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Does Usability Matter? An Analysis of the Impact of Usability on Technology Acceptance in ERP Settings

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Abstract

Though the field of management information systems, as a sector and a discipline, is the inventor of many guidelines and models, it appears to be a slow runner on practical implications of interface usability. This usability can influence end users' attitude and behavior to use IT. The purpose of this paper was to examine the interface usability of a popular Enterprise Resource Planning (ERP) software system, SAP, and to identify related issues and implications to the Technology Acceptance Model (TAM). A survey was conducted of 112 SAP ERP users from an organization in the heavy metal industry in Bangladesh. The partial least squares technique was used to analyze the survey data. The survey findings empirically confirmed that interface usability has a significant impact on users' perceptions of usefulness and ease of use which ultimately affects attitudes and intention to use the ERP software. The research model extends the TAM by incorporating three criteria of interface usability. It is the first known study to investigate usability criteria as an extension of TAM.

Keywords: Enterprise Resource Planning, Interface usability, ERP usability, Technology Acceptance Model, Partial Least Squares

Introduction

In our global, connected economy sophisticated software systems are increasingly made available to management in enterprises for measuring, analyzing, improving, and controlling business activities and overall performance. These enterprise systems can assist organizations to process huge amounts of

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information effectively within complex and usually distributed working environments, against an enormous variety of tasks (from gathering business intelligence to managing safety-critical systems). Enterprise Resource Planning (ERP) systems are claimed to integrate, improve, support, and complete management solutions by transacting and incorporating potentially all business functions of an enterprise (Vaman, 2007). An ERP system can be defined as a software package that permits seamless integration of all company information, including information pertaining to several business units in an organization, such as finance, accounting, manufacturing, and human resources. An ERP system is designed to integrate all functions and departments across an entire enterprise and still serve the needs of each individual department (Forcht, Kieschnick, Aldridge & Shorter, 2007).

The primary benefit of ERP systems relates to the integration of data and processes and improved business efficiency (Huang, Huang, Wu & Lin, 2009). Another benefit of these integrated systems is their focus on customers, improvement in process efficiency, and support for building teams of employees that cross functional areas (Motiwalla & Thompson, 2012). As a result of the potential benefits reaped by ERP systems, they have been adopted by the majority of enterprises globally (Zouine & Fenies, 2014). According to a recent Gartner Forecast Analysis report (Eid & Granetto, 2014), worldwide the ERP software market is predicted to grow from $25.4B in 2013 to $35.2B in 2018. SAP AG is the leading ERP system and in 2013 retained their market leadership position and sold $6.1B in ERP software, a slight increase from $6B in 2012 (Great Speculations, 2014). Oracle was second in sales in 2013 with $3.117B and in third place was Sage with $1.5B.

In spite of the potential benefits of ERP systems and the growing ERP market, ERP system project failure rates are still high (Kimberling, 2012; Panorama Consulting Solutions, 2014). It is predicted that ERP failure rates will not slow down in the near future (Kimberling, 2012). The 2014 ERP Panorama Report revealed that 54 percent of projects exceeded projected budgets and 72 percent exceeded planning durations, with 66 percent receiving only 50 percent of the measurable anticipated benefits (Panorama Consulting Solutions, 2014).

ERP systems are known for being profoundly complex and having poor usability (Faisal, Faridi, Javed & Shahid, 2012; Lambeck, Fohrholz, Leyh, Šūpulniece & Müller, 2014; Oja & Lucas, 2011; Šūpulniece, Boguševiča, Petrakova, & Grabis, 2013; Veneziano, Mahmud, Khatun & Wai-Peng, 2014). Small improvements in usability of an ERP system have been shown to produce many benefits to an organization, and the greater the ease of use of the system, the greater the probability of implementation success (Ceaparu, Lazar, Bessiere, Robinson & Shneiderman, 2004; Almajali, Masa'deh & Tarhini, 2016). Conversely, the Faisal et al. (2012) study revealed that a poorly arranged user interface can negatively affect user performance and efficiency. The poor usability of ERP systems has been reported to cause failures and inefficiencies on process management, which can generate frustration to users or resistance (Hawari & Heeks, 2010; Lambeck et al., 2014; Singh & Wesson, 2009; Yeh, 2006). These users might need longer time to learn how to interact with an ERP system than planned, and they are often faced with a number of difficulties while using it (Lambeck et al., 2014; Topi, Lucas & Babaian, 2005; Wai-Peng, Veneziano, & Mahmud, 2015).

The concept of interface usability is related to Human Computer Interaction (HCI) issues and can be decomposed into a number of different attributes or qualities (Albert & Tullis, 2013). When applied to software engineering, usability provides specific approaches from the field of design, as in user-centered design, to the field of testing, as in Heuristics Evaluations. These approaches should guide the development of “easy to use” or “user-friendly” systems, mostly by leveraging how their features are perceived (and cognitively processed) by its users. Ease of use and user acceptance of a system have both been shown to be an important factor in the success of a newly adopted ERP system (Almajali et al., 2016; Al-Jabri & Roztocki, 2014; Hawari & Heeks, 2010; Soto-Acosta, Ramayah & Popa, 2013).

