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Analysis the Effect of Different Factors on the Development of Mobile Learning Applications at Different Stages of Usage

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ABSTRACT For the development effective and successful mobile learning applications, it is important to understand the users' requirements in different stages of usage. In this paper, we developed a new model to study the effect of different factors on mobile learning applications development at the three main stages of usage (static stage, interaction stage and transaction stage). The results of this study showed that each stage of the three stages, static, interaction, and transaction has different requirements in terms of system compatibility, security, information quality, awareness, perceived functional benefit, self-efficacy, perceived image, perceived uncertainty, availability of resources, and perceived trust. In addition, the results demonstrated that the requirements and perceptions of users towards the adoption and use of mobile learning application in the three stages significantly differ. The novelty of this research will be an added value to the body of knowledge and its implications will be vital for researchers and designers who are developing mobile learning applications.

INDEX TERMS Mobile application development, mobile learning applications, information system adoption, user requirements.

I. INTRODUCTION

Recently, several universities have made a significant transition through utilizing mobile applications to provide their services and conduct learning activities [1]. This transition has created what is known as mobile learning. Mobile learning provides several benefits for learners including the benefits represented in enhancing the delivery of learning materials; consequently, the students have the ability to get instant access on the basis of any time and any place. In addition, mobile learning applications have the ability to open up extra channels for the interaction between students and instructors [2]. These mobile learning applications can support quick access to student information, learning activities and materials anytime, anywhere and anyhow; hence, creating pioneering and new opportunities for innovative learning services management and delivery [3] and [4]. Mobile learning is one of those recent technologies that came to enhance the performance of learning and education as one of the key tools for students and instructors. This innovative and modern trend enables providing learning materials and activities, and universities services and for learners in actual time by using their mobile devices such as smartphones [5].

In fact, through such mobile learning application, universities are able to offer a wide range of learning and administrative services for students that can be acquired using different types of mobile devices, during unlimited time intervals, and from different locations. It has been reported that, while mobile learning initiatives were a crucial step taken by many universities, provision of learning services through mobile technologies is then now inevitable [6]. Yet, similar to any other new technology or digital innovation, mobile learning implementation remain to face some critical technical, as well as non-technical challenges, particularly adoption and acceptance [7]–[9].

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Many existing studies are mainly engaged in exploring and determining the most critical factors for the adoption of mobile learning among students through using mobile software applications. So far, these studies are still used traditional theories related to technology adoption models such as TAM, UTAUT, TRA and TPB and others. However, these studies have not considered the essential factors that play an important role in the adoption of mobile learning in different stages of mobile learning services adoption such as static stage, interaction stage and transaction stage. Consequently, the present study does not attempt to establish the theoretical framework and develop hypotheses based on the traditional technology adoption theories. Therefore, unlike previous studies, this study mainly focuses in predicting the students' adoption of mobile learning applications at the three main stages of mobile learning services (static stage, interaction stage and transaction stage).

In this study, we classified the mobile learning application services into three main stages namely, static, interaction and transaction stage. In the static stage, using mobile learning applications, students can access, search and view their important information anytime such as registration dates, learning courses, university announcements, exam dates, assignments, grades, financial status and others. Also, students can download learning courses and upload assignments. In addition, the mobile learning information system enables faculty members to access to financial and payroll information and see their salaries. In the interaction stage, students through mobile learning application can communicate easily with instructors from anywhere regarding any queries using two-way communications such as e-mail and chat system. In the transaction stage, using mobile learning applications, instructors are able to open virtual classes, download the course materials, evaluate the homework and get the students' profiles from the system. The system also allows faculty members to upload documents, homework and notes during the class. On the other hand, students are able to register in the virtual classes, add and delete new courses, answer the quizzes and pay registration fees by connecting with their bank accounts through self-service technology, virtual interactions, security levels and tasks confirmation. Therefore, we observe that technical requirements and functional characteristics at the transactional stage is very different from static and interaction stage. Thus, users' requirements and perceptions is quite different from stage to other stage.

All of these different actions and functions represent different stages of mobile learning application that require different features for operations, as shown in Figures 1,2 and 3. Learning and administrative services, transactions and operations are very different from stage to stage in mobile learning applications. For example, technical features for security, risks, accessibility, and usability are different from the static stage to interaction stage to transaction stage of mobile learning applications. Also, from the aspect of learners' behavioral intention and users' perception is also different for different phases of mobile learning applications. Considering these differences, developing a theoretical framework to explain the important factors that affect the adoption of mobile learning application during the three main stages is a valuable and significant concern that has so far not been addressed by extant research.

