DIFFUSION OF M-LEARNING: SAKARYA UNIVERSITY CASE

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ABSTRACT: Mobile learning (M-learning) is considered as the next generation of e-learning using mobile technologies to facilitate education for teaching and learning purposes, anywhere and anytime. This paper analyzes seventy college students selected randomly from a state university in predicting their acceptance attributes based upon Diffusion of Innovation (DOI) framework towards using the m-learning. The objectives of this research are to determine the level of usage of mobile learning and to identify the factors that the learners' intentions to adopt are of relative advantage, compatibility, complexity, observability, and trialability. The research uses standard instrument to capture students' responses on the five basic constructs of DOI model that includes relative advantage, compatibility, complexity, observability and trialability. The data is analyzed through Smart-PLS. The PLS allows the researcher to test the relationship within the measures and the hypothesized relationships between the measures simultaneously. The findings indicate that the relative advantage and compatibility are the significant determinants of the adoption of m-learning technology. The explanatory power of model indicates that 42% of the total variance towards adoption intention is explained showing the moderate parsimony of the model. Based upon the conclusion, some pedagogical recommendations are made for the relevant authorities.

Keywords: m-learning, college students, diffusion of innovation, DOI, Sakarya University

INTRODUCTION

Mobile learning (M-learning) is considered as the next generation of e-learning using mobile technologies to facilitate education for teaching and learning purposes, anywhere and anytime (Nasiri and Deng, 2009). M-learning is a relatively new tool to provide teaching/learning approach to the expanding world of distance learning options but also support learners as an additional source of knowledge, with the help of small portable computing devices including smartphone and other similar types of handheld devices (McConatha et al., 2007). Oblinger (2012) made a further step by suggesting to the universities and institutions of higher learning that they must change from using technologies that only changed the delivery of content to a model that supported collaboration, interactivity, and immersion.

Mobile devices are found to be much more affordable than desktop computers and less expensive access to the Internet (even if the cost of connection is higher) (InfoDev, 2010). This increasing use of mobile devices in education enhanced by advances in mobile technology was studied by Fozdar and Kumar (2007) and Meister (2011). Nassuora (2013) reported a research that stated nine different activities students' performance in higher education setting, with their mobiles (Kennedy et al., 2008). However, the benefits gained from mobile services depend on the intentions of the students to use them for education purpose (Khanh & Gim, 2014).

Information technology and the Internet have dramatically increased the convenience of accessing information for the students and general public. Colleges have begun to experiment with the application of mobile technology. However, there are segments of the population who have neither access to nor have accepted recent innovative information technology such as mobile learning, mobile access to the Internet, and mobile information access (Horrigan, 2008a; Horrigan, 2008b; Jones & Fox, 2009; Madden, 2008). Wang and Shih (2008) suggest we need to ensure that there are no groups underrepresented or without adequate access to information. Marshall (2008) further suggests that the digital divide between those with or without innovative
technology should be further investigated.

The rapid development of mobile technology and higher education student and faculty ownership of mobile devices with Internet access have expanded communication methods, opportunities for collaboration, access to traditional learning, and access to information resources. Innovations in cell phones and other devices allow students to have mobile access to academic email, library staff, podcasts, videos, Internet information resources, course documents, and peer collaboration on projects. However, mobile learning and mobile technology acceptance research using diffusion theories such as Diffusion of Innovation (DOI) is limited (Medlin, 2001). In particular, there is a lack of research using diffusion theories on whether college students plan to use or are

currently using mobile devices to support their learning or to access the resources provided by higher education libraries.

Researchers across the globe have studied these theories for various technological innovations such as for e-learning context (Chang and Tung, 2008; Ndubisi, 2004; Lee, 2006), for online shopping (Vijayasarathy, 2004) and for Web- based information systems (Yi and Hwang, 2003). The m-learning is relatively a new field in Sakarya especially among students of a state university, up to our knowledge, no prior studies has been undertaken within the context of a state university students' intention to use the m-learning. So, this paper tries to fill-in the gap by validating the Rogers' DOI to study the Sakarya university students' adoption to use Smartphones for educational purpose.

THEORETICAL FRAMEWORK AND DEVELOPMENT OF HYPOTHESES

This section begins with a brief discuss about Roger's DOI and some related literature. Then our study's theoretical framework is presented and tried to identify what factors might influence adoption of mobile learning.