Usability analysis of Information Technology (IT) and Information Systems (IS) continues to be an expensive and often neglected practice in organizations in developing countries (Grigera, Garrido, Rivero, & Rossi, 2017). Additional research studies are required to determine if the problems in ERP projects are caused by usability problems (Šūpulniece et al., 2013). The high rate of implementation project failure emphasizes the need for research on the usability and acceptance of ERP systems. In this paper, it is argued that the interface usability of the SAP ERP system has not been fully tested and enhanced by its software developers and suppliers, and that there is scope, need, and urgency to revise the way we look at usability, at least in terms of the use of the SAP ERP system. The Technology Acceptance Model (TAM) theory has been applied in several studies of ERP systems (Agrifoglio & Metallo, 2010; Bueno & Salmeron, 2008; Escobar-Rodríguez & Bartual-Sopena, 2014); however, few studies have explored the impact of usability issues on the TAM.

The purpose of this study was to investigate the interface usability (also referred to as usability) and acceptance of ERP systems, particularly the impact of usability on end users' attitude and behavior. In order to achieve this objective, a survey was conducted of users in a medium sized metal company located in Bangladesh. The users were asked to evaluate the usability of SAP ERP and their acceptance of the system. Acceptance of the system was measured by four criteria as proposed by the TAM theory (F. D. Davis, Bagozzi, & Warshaw, 1989), namely: Perceived Usefulness (PU), Perceived Ease of Use (PEOU), Attitude Towards Usage (ATU), and Behavioral Intention to Use (BIU) the SAP ERP system. The statistical analysis technique of Structural Equation Modelling (SEM) was used to test the relationship among the variables of the proposed research model.

The results from this research can contribute to our knowledge about the attitude and behavior of users towards ERP systems in the manufacturing sector in Bangladesh or in similar economies. In addition, this research can provide some deeper insights into the overall ERP usability domain as well as into improving the usability of other IS applications. This research extends the TAM model to include three usability criteria, namely: navigation, learnability, and presentation.

The structure of the paper is as follows. First, it discusses the research problems, followed by a literature review on the background of the TAM theory and a discussion of its relevance to ERP research, methods of measuring the usability of an ERP system, and proposed research model. Then, it documents the research methodology of this study and data analysis. Next, it reports results and discusses research findings. Finally, the paper concludes with discussion of the limitations of the study, future research directions, and implications of the findings for practice.

Related Research

ERP Systems

ERP systems have long been criticized regarding their complexity. This complexity is due to the integration of different business applications and the processing of huge amounts of data. Furthermore, the functionality and complexity of systems create confusion and frustration (Hawari & Heeks, 2010; Matthews, 2008; Ramayah & Lo, 2007; Veneziano et al. 2014, Wai-Peng et al. 2015), which results in negative responses from users and mistakes made while working on such applications (Al-Jabri & Roztocki, 2014; Kwak, Park, Chung, & Ghosh., 2012). Almahamid & Awsi (2015) explained the importance of ERP vendor support and an organizational environment for the users' perceived benefit of ERP. Some studies (Lambeck et al., 2014; Veneziano et al., 2014; Wai-Peng et al., 2015) argue that the complexity of ERP systems stem mainly from the "unfriendly" nature of the user interface with its multiple windows and high level of detail, whilst others (Ceaparu et al., 2004; Matthews, 2008; Veneziano et al., 2014) argue that complex ERP systems end up providing less effective functionality if they have usability problems.

Literature reports that many ERP projects have struggled to achieve expected and significant benefits due to problems with the complexity of their user interface and poor usability (Ceaparu et al., 2004; Singh & Wesson, 2009; Wai-Peng et al., 2015) and with learning how to use the ERP system effectively (C. H. Davis & Comeau, 2004). The complex functions and interface of ERP systems can also cause users to lack interest in these systems (Gumussoy, Calisir, & Bayram, 2007). Low levels of usability and end-user acceptance can contribute to the failure of an ERP system implementation (Al-Jabri & Roztocki, 2014; Hawari & Heeks, 2010; Soto-Acosta et al., 2013).

In Bangladesh, ERP system implementation has increased in medium-sized organizations by almost 11% and for large-sized organizations, up to 26% in the last couple of years (Business Wire, 2011). In the last few years in Bangladesh, the SAP ERP system has become very popular in the manufacturing and telecom industries, with almost 50 local and foreign companies currently using SAP (Imran, 2013). Despite having focused on the need for technology development in Bangladesh, slow internet rates and a lack of proper training has led to ERP systems not meeting acceptable conditions (Mukaddes, Chowdhury, & Uddin., 2010). Problems with ERP implementations in Bangladesh have been reported as due to a lack of communication, structured training, and poor usability (Veneziano et al., 2014; Wai-Peng et al., 2015).

Technology Acceptance Model (TAM) in ERP Research

Despite several investigations of the relationship between TAM and ERP systems in various studies, little is known about the impact of user interface quality on the acceptance of these systems. A richer understanding of the user interface issues encountered and factors influencing users' perceptions, attitude, and behavior can assist software designers, developers, and testers of ERP software with focusing on those factors to increase the intention to use an ERP system.

The TAM theory originally proposed by F. D. Davis et al. (1989) has been used in various versions in several studies (Agrifoglio & Metallo, 2010; Bueno & Salmeron, 2008; Hwang, 2005; Sternad & Bobek, 2013) to investigate ERP system adoption and acceptance for end users. The TAM proposes that a higher level of perceived usefulness (PU) and perceived ease of use (PEOU) will lead to a higher level of positive attitude towards usage (ATU) of that system, which finally indicates a higher degree of behavioral intention to use (BIU) the system. F. D. Davis et al. (1989) defines PU as the extent to which a person believes that the use of a particular system will improve his/her work performance. PEOU is a construct expressing the extent to which the respondent believes that the use of the concrete system is simple for him/her or it will not be hard. ATU (or attitude) can be defined as the user's positive or negative feelings about performing the target behavior (Fishbein & Ajzen, 1975, p. 288). BIU, also known as behavioral intention or BI, is a measure of the strength of one's intention to perform a specified behavior.