II. THEORETICAL BACKGROUND

In Information Systems (IS) literature, systems and applications need to be dynamic, users centric, widely available, and compatible with new features of mobile technologies and modern life style of users [10]. Mobile learning application as a new type of Information systems, which provides many learning and administrative services such as download and upload learning materials, submit assignments, view information are offered by instructors, pay fees and etc. Hence, universities need to offer a unique services and high quality of mobile applications in order to ensure students' adoption of mobile learning application services. Mobile learning applications have emerged to serve learners and meet students' versatile requirements to satisfy them with high quality services [4]. It is clearly evidenced that mobile learning applications offer many benefits for students, instructors, employees and universities. It offers more availability and accessibility since learners have the ability to access the learning resources and information on the basis of anytime and anywhere through their Smart phones. Moreover, it permits the instructors to quickly deliver modified learning content and updated important information to the students.

However, in order to ensure the success adoption of any system, it is important to understand and identify the users' requirements [10]–[12]. Studies [13]–[15] indicated that this problem is still in the adoption of mobile learning applications, where the current researchers, mobile service providers do not have clear perception about mobile learning users' needs and requirements at different stages of the mobile learning services. Although, there are many studies [28], [29] conducted to determine the adoption of mobile learning, little consideration has been paid to explore the main factors that influence the adoption of mobile-learning applications at the three main stages of mobile learning services (static stage, interaction stage and transaction stage). Furthermore, existing literature do not have comprehensive model about important factors for adopting mobile learning applications at static, interaction and transaction stages.

Many researchers [7], [9], [16], [17] and [25] have engaged in exploring and determining the most critical factors for the adoption of mobile learning applications through using traditional theories related to technology adoption models such as TAM, UTAUT, TRA and TPB and others. Almaiah *et al.* [7] tested empirically the TAM model by adding 8 external factors (learning content quality, content design quality, interactivity, functionality, user-interface design, accessibility, personalization, and responsiveness) to investigate students' acceptance of mobile learning in Jordan. The study found that quality factors are positively impacted on students' adoption of mobile learning