Diffusion of Innovation (DOI)

According to Rogers (2003) an innovation is an idea, practice, or object that is perceived as new by an individual or other unit of adoption. Diffusion of Innovation Theory is based on this definition and introduced the perceived characteristics of innovating; relative advantage, compatibility, complexity, observability and trialability. DOI believes that innovation characteristics are the main determinant of innovation diffusion (Zhang et al., 2012) and they are used to predict the implementation of new technological innovations and clarify how these variables interact with one another (Gao, Krogstie and Siau, 2011). The central of this theory is the process in which an innovation is communicated among the member of the system

Since proposed, Roger's model has been widely used in research of adoption of new technologies. Researchers using this sociological theory try to identify key characteristics of technological innovations and their impacts on adoption behavior (Datta, 2011). As this theory aims to explain how innovations are taken up in a population, Moore and Benbasat (1991) also stated that the differences among these perceptions may lead to different user adoption behaviors. Regarding this context, all the characteristics can be crucial in itself. For instance, if someone feels that the new very innovative and useful software is unsurely using, she/he will immediately give up trying it. Only become an innovative software may not always enough criteria for acceptance of users' adoption. Because many researchers have argued that DOI is the best theory for studies conducting in educational environment (Medlin, 2001; Sahin & Thompson, 2006). In this study, we prefer to use this theory to examine the acceptance of m-learning among the higher education students in Sakarya University. Five significant characteristics will be discussed in detail in the following section.

Related Literature on Technology Acceptance

Information systems (Davis, Bagozzi, & Warshaw, 1992), library information studies researchers and practitioners (Kim, 2005; Park et al., 2009; Spacey, Goulding, & Murray, 2004; Starkweather & Wallin, 1999; Totolo, 2007), and education researchers (Cetron, 2007; Dasgupta, Granger, & McGarry, 2002; Lin, Chan, & Jin, 2004; Williams, 2009) have paid considerable attention to technology acceptance. Hendrick and Brown (1984) define technology acceptance as a person's psychological state in regards to their voluntary use of or intention to use a specific technology. Venkatesh, et. al., (2003) describe research into technology adoption, acceptance, and use as "the most mature research area in contemporary information systems research literature" (p. 426). However, technology acceptance research related to mobile information technologies using information systems (IS) theory is very limited, and researchers such as Wang, Wu, and Wang (2008) suggest that further research is needed on the acceptance and use of mobile learning using traditional IS models. Mobile technologies provide new methods for accessing and interacting with information and broaden the means of communication and collaboration among students and between faculty and students.

The design, development, distribution, implementation, and support of technology are expensive investments for institutions such as colleges. The only way innovative information technology will reach its full potential and support this is if students and faculty accept and value it. There are numerous IS theories and models designed to assist in understanding how and why people accept technology and the intention to use and actual use of it. For instance, technology acceptance theory has been used as a framework to examine library staff attitudes toward the Internet (Spacey, et al., 2004), acceptance of web-based subscription databases (Kim, 2005), acceptance of digital libraries in developing countries (Park, et al., 2009), faculty responses to library technology (Starkweather &

Wallin, 1999), social inclusion of digital libraries in academic and clinical settings (Adams, Blandford, & Lunt, 2005), and the role of self-efficacy in electronic library usage (Aafaqi & Ramayah, 2004).

Venkates et. al. (2003) describe technology acceptance research as the most mature research area in IS literature. Taylor and Todd (1995) state that assessing the value of information technology to organizations (e.g., colleges, universities, libraries, public schools) and understanding the determinants of that value are keys to acceptance, integration, and use of the technology. To address this concern, there have been numerous theories and models designed to assist in understanding information technology acceptance, seeking, exchange, and use. Researchers have used theories like the Technology Acceptance Model (TAM), the Theory of Reasoned Action (TRA), The Theory of Planned Behavior (TPB), and Diffusion of Innovation to better understand the diffusion of innovations, how and why technology is accepted, and the intentions of individuals to use and the use of technology (Ajzen & Fishbein, 1980; Dillon & Morris, 1996; Lee, Kozar, & Larsen, 2003; Lucas & Spitler, 1999; Rogers, 1995; Venkatesh, et al., 2003).

