), propose a Sand Clock as an interactive metaphorical symbol of ERP usage problem that represents the importance of taking corrective action. The shape of a sand clock model determines the severe ERP system issues; the wider shape of a glass embodied the problematic ERP usage areas compared to a slimmer shape. For instance, the wider shape of the hour glass for data and system quality problem delineates the intensity of the problem found in their study. However; the infrastructure interface that represents the bottle neck issues that could be potentially create serious system quality issue if it is not being addressed properly.

The classification of the problem in a Sand Clock model (refer to Figure 1) determines its need for timely attention on how soon the organization can overcome the data quality through Infrastructure interface in addressing the system quality issue. The data quality is a problematical area when users are unable to get a timely, accurate and complete data from the ERP system Tajul *et al.* (2011). As the data quality problem is considered as critical barrier to ERP system usage, it is crucial to undertake remedial solution in a timely manner. A significant system quality problem would be the result from the delay in solving data quality problem as displayed in the bottom of a sand clock model. Likewise, the system problems also need to be handled properly since inability of users to understand and to learn ERP system (SAP) will discourage the user to continue using it although the usage of ERP system is mandatory (Tajul *et al.*, 2011). A summarized table of Appendix 1 illustrates the classification of ERP system usage barriers based on the previous literature.

Figure-1. A Sand Clock Model of ERP Usage Problem



2.4. Possible Antecedent Factors to ERP Systems Usage Barriers

Several antecedent factors could possibly shape the emergence of ERP system usage barriers in organisations during the post-implementation phase. The factors identified from the previous studies could be categorised under three broad areas: organisation, user and technology that are encapsulated in Table 2. While some researchers have provided empirical evidence (Behrens and Sedera, 2004; Jones *et al.*, 2004; Strong *et al.*, 2001), others have only provided the ideas conceptually (Houghton and Kerr, 2006; Kerr *et al.*, 2007).

Table-2. A Summary of Theories Used For the Literature of ERP System Usage Barriers

The Antecedent Factors								
ORGANISATION		USER		TECHNOLOGY		TASK		
Training	Technical Support	Control	Knowledge	Computer Self -Efficacy	Attributes	Affordance	Task Interdependence	References
X								Nwankpa (2015)
				X				Rajan and Baral (2015)
X	X	X						Chang *et al.* (2014)
X	X	X						Sun and Bhattacherjee (2011)
				X				Kwahk and Ahn (2010)
X								Maguire *et al.* (2010)
				X				Shih and Huang (2009)
X	X		X	X				Soja and Paliwoda-Pekosz (2009)
			X					Usher and Olfman (2009)
X								Bhattacherjee and Hikmet (2008)
						X		Sodnik *et al.* (2008)
						X		Choi *et al.* (2007)
X	X		X	X				Kerr *et al.* (2007)
X	X			X				Houghton and Kerr (2006)
				X				Shih (2006)
			X					Ko *et al.* (2005)
X								Yu (2005)
	X							Zhang *et al.* (2005)
				X				Behrens and Sedera (2004)
				X				Jones *et al.* (2004)
							X	Kallinikos (2004)
							X	Strong *et al.* (2001)

3. Research Methodology

This study adopts a qualitative research method by utilizing a multiple case studies research design. Yin (1994), suggested, a case study approach is commonly an acceptable method for the early stage of research. Three large Malaysian organizations that have implemented ERP systems participated in this study are referred to Case A, B and C. The selection criteria of these organizations were the following; (i) the company uses ERP system software (SAP R/3) (ii) the company represents a matured implemented ERP organization that had more than 3 years of usage experiences. Thirty (30) semi-structured interviews were conducted. The interview questions were open ended in nature with additional questions expanding on emerging themes. Interview participants were identified through purposive sampling (Cavana *et al.*, 2001). All interviews, a total of 1714 minutes (with an average of 57 minutes per interview) were recorded and transcribed.

Table 3 provides a demographic profile of interviewees with relevant participants' codes. In identifying barriers to ERP system usage, data analysis was performed using the open-ended approach proposed by (Strauss and Corbin, 1998). The open coding was used to extract the categories along with their properties and dimension from the raw data. Next, the thematic coding approach based on Boyatzis (1998), was employed to analyze the data pertaining to the antecedent of ERP system barriers.