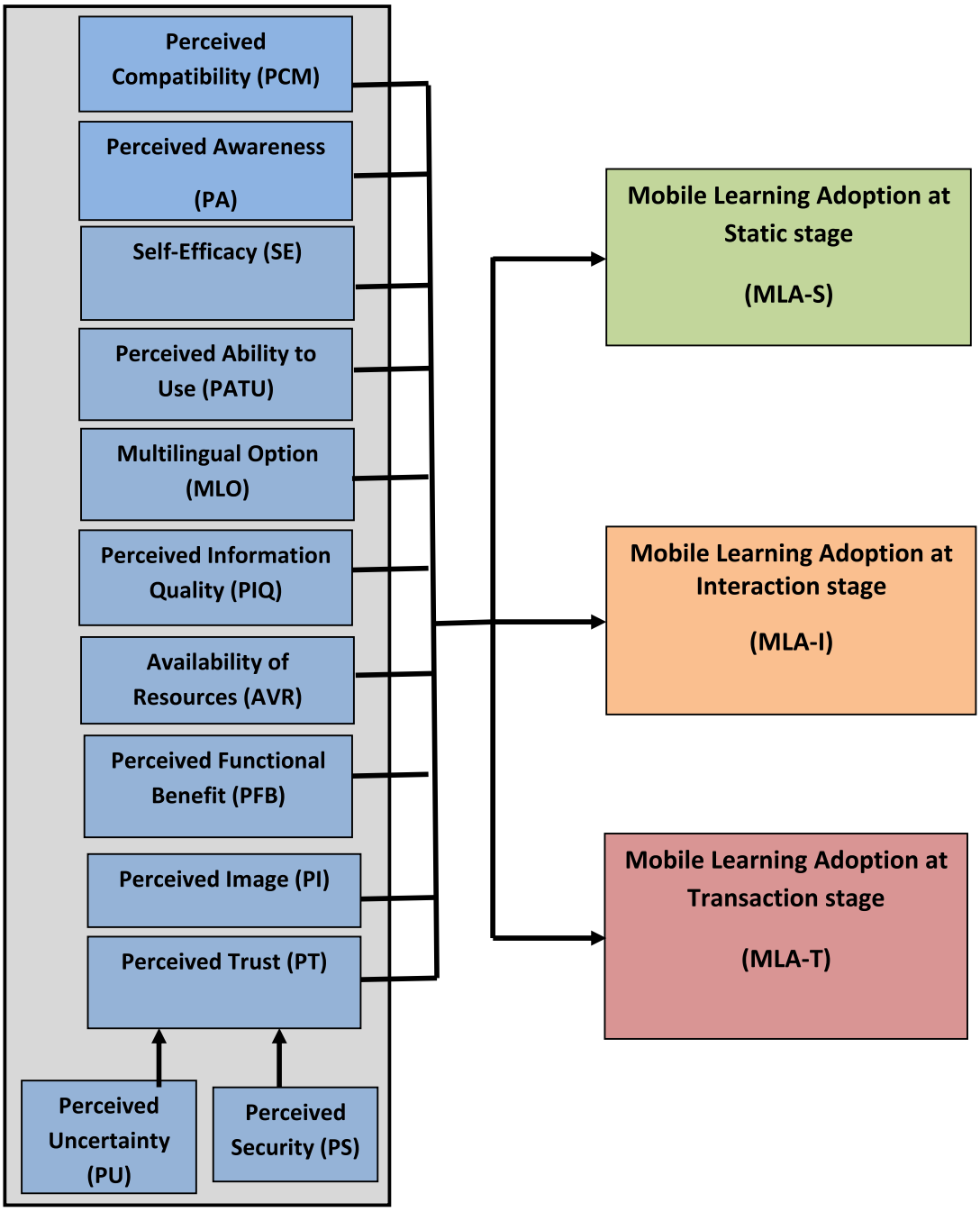

FIGURE 1. Mobile learning adoption model (MLAM) at three stages of service.

applications. Sánchez-Prieto *et al.* [16] proposed a model by integrating the TAM to investigate about the factors that encourage the use of mobile learning among students. The empirical results indicated that resistance to change and attachment have significant impact on the behavioural intention to use of mobile learning applications. Aburub and Alnawas [17] used the TAM model to explore mobile learning adoption in Jordan. They found that cognitive gratification and ease of use are the primary factors for ensuring the adoption of mobile learning among students. While, factors like personal integrative gratification, hedonic gratification and perceived usefulness are not significant in the adoption process of mobile learning.

Some authors have used other models, for example, Almaiah and Alismaiel [9] used the Technology Acceptance Model (TAM) with the updated DeLone and McLean's model (DL&ML) to test the effect of three types of quality factors on mobile learning applications adoption. They indicated that quality of system, content and service had strong effect on motivating students to adopt and use mobile learning