Related Literature on M-Learning and DOI

As a result of a detailed literature research, it was seen that there is lack of study relevant about m-learning using DOI. Celik et al. (2014) developed a mobile learning adoption scale (MLAS) on the basis of DOI. The reliability of the scale was determined through item, test-retest reliability and internal consistency analyses. Total correlation for this scale was positive. Another study about online learning in higher education, Shea et al. used Roger's model to explore the adoption and diffusion of online teaching in higher education. They reached 913 professors from community colleges, four year colleges and university centers to test what factors have significant effect on faculty satisfaction on online teaching. As a result, they indicated that interaction, technical support and opportunities are the key factors (Shea, Pickett & Sau Li, 2005).

Researchers frequently prefer combining the theories to explain the user acceptance of m-learning. For example, Alharbi and Drew (2014) integrated Unified Theory of Acceptance and Use of Technology and Information System Success Model to develop a framework that assist in understanding students' behavioral intention to use m-learning systems in a higher education settings. Pina (2015) explained the perceptions of professors about using mobile devices. Through exploratory interviews based on DOI and related studies18 professors made their consideration. Teacher interest and institutional support are determinant as the most significant factors on acceptance of m-learning. Another study conducted with the combination of Extended Technology Acceptance Model (E-TAM) and DOI (Cheng, 2015). Results show that learners can judge m-learning by how well it meets their perceived compatibility and they will regard m-learning as a useful.

Contrary to the existing literature, our study aims to explain user's m-learning acceptance by using only DOI. For further studies, another least preferred such as Motivational Theory or Information System Success Model can be used to clarify perceptions of students or academic staff towards to m-learning.

Research Model

In this section, critical factors affecting the users' adoption of innovation is discussed.

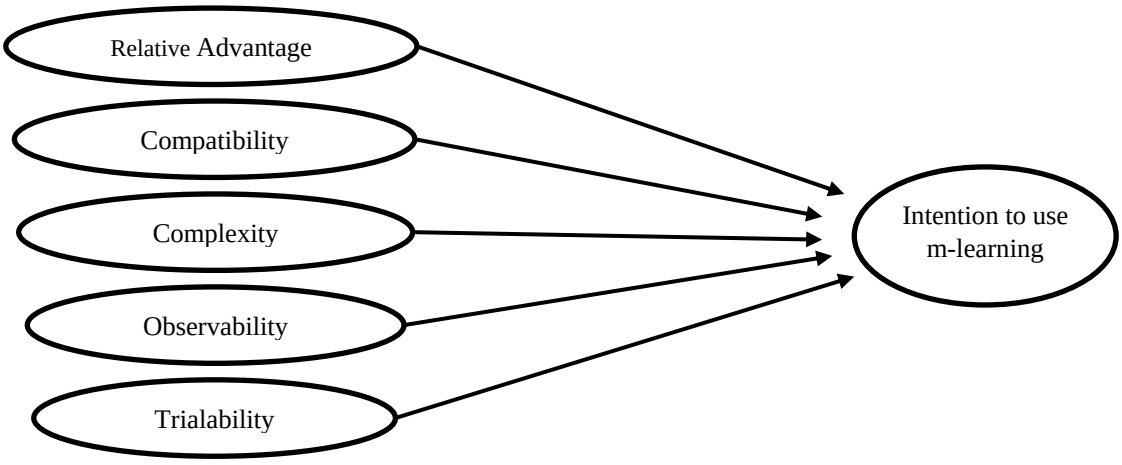

Figure 1. Research model

Relative Advantage

Relative advantage refers to the degree to which an innovation is perceived as providing more benefits than its predecessor (Moore & Benbasat, 1991). Prior researches suggest that when user perceives relative advantage or usefulness of a new technology over an old one, they tend to adopt it (McCloskey, 2006; Rogers, 2003). This feature of Roger's topology has been studied by various researchers in the context of mobile banking adoption (Lin, 2011; Al-Jabri and Sohail, 2012); e-learning & blended learning (Tshabalala, et al. 2014); electronic commerce (Seyal and Rahman, 2003; Ndayizigamiye and McArthur, 2014); Web-supported instructions (Soffer et al. 2010) and mobile learning (Mcconatha et al. 2008). Therefore, we hypothesize that:

H1: Relative advantage is positively associated with the students' intentions to use m-learning.

Compatibility

Clarke (2000) found ease of use to be one of the five significant factors that determined general use of wireless handheld devices. An individual might have a higher intention to adopt mobile learning if they think mobile learning is easy to operate. Again, Lu and Viehland (2008) found a support in their m-learning study in New Zealand. Thus, on that basis, we propose our second hypotheses:

H2: Compatibility is positively associated with the students' intentions to use m-learning.