Our review of literature shows that there are a number of studies using TAM to measure the attitude and behavior of end users (Amoako-Gyampah, 2007; Garača, 2011; Gumussoy et al., 2007; Shih & Huang, 2009). Various researchers detected the links between PU and PEOU (Agrifoglio & Metallo, 2010; Calisir & Calisir, 2004; Escobar-Rodríguez & Bartual-Sopena, 2014), though some researchers also ignored this relation (Ali & Younes, 2013; Al-Jabri & Roztocki, 2014; Garača, 2011). The reliability of the TAM questionnaire was tested by Hendrickson, Massey, and Cronan (1993) and its validity was investigated by Szajna (1996).

Several variables have been proposed within TAM to influence users' technology acceptance behavior towards ERP systems (Table 1). Some of these studies focused on the internal managerial practices such as training (Amoako-Gyampah & Salam, 2004; Lee, Lee, Olson, & Chung, 2010) and management support (Shih & Huang, 2009), whilst another study (Calisir & Calisir, 2004) focused on system capability and learnability and yet others incorporated cognitive (enjoyment) factors into the TAM (Hwang, 2005; Mayeh, Ramayah, & Popa, 2014). Venkatesh and Davis (1996) identified self-efficacy (SE) as an antecedent of PEOU. After that, SE became a very popular construct that was added to the TAM model various times for ERP research. It has been argued that SE has no direct relation with PEOU (Govindaraju & Indriany, 2007; Sternad & Bobek, 2013). However, other researchers (Hwang, 2011; Shih & Huang, 2009) found it otherwise. Shih and Huang (2009) observed a positive relationship between SE and PEOU. The differences in their findings on the impact of SE on PEOU may be due to cultural differences as suggested by Hwang (2011). Power distance is a dimension of culture and can be a barrier to SE since it had a significantly negative impact on SE (Hwang, 2011).

Table 1. Variables investigated for affecting technology acceptance of ERP systems

Variables	Researchers
Training	Amoako-Gyampah & Salam (2004); Lee et al. (2010)
Management support	Shih & Huang (2009)
System capability, user guidance, learnability	Calisir & Calisir (2004)
Enjoyment/cognitive absorption	Mayeh et al. (2014)
Complexity	Chang et al. (2008)
Self-efficacy (SE)	Govindaraju & Indriany (2007); Hwang (2011); Shih & Huang (2009); Sternad & Bobek (2013); Venkatesh & Davis (1996)
Computer anxiety	Garača (2011); Shih & Huang (2009)
Interest	Lee et al. (2010)
Technical support	Kwak et al. (2012)
Data quality, user manual and system performance	Sternad & Bobek (2013)
Project communication	Amoako-Gyampah (2007); Soto-Acosta et al. (2013)
Project champion	Soto-Acosta et al. (2013)
In-house IT personal knowledge	Ifinedo (2011)
Personal innovativeness (PIT)	Govindaraju & Indriany (2007); Hwang (2011); Sternad & Bobek (2013)
Perceived Information Transparency (PINT)	Al-Jabri & Roztocki (2014)

Agarwal & Prasad (1998) proposed that personal innovativeness (PIT) is a variable that measures the willingness of any individual to operate something new. PIT has been used as positive stimuli in many ERP system adoption studies and was shown to have a significant direct effect on PEOU (Govindaraju & Indriany, 2007; Hwang, 2011; Sternad & Bobek, 2013) and SE (Hwang, 2011). Computer anxiety was found not being significantly negatively related to PEOU and PU (Shih & Huang, 2009). Garača (2011) also investigated computer anxiety as a variable but the correlation between computer anxiety and user satisfaction was not statistically significant and thus not confirmed.

Lee et al. (2010) identified that there was a significant relationship between an individual's interest and BIU towards an ERP system. The data quality, user manual, and system performance were considered as system and technological characteristics that impacted the PEOU of an ERP system (Sternad & Bobek, 2013). Within the organization's IT department, the need for a project champion, project communication (Amoako-Gyampah, 2007; Soto-Acosta et al., 2013), and in-house IT personal knowledge (Ifinedo, 2011) were added as extensions to the TAM model. The more recent work of Al-Jabri and Roztocki (2014) suggested that perceived information transparency (PINT), which means sharing of data and knowledge, explained the acceptance or rejection of an ERP system.

Apart from the individual and organizational perspectives, some authors proposed to measure the system characteristics and technical support associated with the external variables of TAM. System complexity was also considered but found to have no significant relationship with actual system use (Chang, Cheung, Cheng, & Yeung, 2008); however, in other research it was found to have a statistically significant impact on PEOU (Bueno & Salmeron,2008).

Measuring the Usability of ERP Systems

In the last two decades, several qualitative and quantitative methods and guidelines have been provided by various usability researchers. Jakob Nielsen's (1994) 10 general principles for interaction design were called "heuristics" because they are broad rules of thumb and not specific usability guidelines for designing interfaces. Similarly, the eight golden rules provided by Shneiderman (1996) for user interface design is a qualitative assessment guideline for user interfaces. From a quantitative point of view, the Software Usability Measurement Inventory (SUMI) was proposed to measure a user's satisfaction on any system (Kirakowski, 1996). Brooke (1996) developed another usability scale, called the System Usability Scale (SUS), which was also empirically tested in an ERP setting by Wai-Peng et al. (2015). More recently, a usability measurement scale, called "SUPR-Q" and developed by Sauro (2015), focused on some human factors like trust and loyalty. Very limited research in recent years has focused on quantitative usability criteria and guidelines for ERP systems.