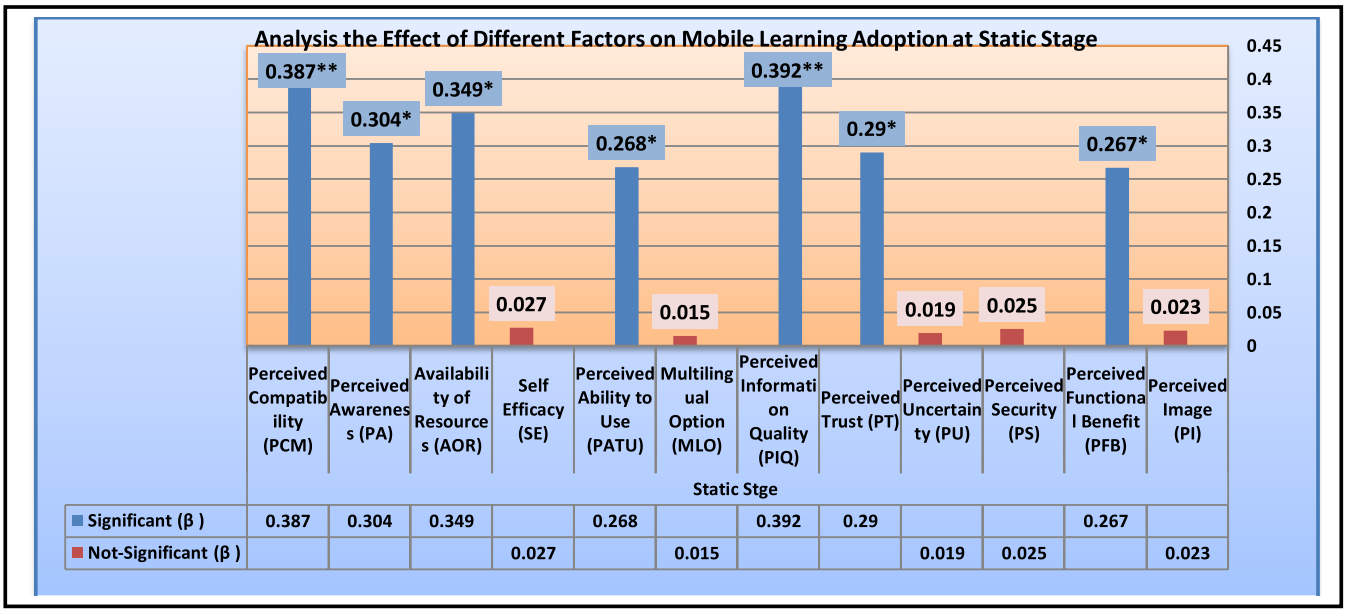

FIGURE 2. Results of path analysis for mobile learning adoption at static stage (MLA-S).