Complexity

Cheung et al. (2000) defined complexity where an innovation could be considered relatively difficult to understand and use. They found that complexity influenced the adoption of Internet use. Chau and Hu (2001) and others had demonstrated that attitude towards using a technology was the significant determinant of behavioral intentions. A vast body of research had suggested that there was a strong support to ease the use of this new technology on its adoption (Luarn & Lin 2005; Wang et al. 2009). Chau and Hu (2001) also found that users were more likely to use new innovation if they had strong feelings of easiness with those innovations. Thus, it is hypothesized:

H3: Complexity is negatively associated with the students' intentions to use m-learning.

Observability

Rogers (2003) defined the observability as the degree to which the results of an innovation are viable to others. Role modeling (or peer observation) is the key motivational factor in the adoption and diffusion of technology (Parisot, 1997). Similar to relative advantage, compatibility, and trialability, observability also is positively correlated with the rate of adoption of an innovation. Al-Jabri and Sohail (2012) used this in the context of mobile banking and found that it was significant. Thus, it is hypothesized:

H4: Observability is positively associated with the students' intentions to use m-learning.

Trialability

According to Rogers (2003), trialability is the degree to which an innovation may be experimented with on a limited basis, where trialability is positively correlated with the rate of adoption. Therefore, more an innovation is tried, the faster its adoption. Potential adopters who were allowed to experiment with an innovation would feel more comfortable with it and were more likely to adopt it (Agarwal & Prasad, 1998; Tan & Teo, 2000). Thus, it is hypothesized:

H5: Trialability is positively associated with the students' intentions to use m-learning.

METHODS

From the review of the literature and on the basis of the model developed that fulfilled the research objectives, the questionnaire was then modified and edited. On the basis of face and content validity, it was revised and refined before administrating the survey. The multidimensional instrument was developed in three parts to capture the information. The source of instrument was adapted from Moore & Benbasat (1991) and Davis (1989) and then it was modified to cater further the m-learning context.

From the review of literature, several quantitative research methodologies existed (e.g. survey, experimental, quasi- experimental) and were frequently used to test a theoretical underpinning (Creswell, 2003) especially when the respondents were asked to provide information about themselves for example about their attitudes, beliefs, demographics or past behaviors (Cozby, 2004). The techniques like step-wise sample size determination were used as suggested by (Simon & Burstein, 1985) in order to justify the sample size, i.e., not be less than 100. The sampling frame included all the students who owned 3Gs mobile phones, tablets or PDAs.

One hundred and fifty questionnaires were distributed to the students in School of Management. Out of them, 80 questionnaires were received. After closer examination, seventy-five were retained for the study. This made the response rate to 50% that would have been considered sufficient to draw logical conclusion. This was in line with the minimum recommended rate of 30% for survey research (Johnson and Owens, 2003).

RESULTS AND FINDINGS

In order to get the reliability of the questionnaire, the coefficient of Cronbach's alpha (1951) was taken into account. Minimum Cronbach's alpha values were greater than 0.70 to indicate reliability of the instrument (Nunnally, 1978). During the initial screening of conducting reliability tests, some items were dropped because of low corrected-item total correlation which was less than 0.40, i.e., the cut-off value suggested (Hair et al., 1998). In addition, the Kaiser- Normalization as techniques of rotation was used to examine both the individual items and the relationship among them (Hair et al., 1998). Churchill (1979) had suggested that convergent and discriminant validities should be examined for construct validity. Therefore, convergent validity was assessed by examining composite reliability (CR) and average variance extracted (AVE) from the four constructs (Hair et al., 1998).

CR is then calculated by squaring the sum of loadings, and dividing it by the sum of squared loadings, plus the sum of the measurement error whereas, the AVE measures the variance captured by the indicators relative to measurement error. The CR values for all four constructs were within the suggested minimum of 0.70 (Hair et al., 1998). The average variance of 0.50 had been suggested to cater the need for further evidence for convergent validity (Fornell and Larcker, 1981) These AVE values could also be used to assess discriminant validity which occurred when the AVE exceed the square pair wise correlation between the construct (Espinoza, 1999).