Problems related to the user interface of systems lead to non-acceptance and failure of these systems. Usability is therefore an important quality factor for the acceptance of interactive software applications (Seffah, Donyaee, Kline & Padda, 2006), and these applications include ERP systems. Ease of use as a factor for ERP system acceptance was investigated by Almajali et al. (2016). Ease of use refers to the user's belief that the technology in question is easy-to-use (F. D. Davis et al., 1989). If a particular part of technology or a complex system is difficult to use, it is unlikely to be used when there is an alternative way. The ISO/IEC 25010 definition of usability is *"the capability of the software product to be understood, learned, operated, attractive to the user, and compliant to standards/ guidelines, when used under specific conditions"* (ISO, 2011). Preece, Rogers, and Sharp (2011) describe usability as easy to learn (learnability), effective to use (effectiveness), and enjoyable from the user's perspective.

Three criteria of usability for ERP systems were used in the study by Scholtz, Calitz, and Cilliers (2013), and they are navigation, presentation, and learnability. We chose to utilize these three criteria in this study as well since they have been successfully used in several studies of ERP usability (Singh & Wesson, 2009; Scholtz et al., 2013). The first criterion, navigation, has been reported as a design issue in several ERP usability studies (Calisir & Calisir, 2004; Lucas & Babaian, 2012; Šūpulniece et al., 2013; Singh & Wesson, 2009). Poor navigation can prevent users and ultimately the organization from obtaining the proper benefits from their ERP system (Matthews, 2008; Maurizio & Rosemann, 2005). Navigation of a system should be improved by providing guidance for novice users (Surendran, Somarajan, & Holsing, 2006).

The second usability criterion is presentation of system functions, which if not designed appropriately would lead to complications in understanding or interpreting the system's outputs. The purpose of the presentation criterion is to determine the appropriateness of the layout of menus, dialog boxes, controls, and information elements on the data entry screen as well as included in output. These issues are particularly prevalent in ERP systems with their many and complex menu structures (Scholtz et al*.,* 2013). This criterion therefore refers to how well the visual layout is designed and presented, and it is related to the concept of visual attractiveness defined as the system's appearance being attractive to its users, such as the color and nature of the graphical design (ISO, 2001).

The last criterion of usability adopted in this study was learnability, which is defined as the required period that a user takes to learn how to use the system effectively (Nielson, 1994). Learnability is also defined as the ease with which new or novice users can start effective interaction with the system and achieve the maximum performance (Dix, Finlay, Abowd, & Beale, 2011). Learnability was adopted in this study since it is one of the most commonly cited criteria of usability (Dix et al*.,* 2011; Nielsen, 1994; Seffah et al*.,* 2006; Shneiderman, 1996; Shneiderman et al*.,* 2010), and it is particularly appropriate for ERP systems due to the extensive training they require, the steep learning curve, and the diversity of user experience. Features that make a system easy to use and to learn for novice users could be more complex and cumbersome for more experienced users (Molich & Nielsen, 1990). The learnability of an ERP system can be improved by providing an introductory interface catered for novice users learning to use the system (Topi et al*.*, 2005). Another way of improving the learnability of ERP systems is to employ in the interface only concepts and language familiar to the user (Galitz, 2007; Hustad & Olsen, 2011), which in turn improves user satisfaction (Calisir & Calisir, 2004).

Research Gap

Our reviewing of the literature revealed that the majority of studies using TAM for ERP evaluation (as listed in Table 1) discussed several human factors of ERP systems, but offered little on guidelines and criteria for the design and evaluation of less complex ERP systems. On the other hand, studies (Scholtz et al., 2013; Singh & Wesson, 2009) that focused on ERP system usability criteria did not investigate the TAM or extension of it to include usability. This highlights a gap between HCI/usability and technology acceptance and the need for research to bridge the gap.

By linking interface usability to end users' intention to use an ERP system, this work contributes to research on ERP implementations and on ERP and other IT usability. This work responds to the call to move beyond individual or organizational constructs as well as beyond using traditional Nielson's heuristics as predictor variables for examining interface usability. The importance of understanding users' perceptions of presentation, navigation, and learnability will lead to positive perceptions of usefulness and ease of use of an ERP system in the post implementation stage, which will in turn improve users' acceptance and adoption of the system.

Research Model and Hypotheses

For the purpose of this research, the TAM theory was extended to include usability (Figure 1). The general hypothesis is that interface usability (in terms of navigation, presentation, and learnability) will impact the PU and PEOU of an ERP system.

The directly related hypotheses in this study are:

H1: Perceived Usefulness has a positive effect on Attitude Towards Usage of an ERP system.

H2: Perceived Ease of Use has a positive effect on Attitude Towards Usage of an ERP system.

H3: Perceived Usefulness is positively influenced by Perceived Ease of Use.