Table-3. Demographic Profile of Interviewees

Case	No of Participants	Department Covered	Job Position	Case	No of Participants
A	13	- Engineering and Services - Operating Performance Improvement - Plant Operations - Technical Service -Human Resource Management - Finance & Planning	-Senior Manager (1), Executive (2) - Manager(1), Executive (1, Clerk (1) - Manager (1) , Executive (1) - Manager (1) - Executive (1), Supervisor (1) - Executive (1), Clerk (1)	M1 E2,E3 M4 E5 C6 M7 E8 M9 E10 S11 E12 C13	M, M, F M, M, F M M M F M F M
B	13	MIS/SAP -Finance -Production Planning & Control	- Senior Manager (1), Manager (1) , - Internal Consultant (2) - Manager (1), Assistant manager (2), Supervisor (1) - Executive (1), - Supervisor (1),	M14, M15, E16, E17 M18 M19, M20 S21 E22 S23	M M,F M F, M F M M M

		-Purchasing Vendor Development	Clerk (1) -Assistant Manager (1), Clerk (1)	C24 M25 C26	M F
C	4	- Supply Chain Management - Finance and Planning - Human Resource Management Administration	-Executive (1) -Executive (1), Clerk (1) -Executive (1)	E27 E28,C29 E30	M M,F M

Notes: Job Position:* *M-Manager, E-Executive, C-Clerk* **Sex: *M-Male, F-Female*

4. Results

4.1. Case Description Background

Case A is a wholly owned subsidiary of PATRON BERHAD (a pseudonym), with the principal activities of the production and selling of ammonia, syngas and carbon monoxide. **Case B** is a public limited company founded in 1991, incorporated and domiciled in Malaysia. The major activity of Case B is manufacturing automotive components. **Case C** is another wholly owned subsidiary of PATRON BERHAD (a pseudonym). The Case A is one of the ammonia/urea plants in Malaysia. Overall, Table 4 outlines the summary of cases profile.

Table-4. Demographic Profile of Interviewees

Case (No)	Area	Incorporated	ERP System (SAP) Go Live	SAP System and Modules
A (13)	Subsidiary of leading Oil and Gas Company in Malaysia	August 1974	1997	**SAP R/3** Material and Management, and Financial Information Costing (FICO), Human Resource Information System (HARIS) and Plant and Maintenance
B (13)	Automotive Components Manufacturer	May 1991	1991	**SAP ECC 5** Financial (FI), Cost Controlling (CO), Material Management (MM), Production and Planning (PP), Sales and Distribution (SD)
C (4)	Subsidiary of leading Oil and Gas Company in Malaysia	November 1999	1999	**SAP R/3** Material and Management , Financial Information and and Costing (FICO), Human Resource Information System (HARIS) and Plant and Maintenance

4.2. Classification of ERP Sand Clock Usage Barriers

Analysis of the case study illustrated several barriers encounter by SAP (ERP) users that hinder the full utilization of such integrated system. These barriers clustered into five main areas; system quality (usability, functionality and utilization), data quality (inaccuracy incompleteness and untimeliness), Technical infrastructure (poor infrastructure capability) and Interface issues over the poor quality of the SAP screen design. The finding analyses from the three cases are summarized in the Appendix 1.

4.3. Antecedent Factors to ERP System Usage Barriers

The respondents from the three cases suggested a range of antecedent factors that fall under the organization, technology and user-related umbrella leading to SAP usage barriers is in all the cases. It is interesting to note that three dominant antecedent factors of a particular interest are: (i) lack of individual strength (user-related factor), (ii) lack of technical support (organization-related factor), and (iii) lack of technology affordance (technology- related factor).

User Related-Factors - Analysis of the interviews highlights individual strength and awareness as the two main user-related factors. ***Lack of Individual Strength*** barriers were found across the three cases (A, B and C). The situation refers to when users do not possess the self-confidence to do their work using SAP. In one of the example, the executive, who had worked at Case A for more than 10 years in the Engineering and Services Department (E2), highlighted that the data inaccuracy found in the calculation of MTBF (mean time between failures) is partly related to the mistakes that users make while using the SAP system. Because the end users do not have enough confidence and experience concerning how to use the system correctly, mistakes such as entering inaccurate data are frequently made, leading to the deterioration in data quality.

To reinforce this example, one executive from the Engineering and Services Department (E3) stressed the importance of users completing the relevant columns in SAP so that they could be used for future analysis or reference.