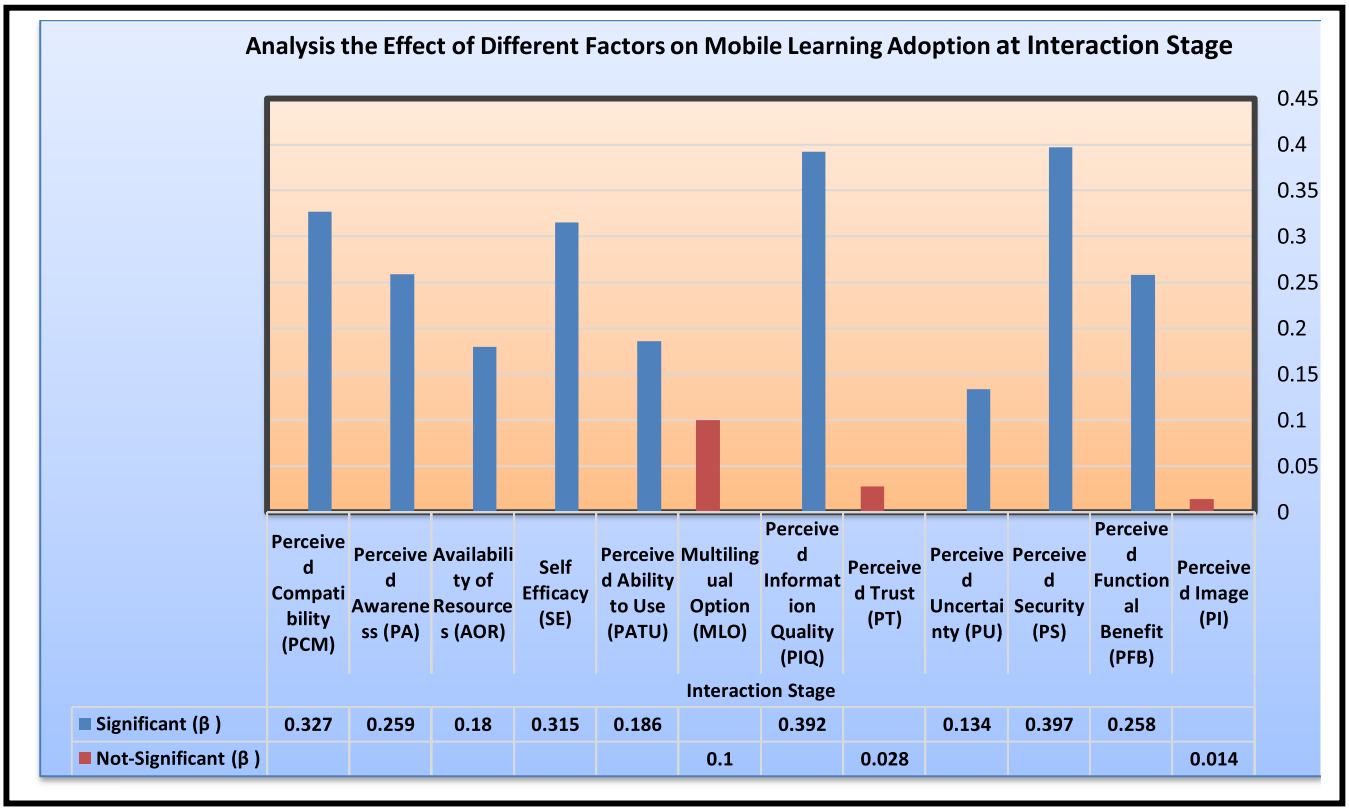

FIGURE 3. Results of path analysis for mobile learning adoption at interaction stage (MLA-I).

applications. Cheng [18] used TAM with IDT to predict the main factors of mobile learning adoption in Taiwan. Researchers found that three technological factors namely compatibility, convenience and navigation has a key role on enhancing the adoption and usage of mobile applications among students. In another study, Al-Shihi *et al.* [19]

TABLE 1. Description of mobile learning services at the three main stages.

Stages	Description
Static Stage	At the static stage level of mobile learning services, students and instructors can use mobile learning application by their accounts for accessing and checking their important information. For students, the application enable them to access and check their registration courses, date and time of courses, course grades, fees, university announcements, exam dates, assignments, and financial status. The mobile learning application enables faculty members to access to courses schedule, number of students in each course, financial and payroll information and see their salaries.
Interaction Stage	At the interaction stage level of mobile learning services, students and instructors through mobile learning application can download, fill and upload the required forms, update their information, download learning courses and upload assignments. Also, students through mobile learning application can communicate easily with instructors from anywhere regarding any queries using two-way communications such as e-mail and chat system. Then, instructors through mobile learning application can respond to their queries in timely response with up-to-date and authentic information.
Transaction Stage	At the transaction stage level of mobile learning services, through mobile learning application, instructors are able to open virtual classes, download the course materials, evaluate the homework and get the students' profiles from the system. The application also allows faculty members to upload documents, homework and notes during the class. On the other hand, students are able to register in the virtual classes, add and delete new courses, answer the quizzes and pay registration fees by connecting with their bank accounts through self-service technology, virtual interactions, security levels and tasks confirmation. Therefore, we observe that technical requirements and functional characteristics at the transactional stage is very different from static and interaction stage. Thus, users' requirements and perceptions is quite different from stage to other stage.

propose a model to investigate the main adoption determinants of mobile learning in Oman using TAM and UTAUT. The analysis results showed that enjoyment, efficiency learning, suitability learning, social learning and flexibility learning have significant effect on mobile learning adoption process.

Based on literature analysis of previous studies on mobile learning adoption, researchers found that these studies have not considered the essential factors that play an important role in the adoption of mobile learning in different stages of mobile learning services such as static stage, interaction stage and transaction stage. Consequently, the present study does not attempt to establish the theoretical framework and develop hypotheses based on the traditional technology adoption theories.

Unlike previous studies, in the current study, we proposed a unique model named MLAM in the mobile learning adoption context, which consists of three stages, namely, MLA (S) to reflect users' requirements at the static stage, MLA (I) for the interaction stage and MLA (T) for the transaction stage, to predict users' mobile learning applications adoption requirements and reveal the important factors that affect on users' adoption at the three stages of mobile learning services. Figure 1, presents the basic theoretical framework for MLAM model. Depending on the MLAM model, conceptual definitions of all constructs are revised for suitable with mobile-learning context and the causal relations are hypothesized. This is illustrated in Table 2.

The MALM model covers mobile learning adoption in several aspects like technology, system functions, security requirements and human factors. This research adopts several factors from the literature and applies them to the context of mobile learning adoption. The proposed factors in the MLAM model are (Perceived Compatibility (PCM), Perceived Awareness (PA), Availability of Resources (AOR), Self-Efficacy (SE), and Perceived Ability to Use (PATU), Multilingual Option (MLO), Perceived Information Quality (PIQ), Perceived Trust (PT), Perceived Uncertainty (PU), Perceived Security (PS), Perceived Functional Benefit (PFB) and Perceived Image (PI)). Therefore, MALM model can have potential to explore the effect of these factors on mobile learning adoption at the three stages of mobile learning services (static stage, interaction stage, and transaction stage).