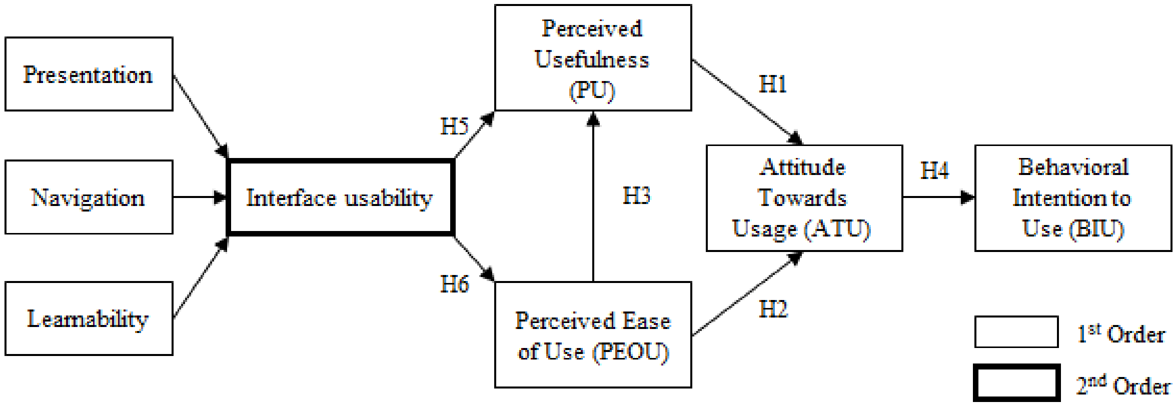

Figure 1. Research model

Amoako-Gyampah (2007) concluded that the users' PE, PEOU, and level of intrinsic involvement are the most important factors that affect their BIU. He also suggested that since an ERP system is mandated technology, actual use should not be considered. So we formulated the hypothesis:

H4: Attitude Towards Usage has a positive effect on the Behavioral Intention to Use an ERP system.

A number of researchers (Calisir, Gumussoy, & Bayram, 2009; Sūpulniece et al., 2013; Usmanij, Khosla, & Chu, 2013) have suggested that user satisfaction is one of the key factors leading to the success of an Information System (IS) and that interface usability can be seen as one of the factors that influences end user satisfaction (Babaian, Lucas, & Topi, 2006; Šūpulniece et al., 2013). A user friendly interface decreases system complexity and impacts on user behavior (Bueno & Salmeron, 2008). Identification of user interface characteristics should be enforced in the implementation stage of an ERP system (Ehie & Madsen, 2005). Therefore, the fifth and sixth hypotheses of this study are:

H5: Interface usability has a positive effect on Perceived Usefulness of an ERP system.

H6: Interface usability has a positive effect on Perceived Ease of Use of an ERP system.

Research Design & Methods

Survey Participants

A paper-based survey was conducted to explore usability issues that emerged after system implementation, with the questionnaire consisting of two instruments derived from the literature. The survey participants were employees in a renowned, well established organization in the heavy metal manufacturing industry in Bangladesh. For purposes of anonymity, the organization will be referred to as MetalCo in this paper. The random sampling technique suggested by Sekaran (2006) was used as the total population was known. There were 140 ERP users in MetalCo and by using the formula provided by Sekaran (2006), our targeted sample was 103. The survey was distributed to all available users (n = 124), all of whom operate on a daily basis on different modules of SAP ERP and, therefore, have experience of the system. A response rate of 90% was obtained since 112 of the 124 users (83% male, 17% female) completed the survey. A post-hoc power analysis was conducted with medium effect size using G*power calculator. It shows a power (0.889) greater than .80, which is considered adequate given the typical α level of .05 (Sykes, 2015).

Instruments

As noted above, the survey questionnaire is essentially a combination of two measuring instruments, usability measurement and TAM measurement, both adopted from previous studies.

Usability measurement scale

The usability scale, proposed by Scholtz et al. (2013), which in turn was adapted from the framework proposed by Singh and Wesson (2009), was used in this study to measure the interface usability of the ERP system. The three usability criteria implemented in the scale are navigation, presentation, and learnability (Table 2). Each of these three criteria has several usability attributes to be rated on a positive 5-point Likert scale (where 1 = Strongly disagree, 2 = Disagree, 3 = Slightly agree, 4 = Agree and 5 = Strongly Agree).

Table 2. Usability criteria and measurement items

Navigation	
NEV1	Information can be easily accessed
NEV2	Functionality can be found quickly and easily
NEV3	The user interface supports efficient and accurate navigation of the system
NEV4	There is a correlation between the searched item and the required item
Presentation	
PRES1	The visual layout is well designed
PRES2	The information provided by the system is timely, accurate, complete and understandable
PRES3	The layout of menus, dialog boxes and controls are easy to understand and interpret and well structured
Learnability	
LER1	A user can learn how to use the system without a long introduction
LER2	The various functions of the system can be identified by exploration
LER3	There is sufficient on-line help to support the learning process

TAM measurement

The TAM questionnaire from F. D. Davis et al. (1989) was adopted for measuring PU and PEOU, and it is supplemented with additional questions drawing on more recent literature to measure ATU and BIU. All the constructs in the research model were therefore operationalized using standard scales from past literature. In summary, our TAM measurement instrument consists of 20 items in total, with five items for each of the four constructs (PU, PEOU, ATU, and BIU), as listed in Table 3. The response scale for all items is a positive 5-point Likert scale (Lam & Klockars, 1982), where 1 = Strongly disagree, 2= Disagree, 3= Slightly agree, 4= Agree, 5= Strongly Agree.