> *"For instance, the remark column is very useful for us in the future. Say, for example, the equipment keeps on failing, so we have to know its history, what happened to the equipment so*

that we can derive some conclusion! Maybe the equipment has been failing for the past two years, what is the reason for this?"[Engineering and Services Executive - E3]

In order to further demonstrate how the lack of individual strength affects data accuracy, an executive from the Supply Chain Management Department (E27) of Case C gave an example:

"*Normally there are too many details that need to be entered into the system when we want to purchase the material. Some of our SAP users are still not familiar with how to raise Purchase Requisitions correctly. This would trigger a problem in using SAP because they are likely to make mistakes in the data entry process, such as keying in the wrong material code. The user's lack of knowledge of the business process is probably the reason behind this issue."* [Supply Chain Management Executive - E27]

Lack of Awareness – this pertains to awareness (consciousness) on how the user's task will be completed using the SAP system. From the positive side, user awareness would boost the confidence level of system usage in contrast to the lack of awareness. Lack of user awareness would hinder effective used through low confidence level of oneself (individual strength). A supervisor in the Human Resource Management and Administration department from Case A remarked:

"*We do not see the benefit of the system in the early stage. For example, in terms of reporting, supposedly it is much easier to use SAP where we do not need to retype the same things."*

Users' lack of awareness also affects the way users perform the users' task such as slowing down the SAP learning process. The underutilization issue, that was reported as usage barrier found in Case B, is originated by users' lack of awareness. A Purchasing and Vendor Development clerk's experience suggests that lack of awareness has led to both the underutilization of the stock variance function and the preference for Excel for getting approval for any stock discrepancies. He said:

"*I am not sure whether the stock variance function is available in SAP. As for now, we have never explored it. Even when I asked the previous staff, they would say that we must get an approval from management by using Excel, before keying into the system.... The manager and executive would prefer to authorize the stock variance from Excel and then transfer to SAP."* [Purchasing and Vendor Development Clerk - C26]

Organizational Related-Factors-The results suggested that four important organizational factors, either directly or indirectly, contributed to the ERP system usage barriers (data, system's functionality and interface problem) embraces of inadequate training, lack of technical support, lack of control and lack of funds. ***Inadequate Training***- Training is important during the early implementation and the post-implementation phases of ERP. ERP implemented organizations must invest in the training to facilitate the development of skilled users in the company. In Case B, the training was perceived as not sufficiently comprehensive. This refers to the content of the initial SAP training, which users perceived as too general. Most interviewees felt that the training offered was introductory knowledge of the specific modules and tasks, thus leaving them to learn the SAP system through their own experience. An Assistant Manager of the Purchasing Vendor Development Department (M25) spoke about the content of the existing training:

"We do train our staff but it is more of on-the-job training. The training is not adequate or up to date. We need to provide them with sufficient training. We need to monitor them closely…The training given specifically on the Material Management module is not comprehensive."[Purchasing and Vendor Development Assistant Manager - M25]

Lack of technical support aggravates lack of individual strength that triggered the system and data quality issues. An Interview participant from Case C had highlighted on the scarcity of support provided by the external vendor, iPerintis. An executive from the Supply Chain Management Department (E27) also pointed out the lack of technical support from iPerintis. She said:

"What happens in PATRON was that in the year 2000, we outsourced our IT Department to iPerintis. They became the service provider for IT. This includes taking care of the IT infrastructure, maintaining the internal Information system, maintaining the server and some other related functions. However, with respect to SAP, iPerintis have not yet played a major role. iPerintis have been unable to assist our staff effectively in terms of providing the necessary support services since most of their staff [iPerintis] are also not conversant with the system." [Supply Chain Management Executive - E27]

Case A which is also under the same organization's umbrella (PATRON BHD) shared a related experience when dealing with the third party vendor, iPerintis. In one of the case, the participant (clerk) from the Finance and Planning (FP) Department (C13) had the same experience. She is still unable to fully rely on iPerintis for technical support because: '*They [iPerintis] do not have the expertise and that is why we are quite slow in SAP.'* An executive from the same department (E12) supported her view by elaborating on the role of iPerintis stated in the contract.