III. RESEARCH METHODOLOGY

A. RESEARCH RESPONDENTS

In this study, the respondents are the students and instructors of Jordanian universities, from Information Technology School who have experience using and developing mobile learning apps. This research was conducted in three large public universities in Jordan namely, University of Jordan, University of Science and Technology and AL Yarmouk University. We selected the respondents from these universities because, first, they are the leading universities in terms of offering mobile learning services. Implementation of mobile learning services in these universities are very mature, and

TABLE 2. Conceptual definitions of all constructs and hypotheses.

Constructs	Conceptual definitions	Hypotheses
Perceived Compatibility (PCM)	The degree to which an mobile learning application is perceived as consistent with the needs and perceptions of potential users.	Perceived Compatibility (PCM) has a significant relation with Adoption of mobile learning
Perceived Awareness (PA)	The degree of users' consciousness through acquiring knowledge to be sufficient to learn the characteristics of mobile learning application, use it with skill, and realize its functions, advantages and disadvantages.	Perceived Awareness (PA) has a significant relation with Adoption of mobile learning
Availability of Resources (AVR)	Availability and freedom of using mobile devices, mobile applications and internet with competitive features such as speed, access and cost.	Availability of Resources (AOR) has a significant relation with Adoption of mobile learning
Self-Efficacy (SE)	The degree of users' technological capability to use, interact, and transact with mobile learning applications based on prior knowledge, experience, and skill as they perceive it is required to do so.	Self-Efficacy (SE) has a significant relation with Adoption of mobile learning
Perceived Ability to Use (PATU)	The degree to which a user perceives his/her competence in and comfortable ability for using mobile learning application technologically, organizationally, and psychologically that match with individual's values, social needs, and overall attitudes.	Perceived Ability to Use (PATU) has a significant relation with Adoption of mobile learning
Multilingual Option (MLO)	Mobile learning application supports different prime languages to facilitate users in viewing, searching, selecting, downloading, interacting, and transacting with their convenient language in the absence of human interaction	Multilingual Option (MLO) has a significant relation with Adoption of mobile learning
Perceived Information Quality (PIQ)	Information quality covers the extent to which complete, accurate, organized, understandable, up to date, and timely information is provided in mobile learning application for users to obtain information about any of their intended services	Perceived Information Quality (PIQ) has a significant relation with Adoption of mobile learning
Perceived Trust (PT)	A user`s confidence in the mobile learning application's ability to provide a reliable and efficient service	Perceived Trust (PT) has a significant relation with Adoption of mobile learning
Perceived Uncertainty (PU)	The degree to which users perceive risk in transactions due to uncontrollable and unknown situations in the virtual environment associated with mobile learning application	Perceived Uncertainty has a significant relation with perceived trust of mobile learning
Perceived Security (PS)	The degree to which users perceive that the level of data privacy and data integrity is an efficient, and ensure security for all electronic transactions and online identity authentication via mobile learning application.	Perceived Security has a significant relation with perceived trust
Perceived Functional Benefit (PFB)	The degree to which users perceive the overall functional benefits, including cost, time, efficiency, and effectiveness of using mobile learning application—instead of using traditional physical office functions.	Perceived Functional Benefit (PFB) has a significant relation with Adoption of mobile learning
Perceived Image (PI)	The degree to which users behaviorally and culturally perceive that adoption of mobile learning application enhances and improves social status and prestige	Perceived Image (PI) has a significant relation with Adoption of mobile learning

have different services in the static, interaction, and transaction stages. Thus, these universities can be viewed as the most focused universities for mobile learning application development in Jordan. Second, the usage rate of mobile learning applications (29.8%) is still very low, despite the maturity of services of mobile learning is very high in Jordanian universities according to the study conducted by Almaiah [1]. Since the main objective of this research is to explore

adoption factors and requirements of users at different stages of services offered by mobile learning application, these universities are assumed to help this research to fulfill the determined objectives.

To collect the data and test the model, the study was applied a survey (a self-administered questionnaire) of a broad diversity of students and instructors at different specializations of IT such as Computer Science, Information System and Software Engineering during the classrooms. The number of independent variables (20 samples per independent variable) for conducting structural equation modeling (SEM) analysis can determine according Stevens [20], the size of sample. Since the proposed model of this study consists 12 constructs, the number of respondents should be at least 240 in this study. Based on that, 355 questionnaires were distributed among students and instructors in the previously mentioned three universities in Jordan. 317 completed questionnaires were received, and 38 returned questionnaires were blank, showing a response rate of 89%.