Table 3. Questionnaire blocks of different constructs of TAM

Perceived Usefulness (PU)		
PU1	Using the ERP system enhanced my effectiveness at work	F. D. Davis et al. (1989)
PU2	Using the ERP system improved my performance	
PU3	Using the ERP system increased my productivity at work	
PU4	Using the ERP system enabled me to accomplish tasks more quickly	
PU5	I found using the ERP system useful	
Perceived Ease of Use (PEOU)		
PEOU1	Overall, I found the ERP system interface easy to use	F. D. Davis et al. (1989)
PEOU2	Learning to use the ERP system interface is easy to me	
PEOU3	Interaction with the ERP system interface is clear and under-standable	
PEOU4	It was easy for me to become skillful at using the ERP system	
PEOU5	I found the ERP system interface was flexible to interact with	
Attitude Towards Usage (ATU)		
ATU1	I generally have a favorable attitude toward using the ERP system	Al-Jabri & Roztocki (2014)
ATU2	I believe it is a good idea to use the ERP system for my work	Al-Jabri & Roztocki (2014)
ATU3	I like the idea of using the ERP system	Choi, Kim, & Kim. (2007)
ATU4	Using the ERP System provided me with a lot of enjoyment	Al-Jabri & Roztocki (2014)
ATU5	Overall, I enjoyed using the ERP system	Al-Jabri & Roztocki (2014)
Behavioral Intention to Use (BIU)		
BIU1	I intend to use the ERP system always	Mayeh et al. (2014)
BIU2	I intend to use the ERP system frequently rather than manual way	Mayeh et al. (2014)
BIU3	I intend to use the ERP system as often as possible	Mayeh et al. (2014)
BIU4	I plan to use more modules in the ERP system in the future	Calisir et al. (2009)
BIU5	I expect my use of the ERP system to continue in the future	Calisir et al. (2009)

Data Analysis and Results

Data Analysis

The second generation statistical analysis technique called Structural Equation Modeling (SEM) was used to test the theoretical model. SEM has recently grown very popular in IS research (Aziz & Kamaludin 2014; Roberts & Grover, 2009). The Partial Least Squares (PLS) based SEM (PLS-SEM) provides a visual display of the relationship between hypotheses and variables (Hair, Ringle, & Sarstedt, 2011). PLS-SEM evaluates path coefficients that make the most of R^2 values of the variables. PLS can control complexity with the correction of various models and produce high levels of statistics with small sample sizes. The PLS approach follows two levels of processing. The first level evaluates the measurement instrument by investigating the reliability and discriminate validity of constructs. The second level determines the significance level of path coefficients within the model to test the associated hypotheses (Esposito Vinzi, Chin, Henseler, & Wang, 2010). In the case of interface usability, the higher order construct model was used as suggested by several researchers (MacKenzie, Podsakoff, & Jarvis, 2005; Petter, Straub, & Rai, 2006).

The Smart PLS Version 3.0 software was used to analyze the data as done in several other studies (Al-Jabri & Roztocki, 2014; Nwankpa & Roumani, 2014) to measure ERP adoption. Following the recommendations by other researchers (Chin, 2010; Gil-Garcia, 2008), the bootstrapping method (500 resample) was used to determine the significance levels of loadings, weights, and path coefficients.

Common Method Bias

The sample might be subject to common method variance (CMV), since the dependent and independent variables were measured from the same participants (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). Therefore, we conducted Harman's single factor test, following the suggestions by Sharma, Ringle, and Sarstedt (2009) and Lin, Huang, and Hsu (2015). The results show that the restricted extraction of a single factor only explains 39.16% of the variance, implying that the data did not have a CMV problem.

Measurement Model

In Table 4, the results of loadings, Average Variance Extracted (AVE) and Composite Reliability (CR) measures of all items for first order constructs are reported. The measurement would be acceptable if the AVE for each construct is greater than 0.50 (Nunnally & Bernstein, 1994) and CR is greater than 0.80 (Chin, 2010). In this case, all items are loaded highly on their own latent variable, and thus all measurements have satisfactory levels of reliability.

Table 4. Measurement model of first-order constructs

Items	Loadings	AVE	CR	Mean	Std. Dev	Skewness	Kurtosis
1st order Constructs (Reflective)							
ATU2	0.798			4.14	1.21	1.35	0.89
ATU3	0.754	0.609	0.823	4.35	1.04	1.40	0.75
ATU5	0.787			4.04	1.18	0.79	-0.80
BIU1	0.638			3.97	1.09	-0.66	-0.91
BIU2	0.627			3.79	1.26	-0.659	-0.76
BIU3	0.755			3.99	1.06	-0.673	-0.81
BIU4	0.781	0.513	0.839	4.09	1.19	-0.960	-0.58
BIU5	0.766			4.20	1.13	-1.12	-0.14
LER1	0.868			2.41	0.665	-0.50	-0.46
LER2	0.826	0.661	0.854	2.32	0.674	-.031	-0.55
LER3	0.740			2.27	0.671	-0.19	-0.51
NEV2	0.853	0.765	0.867	2.46	0.721	-0.64	-0.47

Items	Loadings	AVE	CR	Mean	Std. Dev	Skewness	Kurtosis
NEV3	0.896			2.40	0.726	-0.39	-0.50
PEOU1	0.640			3.5	1.22	-0.135	-1.48
PEOU3	0.776	0.591	0.851	3.49	1,090	-0.147	-0.80
PEOU4	0.789			3.78	1.113	-0.424	-1.018
PEOU5	0.856			3.89	1.093	-0.500	-1.09
PRS1	0.785			2.44	0.745	-0.11	-0.32
PRS2	0.793	0.665	0.856	2.26	0.781	-0.54	-0.50
PRS3	0.866			2.29	0.687	-0.25	-0.60
PU2	0.889			3.97	1.061	-0.776	-0.428
PU3	0.824	0.710	0.880	4.04	1.082	-0.811	-0.491
PU5	0.814			3.96	1.138	-0.675	-0.867