"It was stated in our agreements that all the IT technical services will be provided by iPerintis including the SAP system. However, when we migrate to iPerintis, the technical expertise was not available, especially for the SAP functions." [Finance and Planning Executive – E12]

Lack of Control – the SAP system was implemented in Case A, with the aims for better management of operations. Yet, based on the interview responses, the aims were not entirely achieved. This could be partly due to the lack of control that has contributed to SAP usage problems such as data inaccuracy. For instance, lack of general control in Case A and Case B were illustrated through the sharing of the same SAP ID/password. Essentially, access control in ERP should be implemented by user authentication using a username and password. Every SAP user

should be assigned to a unique user ID pertaining to their specific user profile indicating their eligibility to access the system. For example, Case B experiences lose control of access security and lack of segregation of duties. First, each user is assigned a unique username and password created by the MIS and SAP Department to ensure that each user holds the right privileges to access data and processes in the system. Nevertheless, in the Finance, Production Planning and Control Department and the Purchasing and Vendor Development Department, sharing a user ID is considered an acceptable norm.

A clerk from the Production Planning and Control Department (C24) stated: *For the internal production, we are required to key in the list of internal material used for the operation. Meanwhile, someone, say from the Purchasing Vendor Development Department, needs to key in the purchase part that they bought from outside. This process is crucial to enable the back flush process. Due to this requirement, I have to share the same ID with the user from the Purchasing Vendor Development Department. We are aware that that this is an unauthorised practice, yet it has frequently occurred in the past."*[Production Planning and Control Clerk - C24]

The practice of sharing a SAP ID persists even though it jeopardizes the accuracy of the SAP data. This is intended for cost-saving purposes, as elaborated by one of the Executive (E22) in Case B: *'I know it is quite difficult to eliminate the sharing of ID since it is a long practice in our company, and, furthermore, additional costs would be involved. When it comes to cost, the management would become skeptical about it."* [Production Planning and Control Department Executive -E22].

Lack of Funds- The level of SAP funding allocated in Case A is perceived as one of the contributing factors to the SAP barriers of unavailability. Most interviewees perceived that neither Case A nor the parent company adequately budgeted for the SAP upgrade and customization. Although the majority of staff in Case A had acknowledged the importance of the existing SAP system, there is a need for further improvement to keep pace with the rapid changes occurring in the ERP system environment as well as the business requirements. However, upgrading to a new release requires an extensive capital investment and was affected by the company's financial constraints. A senior manager in ESD (M1) echoed this view and stressed on the additional cost involved in the customization of SAP that is needed to overcome the interoperability issues: *"With the latest SAP release, it can be integrated with the other applications in Case A and PATRON BHD. However, this new release would require a large amount of investment."*

Unavailability of functions resulting from lack of adequate funding adversely affects the accuracy of SAP data. In addition, lack of funds that have caused limited customization of system functionality aggravates non-interoperability issues and subsequently negatively affects data accuracy. For instance, due to the non-interoperability issues between these two systems, users keep two versions of data and manually adjust the data in each system by making a copy from one of the systems. An executive (E2) from the ESD remarked:

> "*As soon as the changes took place for the information in SAP system, then the data in the Intergraph should be updated as well. We are unable to update in Intergraph immediately. As a start that is fine, we have duplication of data, one in SAP and another in Intergraph, but as the information revolves over time, this creates problems for us. Until we are able to provide that link, I would say that it is always a problem."*[Engineering and Services Executive - E2]

5. Technology Related-Factors

Technology Affordance – This factor is another cause leading to SAP system usage barriers found in all three Cases A, B, and C. For example, an Assistant Manager of Finance in Case B reported the use of Excel for Budget comparison due to the unavailability of such function SAP: "*We are supposed to compare between actual and budget financial figures but the report is not available in SAP."*(M21). For Case C, lack of SAP technology affordance is seen through the generation of contract documents. An executive of Supply Chain Management commented that the lack of additional information required for the contract was mainly due to the restriction of SAP screen design which did not allow the users to enter other detailed information like insurance. In the other scenario from Case A, technology affordance is highlighted pertaining to the unavailability of planning and scheduling functions in the Engineering and Services Department. One of the interviewees remarked:

"*We are unable to get the schedule function from SAP. Hence, Microsoft Project is used for preparing the Gantt chart for the scheduling of maintenance jobs. As far as my work is concerned, I am not able to perform the planning of manpower by using the SAP system."* [E3].