To examine the common method variance, we conducted a Harman's single factor test (Podsakoff et al., 2003) by using SPSS factor analysis. The result has indicated that the largest variance explained by an individual factor is 45%. It might seem high but is still below 50% of the cut-out limit. The relationship of the students' various attributes of DOI with the dependent variable intention to use was investigated using Smart-PLS; multiple regression analysis. The Partial-least squares were used to test the hypothesized relationship among the variables in the model. This PLS is a second-generation multivariate technique that facilitates testing of the psychometric properties of the scales used to measure a variable, as well as the estimation of the parameters of the structural model i.e. the strength and direction of the relationship among the model variables (Fornell and Larcker, 1981; Lohmoller, 1981).

The PLS allows the researcher to test the relationship within the measures and the hypothesized relationships between the measures simultaneously (Lohmoller, 1989). Re-sampling procedure such as bootstrapping which produce t-statistic was used to assess the structural paths (Chin and Newsted, 1999). In addition, model's predictive power was assessed by using R2 value for the endogenous variables (Fornell and Larcker, 1981). The explanatory power of model indicates that 42% of the total variance towards adoption intention is explained showing the moderate parsimony of the model.

The study fulfills the objectives of this paper as to determine the level of usage of m-learning and to identify the factors that are significant in explaining the adoption of m-learning among students of a university in Sakarya. The objectives of this paper are to determine the level of usage of mobile learning and to identify the factors that the learners' intentions to adopt are of relative advantage, compatibility, complexity, observability, and trialability.

Previous studies have suggested that only the relative advantage, complexity, and compatibility are consistently related to innovation adoption (Ryu et al, 2009; Wu & Wang, 2005). Similar with the existing literature our results show that the relative advantage has remained the significant determinants of m-learning adoption. This further elaborates that learners still agree that any new IT/IS features should provide benefits when compared to other conventional technologies (that is equivalent to perceived useful component of TAM). These results have indicated that 80% of the students (mean = 3.84) ave understood that using m-learning platform for educational purpose have provided benefits such as accessibility, immediacy and portability as mentioned by Barker et al. (2005) and

Joo et al. (2014). The results therefore support all previous studies such as; Joo et al. 2014; Ndayizigamiya and MacArthur, 2014; Fu et al., 2007; Jebeile and Abeysekera, 2010 and Al-Jabri and Sohail, 2012.

Compatibility with university technological infrastructure and value system further strengthen the students' intention of m-learning adoption. This has been confirmed that subjective norms in TRA/TPB and compatibility with technology infrastructure and existing value system were significant predictors of various IS/IT adoption (Seyal & Rahman, 2003; Seyal, 2010; Seyal et al., 2012; Lu and Viehland, 2008). About 78% of the users (mean= 3.40) have shown concern about their compatibility issue which is very significant.

The complexity attribute remained insignificant contributor towards learners' intention to adopt m-learning. The negatively worded items were changed so the high mean value of (mean = 3.84) is in fact not high but indicated low value that further suggests that for the majority of the learners' complexity was not a big issue. Our results therefore do not support Joo et al. (2014) and Wang et al. (2009).

Both trialability and observability results support the previous studies (Sheng et al., 2011; Joo et al., 2014). 42% of the shared variance is in fact shows better predicting power than the contemporary model even better than the original TAM model that explained roughly 40% of the variance towards behavioral intention. Results also support Chau and Hu (2001) who stated that 42% of the variance was explained in intention to use.

CONCLUSION

This preliminary study on students used of the m-learning was necessary because the m-learning in higher education institution is still at early stage. The results indicate that two of the five constructs of the original DOI are strong predictor of students' intentions on m-learning. We therefore, could use the results of the study for supporting research on developing m-learning technology for the students in future. The model as sufficient parsimony as determined by 42% of the shared variance toward m-learning was explained by the two significant predictors.

As in most researches using survey methodology, this study has its weaknesses. Several limitations of this study qualify the findings and suggest direction for future research. The study is limited to its small sample size and it model. The study is further based on single institution and caution should be taken to generalize the results of this study on this basis. By readdressing and expanding the study with extended items from TAM 2, TAM3 and/or UTAUT, will bring further insight that will definitely help to improve the study.

The study found relative advantage and compatibility from DOI contributed towards students' intention to use m-learning. This further suggests that there is a strong need for the university administration and other policy makers to be acquainted with the various benefits of m-learning in order to stimulate its adoption. Therefore, a step-wise approach as proposed by Ndayzigamiya and McArthur (2014) to start with simple m-learning application that provides relative advantage and compatibility with existing university infrastructure and then move gradually toward more complex m- learning applications and in this transition, all the stakeholders should be taken on board.

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