Note: [a] AVE = (summation of squared factor loadings) / (summation of squared factor loadings) (summation of error variances) [b] CR = (square of the summation of the factor loadings) / [(square of the summation of the factor loadings) + (square of the summation of the error variances)]

(To get better reliability and discriminant validity lower loadings Item PU1, PU4, NEV1, NEV4, PEOU2, ATU1 and ATU4 were dropped)

Table 5. Measurement model of second level constructs (formative)

Usability	Weights	t value	VIF
Learnability	0.394	18.497***	2.692
Presentation	0.469	26.984***	2.955
Navigation	0.232	16.180***	2.107

For second order constructs, Table 5 shows that the VIF values for learnability, presentation and navigation are all below the threshold of 3.33 (Diamantopoulos & Siguaw, 2006). The results therefore did not indicate a multicollinearity problem. As show in Table 6, the analysis of discriminate validity shows a reasonably higher loading of each item on its intended construct than on any other constructs.

Table 6. Discriminate validity of first-order constructs

	ATU	BIU	LER	NEV	PEOU	PRS	PU
ATU	0.780						
BIU	0.719	0.717					
LER	0.615	0.600	0.813				
NEV	0.534	0.553	0.661	0.875			
PEOU	0.646	0.583	0.669	0.553	0.769		
PRS	0.567	0.685	0.775	0.700	0.694	0.816	
PU	0.755	0.660	0.685	0.481	0.765	0.654	0.843

Note: Diagonals represent the square root of AVE while the other entries represent the squared correlations.

Multicollinearity among the variables was also measured since high correlations were observed between ATU and BIU (0.719), BIU and PRS (0.685), LER and PRS (0.775). The calculation yielded variation inflation factor (VIF) values in the range of 1.279 and 2.884, which is less than 10. Therefore, it is confirmed that no multicollinearity exists among the constructs (Bock, Zmud, Kim, & Lee, 2005; Neter, Kutner, Nachtsheim, & Wasserman, 1996).

Structural Model

The structural model is presented in Figure 2, with annotation of path coefficients (β) and portions of variance explained (R^2), and the results of hypothesis testing by determining the significance levels of path coefficients are summarized in Table 7.

Specifically, strong and statistically significant evidence was found in support of hypothesis H1 (PU→ATU, β= 0.629, p<0.01), which is consistent with the findings of Soto-Acosta et al. (2013). Similarly, statistically significant support is found for H3 (PEOU → PU, β= 0.543, p<0.01), and this confirms previous studies reporting a positive effect of PEOU on PU (Agrifoglio & Metallo, 2010; Calisir & Calisir, 2004; Escobar-Rodríguez & Bartual-Sopena, 2014). In addition, the results also revealed that ATU positively influences users' BIU of ERP systems, and H4 is supported as well (ATU → BIU, β= 0.719, p<0.01), confirming the findings of previous researchers (Ramayah & Lo, 2007; Soto-Acosta et al., 2013). However, H2 (PEOU → ATU) is not supported since β= 0.163 and p>0.05.

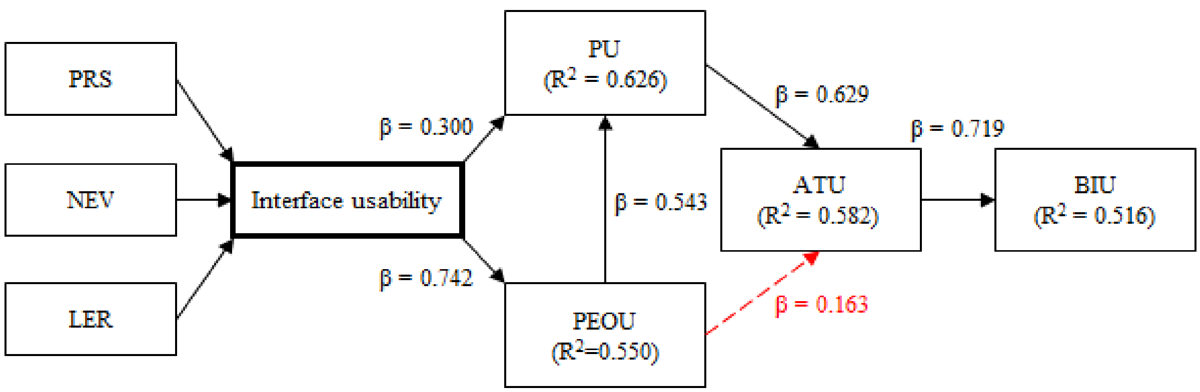

Figure 2. Results of evaluating the structural model

Table 7. Results of hypothesis testing

Hypothesis	Relation	Path co-efficient (β)	t value	Result
H1	PU → ATU	0.629	6.182	Supported**
H2	PEOU → ATU	0.163	1.809	*Not supported*
H3	PEOU → PU	0.543	6.182	Supported**
H4	ATU → BIU	0.719	13.626	Supported**
H5	Usability → PU	0.300	2.697	Supported**
H6	Usability → PEOU	0.742	18.828	Supported**

Note: **p< 0.01,

Our study found significant evidence supporting hypotheses H5 (β= 0.300, p<0.01) and H6 (β= 0.742, p<0.01) which address the direct impact of interface usability, meaning that a higher level of ERP system usability has positive impact on PU and PEOU of the system. This result is similar to the studies of Calisir and Calisir (2004) and Holden and Rada (2011); however, Holden and Rada (2011) measured usability as a part of PEOU and Calisir and Calisir (2004) focused on system capability and learnability. Neither of these two studies used standard HCI techniques for evaluating specific usability criteria (presentation, navigation, learnability).