6. Discussions

6.1. Antecedent of ERP Usage Barriers and Their Interrelationships

For the user dimensions, the two apparent antecedent factors revealed from the case studies are: (i) lack of individual strength and (ii) lack of awareness. First, lack of individual strength seemed to strongly affect system usability and SAP data quality across all three cases. The findings suggest basic computer skills that are essential in using the system. In gauging efficacy, individuals assess their skills and their capabilities to translate those skills into actions. Hence, greater computer self-efficacy contributes to users' perceptions of their ability to use SAP effectively. On the other hand, the absence of computer experience reduces the users' self-confidence. This is because users who are computer illiterate tend to perceive SAP as being complex and difficult to use as demonstrated from the findings of the case studies.

The argument is supported by previous study, such Kwahk and Ahn (2010) who suggested that when individuals believe they are able to use computers and IT with great skill, they are more likely to expect beneficial outcomes

from using computers and IT compared to individuals who doubt their computer capabilities. Since the ERP systems are considered as technologically sophisticated information systems, they require more technical knowledge than traditional transaction-processing systems. The findings for this present study also reveal that the individual factor does play an important role in supporting the utilization of learned skills. Hence, it supports the argument of previous research that a high user confidence level in using computer at work has a positive influence on learning performance (Hasan, 2006) and computer utilization (Liu *et al.*, 2011).

Lack of awareness is noted to directly contribute to SAP data quality issues such as untimeliness and inaccuracy. This antecedent factor of lack of awareness also seems to influence the users' lack of individual strength that caused system usability issues. The definition of 'lack of awareness' offered by Gutwin *et al.* (1995) signify on how a task could be accomplished. With regard to this study, lack of awareness indicates users' lack of a SAP user's attentiveness to how their tasks would be completed using the SAP. In this study, the capabilities of the SAP system was not properly appreciated; therefore, any potential transformational aspects remained relatively unexplored. A low level of awareness was evidenced among SAP users in both Case A and Case B. In these two companies, the users seemed unable to understand the full capabilities of the system. The inability to identify what the system is capable of doing led to underutilization issues. Lack of awareness contributes to users' low self-confidence; hence, it influences their use of the system, leading to data accuracy issues of untimeliness and inaccuracy.

Organizational factors are the most common reasons for **usability and utilization** problems. First, *inadequate funds* contribute to *inadequate training* that in turn influence users' awareness and individual strength to learn, understand and utilize the SAP. This finding is identical with the previous studies that suggest training as a key issue not only during the implementation phase, but also in the use phase (Yu, 2005). According to the relationship noted above, lack of training results in lower SAP user knowledge and SAP skills that aggravate the learnability problems of SAP. This finding supports a previous study which argued that lack of training discourages users from using the system (Chang *et al.*, 2008). ***Lack of support*** erodes users' confidence and strength and leading to problems of system usability (non-learnability), underutilization or data quality (inaccuracy, untimeliness). From the cross case-analysis, all three cases encountered either system or data quality problems that were due to lack of support. Mixed results were found with regard to this antecedent factor. While lack of technical support in cases A and C pertains to external expertise or support team, in case B, SAP users did not get adequate support from their internal expertise. Hence, the finding from this study confirms the prior research on the importance of adequate support from the external support team Longinidis and Gotzamani (2009) and internal team (Rajan and Baral, 2015).

Analyses from the case studies suggested that system non-learnability and underutilization problems are influenced by low confidence to use SAP, which is derived from insufficient support by third party vendors. Moreover, prior research has confirmed that the quality of external expertise has a positive relationship with IT system (Seyal and Rahman, 2014) and the use of ERP systems (Ifinedo and Nahar, 2009; Ifinedo, 2011; Ko *et al.*, 2005). For instance, Ifinedo (2011) suggested that external expertise (an exogenous factor) and internal computer/IT knowledge (endogenous factors) are pertinent to the success enhancement of ERP systems adopted organization. An ERP system is an ideal control technology since SAP emphasizes the standardization, streamlining and integration of the business process.

ERP systems and integrated systems must have the highest levels of integrity and controls. Yet, from the findings analysis, ***lack of control*** was reported as the common antecedent factor that caused a data quality problem in both Case A and Case B through sharing of SAP password (see Appendix 2 for details). Sharing a SAP user ID and password was intended to overcome the underuse of the ERP system in both cases. However, this practice eventually leads to the control issue of authorization, which is the process used for determining what accesses or privileges are allowed for users (Ali and Hasan, 2010). Lack of control as discussed leading to data inaccuracy problems of ERP system. This is in line with the study by Xu *et al.* (2002) who suggested that lack of control could degrade the data quality in the ERP environment due to its integrated nature, since any data error could pass through the whole system unnoticed.

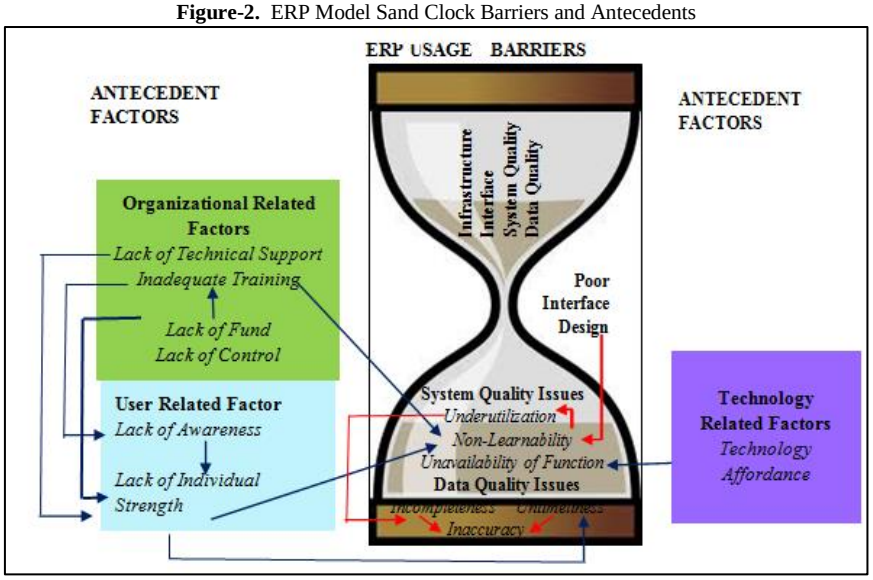
The next category of antecedent factors in the technology dimension is ***lack of affordance*** that refers to the inability of the SAP system to provide the functionality required by users. Findings from the previous studies have suggested that the affordance concept is the result of the intertwining of IT and organizational features (Stendal *et al.*, 2016; Zammuto *et al.*, 2007). Zammuto *et al.* (2007) suggested that the technology organizing possibilities that are referred to as affordances for organizing depend not only on the functionality characterizing the information technology but also on the expertise, organizational processes and procedures, controls, boundary-spanning approaches, and other social capacities present in the organization. Lack of technology affordance does seem to contribute to the system functionality problem. In this study, lack of technology affordance results in the unavailability of the required functionalities of the ERP system across the three cases.

6.2. ERP Sand Clock Barriers and Antecedents Model

The finding from this study suggested numerous ERP system usage barrier faced by end users across three cases. The barriers include system quality, data quality, interface and technical infrastructure barriers. The outcome of this paper in the form of an ***ERP Sand Clock Barriers and Antecedent Model*** that is a refinement from the original "Sand Clock Model" Tajul *et al.* (2011) of ERP Usage Problem" (refer to Figure 2). Similar with the original model, the criticality of ERP system usage barriers is reflected through its shape. The top shape of an ERP Sand Clock Barriers and Antecedents Model, in contrary, portrays some possible potential of ERP system usage barriers. Meanwhile, the critical barrier is symbolised through the wider bottom shape of a glass. The placement of the usage barriers on the bottom part of a glass signifies how severe the barriers are and urgent remedial attention

was sought after. In line with prior studies, amongst the possible barriers contributing to ERP system usage include data quality (Deng and Chi, 2012; Haug *et al.*, 2009), system quality (Deng and Chi, 2012; Lin, 2010), and interface users (Arasanmi *et al.*, 2013) and infrastructure problem (Soja and Paliwoda-Pekosz, 2009).