Findings and Discussion

At the time of writing, no previous evidence could be found on the impact of ERP system usability on PU and PEOU and ultimately on ATU and BIU in the context of a developing country such as Bangladesh. The results of the survey supported hypothesis H1 since a significant relationship was revealed between PU and ATU, thus confirming the findings of previous research (Al-Jabri & Roztocki, 2014; Escobar-Rodríguez & Bartual-Sopena, 2014; Sternad & Bobek, 2013). However, the impact of PEOU on ATU was not significant and H2 was not supported. This result is surprising and does not align with the traditional TAM model by F. D. Davis et al. (1989). On the other hand, hypotheses H3 and H4 are supported, which is in agreement with the research findings of Bueno and Salmeron (2008), Calisir et al. (2009), and Samander and Abdul Rahman (2014). The results seem to reinforce the rather important observation that if things are not perceived as easy to use then they are not considered useful. The findings also show that if the attitude to use a system is negative, people will simply not use it.

Theoretical and Practical Contributions

This study made several theoretical contributions to the field of ERP usability research. This paper contributes to the body of work focused on improved understanding of ERP implementations and ERP usability. It complements the micro-level examinations of ERP adoption by building on our understanding of the individual users' experience. This research identified the strengths and weaknesses of usability in terms of navigation, presentation, and learnability, and it complements existing IS and HCI research by investigating the role of usability in the context of ERP acceptance.

It is interesting to note the research finding that interface usability can positively affect the users' perception of usefulness, ease of use, and attitude towards an ERP system. Specifically, interface usability (in terms of navigation, learnability and presentation) could lead to a significantly higher rating of perceptions and attitudes of SAP ERP users.

Previous research focused on factors related to attitude and behavior of users, and only a few studies have examined the link between interface usability and its impact on user acceptance of ERP systems. It is in this regard that this research made a primary contribution by extending the traditional TAM theory to include interface usability as an external variable along with the three criteria of usability assessment (navigation, presentation, and learnability). The results also verified the use of these criteria for designing and evaluating ERP systems, as suggested by Scholtz et al. (2013). It follows naturally that by improving the navigation, presentation, and learnability of an ERP system, the PEOU and PU of the system will improve, which in turn will lead to increased usage of the system. Several guidelines regarding improving the navigation, presentation, and learnability of ERP systems were confirmed by the research participants in their responses to the survey.

This work has practical implications for practitioners and designers. From this research, stakeholders of ERP systems, particularly SAP partners, can gain a clearer understanding of the factors influencing ERP usability, ERP adoption, and ultimately ERP project success. The research findings may serve for ERP designers as guidelines for improving the usability of the user interface by focusing on the navigation, presentation, and learnability of the system, thereby ultimately increasing users' intention to use the ERP system. It is argued that the issues and problems in learnability are mostly due to lack of (or limited) help and support embedded in the interface of an ERP system and that this would cause the industry to face huge costs (in terms of time and money) for training "after" the system has been implemented and deployed. This study has shown the importance of interface usability to ERP specialist and ERP designers/developers in Bangladesh, and the recommendations from this study can assist SAP AG and other ERP system vendors to rethink usability when developing their products.

Methodological Contributions

In this research, SEM was used to measure the relationship among the variables of the proposed research model. There are several reasons for using SEM. Firstly, SEM allows researchers to analyze a complex model with multiple independent and dependent variables comprehensively and simultaneously. As a result, IS, business management, and social science researchers are using this technique for their research (Gefen, Straub, & Boudreau, 2000; Kline 2005). Secondly, higher order variable modelling (e.g., 2^{nd} order formative measurement for usability as done in this study) can be easily done in SEM (Edwards, 2001), thereby motivating IS researchers to measure their constructs, develop research model, or test theories.

This paper reports on a quantitative analysis of the proposed model of ERP system adoption using SEM. The PLS approach from SEM was implemented, which is an appropriate method for testing a multivariate, multi-path model. Methodologically it reduces the risk of common method bias by the implementation of Harman's single factor as suggested by Podsakoff et al. (2003). The study therefore also offers contributions to the literature on the use of PLS in studies of manufacturing industries.

Conclusions

There are some limitations of this study due to time and budget constraints. Firstly, the sample size was relatively small, and the survey was distributed only in one company. Secondly, control variables like age, education level, staff seniority, and gender were not considered in this research although they were suggested by other researchers (Burton-Jones, Storey, Sugumaran, & Ahluwalia, 2005; Mathieson, Peacock, & Chin, 2001). Further, the users' perceptions, memory abilities, and reasoning skills are cognitive abilities. Again, cognitive style is a fundamental individual characteristic and refers to consistent individual differences in their preference of ways of organizing and processing information and experience. Usability of any IT is combined with both technology and human factors. Therefore, the influence of technology induced stress (Ayyagari, Grover, & Purvis, 2011) might impact interface usability and technology adoption, which should be investigated in future research. Since usability deals with human behaviors, longitudinal studies should be conducted as well to observe the changing of intention to use over time.

This study helps us to gain a better understanding of how attitude is perceived and processed by users by producing empirical evidence on the impact of interface usability. We believe this is a vital contribution to the profession of system developers and managers worldwide since their ultimate aim is to improve system usability, upon which the whole economy relies.

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