Figure-2. ERP Model Sand Clock Barriers and Antecedents



The bottom shape of a model indicates the classification of the usage barriers which was found the most critical issues of all three cases. The two most frequently cited usage barriers found were system and data quality that were ranked first and second subsequently. Whereas, interface and technical infrastructure usage barriers were placed in the slimmer shape of the glass embodying the less critical usage hurdles. Within the system quality, among the notable barriers were non-learnability, unavailability of SAP (ERP) system functionalities and underutilization. Following that are data quality issues that are represented by incompleteness and untimeliness of data that make up the data inaccuracy problem of SAP data. Thus, based on the model, priority needs to be given to resolve both system and data quality usage barriers. The bottleneck of the ERP Sand Clock Barriers and Antecedents model is represented by poor interface design (interface barrier) and poor IT infrastructure capability (infrastructure barrier) that would also aggravate the system and data issues. These two usage barrier were placed in the slimmer shape of the glass that embodies the less critical usage barriers. Unlike the initial model by Tajul *et al.* (2011), the improvised Sand Clock Barriers and Antecedents Model introduce the elements that lead to ERP (SAP) system problem (refer to Figure 2). The element known as antecedent factors domain that comprises four major categories of organizational-related factors (inadequate training, lack of control, lack of technical support and lack of funds), user-related factors (lack of individual strength, lack of awareness), and technology-related factors of lack of technology affordance.

In a nutshell, the followings are the summary of the interrelationship between ERP systems usage barriers and their antecedent factors:

- Lack of funds → Inadequate training → Lack of awareness / lack of individual strength → System non-learnability → System underutilisation
- Lack of technical support → Lack of individual strength → System non-learnability System underutilization → Inaccuracy of data
- Lack of individual strength → System Non-learnability → System underutilization
- Lack of individual strength → Untimeliness/incompleteness of data → Data inaccuracy
- Lack of awareness → Lack of individual strength → System non-learnability → System underutilization/ Data inaccuracy/Data untimeliness
- Lack of technology affordance → Unavailability of system functionality

7. Conclusion, Limitation and Future Research Iscussions

This study addresses the research questions of "*What and how the antecedent factors (within organization, user, and technology) leading to ERP system usage barriers?"* The study classified three major usage barriers that end user encountered in ERP (SAP) system used. These include three main areas: system, data and interface barrier. System quality issues cover system functionality issues (unavailability of functionalities), system underutilization and system usability issues (non-learnability). Data quality issues cover untimeliness, inaccuracy and incompleteness of SAP data. While interface issues pertains to poor quality of the SAP input-output screens. The antecedents to ERP system usage suggested a range of causal factors that fall under the organization, user and technology-related factors. Amongst the three dominant antecedent factors observed are lack of technical support (organization-related factor), lack of individual strength (user-related factor) and lack of technology affordance (technology- related factor). The classification of the usage barriers and antecedent factors is depicted through a formulation of the ERP Sand Clock Barriers and Antecedents Model.

Through a proposed new Model, this paper provides a theoretical contribution to ERP system literatures. This model provides classification of ERP usage barriers by also introducing the antecedent factors to the usage barriers. Additionally, this study presents the empirical results based on 3 cases of two diverse industries; manufacturing and oil and gas organizations in Malaysia. Thus, the present effort is also among the first to untangle these multifaceted relationship (barriers and antecedent factors) especially in the context of developing country. From the practical perspective, the end users' usage problems are the result of user, organisation, technology and task issues. Hence, the identification of the underlying causes of SAP usage problems could become the motivating factor for individual users to undertake reflective feedback and to achieve extended use of the implemented ERP system. From this classification of problem and antecedent factors, manager would be able to use the revised model as a benchmark to measure the intensity and the urgency of the problems to be solved by prioritizing the more critical problems. Moreover, the proactive action could be undertaken to curb ERP usage problem by identifying the root cause of the problem at the first place.

The research has some limitations. Since the research was conducted in three organizations in Malaysia, with a unique organizational culture and some special characteristics, the result might hold true in other organizations and environment. A similar study should be replicated using a broad and diverse sample from other countries that further extend and enhance these findings. Additionally, the ERP Sand Clock Barriers and Antecedents Model are derived from a limited number of case studies. Therefore, more research is needed to validate and extend the proposed model in this paper. More research is crucial to verify the antecedent factors of end user usage barriers. For instance, a quantitative research should be useful to be carried out to validate the result in a broader context. In addition, further studies may also highlight the control mechanism used by the organisation in order to overcome this problem. This is because by knowing and identifying the problem alone is not sufficient to address the various problems that hinder the effective usage of ERP system.

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Appendix-1. A Summary of Literature of ERP System Usage Barriers

System Related Barriers	**Data Related Barriers**	**Infra structure Related Barriers**	**Interface Related Barriers**	**References**
System error System complexity System quality System usability System Misfit				Deng and Chi (2012); Elbertsen *et al.* (2006). Tajul *et al.* (2011); Elbertsen *et al.* (2006); (Soja and Paliwoda-Pekosz, 2009). Lv and Chen (2010); Lin (2010); Schoenherr *et al.* (2010); Topi *et al.* (2005). Tajul *et al.* (2011); Singh and Wesson (2009); Topi *et al.* (2005); Markus *et al.* (2000). (Soja and Paliwoda-Pekosz, 2009); Peng and Nunes (2009).
	Data quality problem			Deng and Chi (2012); Tajul *et al.* (2011); Lin (2010); Haug, Arlbjørn, & Pedersen, (2009); Peng and Nunes (2009); Usher and Olfman (2009); Markus *et al.* (2000). Gattiker and Goodhue (2005); Zhang *et al.* (2005).
			Interface Issues	Arasanmi *et al.* (2013); Tajul *et al.* (2011); Singh and Wesson (2009); Topi *et al.* (2005). Choi *et al.* (2007).
		IT Infra-structure (Technical)		Tajul *et al.* (2011); (Soja and Paliwoda-Pekosz, 2009); Markus *et al.* (2000).

Appendix-2. Summary of Finding on the ERP Usage Barriers

Category	Sub-Category	Illustration of Interview Log	Frequency of similar quotes occurrence
System Quality			
Sissues **Syste M** **System** **System** **Usability** **Barrier** **System** **Usability** **Barriers**	***Non-Learnability*** The lack of SAP system inbuilt capability that enables users to learn how to use it	*SAP system is technical in nature, and you cannot understand at the first glance most of the technical nature system……..from what I have observed, sometimes the head department have knowledge on the system.* [Group Finance Assistant Manager of CBCD -M15]	18
System **Funcationality** **Barrier**	***Unavailability*** Lack of SAP functionality to perform a required task in a timely way	*SAP does not support some of the business functions. We have to use other software first before we can enter the data through SAP. This is because SAP is commercialised software that does not support some of our required function.* [Finance Manager of CBSC – M7]	21
System **Underutilization** **Barrier**	***Underutilization*** SAP features have not been fully exploited by SAP users	*According to the expertise out there, they have come and visited us and they have performed an audit and concluded that we are still not fully optimising the SAP features. So, I can say that we are still far behind….So, basically SAP just helps us to ease some of our burden but it does not take us to a higher level in which we are able to perform further analysis. I mean, what I can say is that the users have not fully exploited the system.* [MIS and SAP Senior Manager - M1]	23
Data Quality			
Data Barrier	***Inaccuracy*** elsewhere (based on Ballou and Pazer (1985)	*Normally, the amount in SAP is never the same. It seldom matched, sometimes we have more but sometimes we have less.* [Finance Manager of CBSC – M7]	20
	Incompleteness Omission of data or missing data entered into SAP (Based on Ballou and Pazer (1985)	*The data seems incomplete since when some of the data was being transferred from SAP system to SAP, data is not fully transferred. Say, if there is 10 line of information, 1 line will be missing* [Purchasing and Vendor Development Clerk of CBSC – C13]	18

	Untimeliness The recorded SAP data is out of date (Based on (Ballou and Pazer (1985))	*When we wanted to run the project evaluation in the SAP systems, sometimes the result did not reflected the actual ….the new results are similar with the previous ones.* [Group Finance Supervisor of CBCD – S6]	17
Interface			
Interface BARRIRS	*The ERP software is considered as* ***not user-friendly*** *and* ***unattractive too.***	*SAP screen is not attractive which is it has dull background, too much things that we need to enter, we must undergo from one step to another….* [Finance Supervisor of CBCD – S6]	22
		The SAP interface is not user friendly, not attractive and organized enough….. All the functions and menu are in the same page. [Purchasing and Vendor Development Clerk of CBSC – C13]	
Infrastructure			
Technical Infrastructure Barrier	***Poor IT infrastructure capability*** (inclusive of server and networking capacity) , system configuration and technical scalability	*The system itself is quite slow; it has to do with the server. So, if we need to process the transaction urgently, sometimes we cannot do it through SAP as the server hangs or becomes too slow. We always have this problem.* [Purchasing and Vendor Development Department Assistant Manager of CBSC – M12]	10