B. INSTRUMENT MEASUREMENT

This section presents the instrument measurement items for all constructs (dependent and independent variables) of the proposed research model, which developed and adapted from previous studies on e-learning, Information Systems (IS) and IT expert opinions, as shown in Appendix A and B. For example, Perceived Trust, Perceived Information Quality, Perceived Awareness,, Availability of Resources, Perceived Ability to Use, Perceived Compatibility, Self-Efficacy and Perceived Security were adapted from [7], [22]. Perceived functional benefit, multilingual option, and perceived image were taken from [22], [23]. All questionnaire items were pre-evaluated by three faculty members from IT School, University of Jordan, who have expertise in analyzing and developing the information systems, and ten master students from the Information System and Software Engineering departments of University of Jordan who have extensive knowledge in using mobile learning applications to verify the structure, constructs, and respective measurement items of the questionnaire. The questionnaire also includes five questions that identify the demographics of participants. The questionnaire uses a five-point Likert scale ranging from 'Strongly Disagree' to 'Strongly Agree'. The five-point Likert scale is believed to be more accurate than the three-point scale (Adelson, Jill, & Betsy McCoach, 2010).

IV. DATA ANALYSIS AND RESULTS

In the analysis data process, several steps were conducted to ensure the reliability and validity of the data in order to get correct results. These steps involved examining the demographic data and conducting a reliability analysis to identify the consistency of the measurements. Two construct validity methods were performed; they were convergent validity and discriminant validity. Finally, structural equation modeling (SEM) analysis was done with SmartPLS version 3.0, to test the research model and hypotheses. The following sections will describe the data analysis techniques that were used in the analysis.

A. RELIABILITY ANALYSIS

Before conducting the primary analysis, the research instrument must be verified. A reliability analysis measures the consistency between items in the same construct using Cronbach's Alpha. Hair *et al.* [26], states that ideally a value of above 0.7 is required to be classed as highly reliable, and values between 0.6 and 0.7 are deemed to be acceptable. Table 3 shows the reliability values for all constructs was greater than 0.7, and that questionnaire is considered reliable.

B. CONVERGENT VALIDITY AND DISCRIMINANT VALIDITY ANALYSIS

In this study, the validity of constructs was assessed for convergent validity and discriminant validity. For the convergent validity, the results in Table 3 show that the average variance extracted (AVE) was above 0.5. Hair *et al.* [26], state that an acceptable level of variance is higher than 0.5.

For the discriminant validity analysis, the square root of AVE was taken to correlate the latent constructs. Table 4 shows that the square root of the AVE for all constructs is higher than the pairwise correlations. Therefore, the psychometric characteristics of the instrument are acceptable in terms of discriminant [27].

V. RESULTS OF PATH ANALYSIS OF CAUSAL

In the final step of the data analysis, this study has applied the SEM analysis to test the causal relationships in the proposed model, to test the effect of 12 constructs as independent variables (PCM, PA, SE, PATU, MLO, PIQ, PFB, PI, AVR, PT, PU, and PS) on mobile learning adoption at static stage (MLA-S), mobile learning adoption at interaction stage (MLA-I) and mobile learning adoption at transaction stage (MLA-T) as dependent variables. For analysing the collected data, path analysis of structural equation modelling was used. This kind of analysis method has been used in many previous researches such as mobile learning adoption [1] and e-learning adoption [21]. Therefore, this type of analysis method is suitable for this study. Based on that, the study used SEM to analyse the data for each of the three stages of mobile learning services.

A. PATH ANALYSIS OF CAUSAL RELATIONSHIPS AT STATIC STAGE (MLA-S)

Based on analysis of the results in Figure 2 for the effect of different factors on adoption of mobile learning at the static stage (MLA-S). The results revealed that unlike previous studies, perceived information quality (PIQ), perceived functional benefit (PFB), perceived trust (PT), and perceived ability to use (PATU) have a significant positive effect on mobile learning adoption at static stage (MLA-S). The results also showed that perceived compatibility (PCM), perceived awareness (PA), Availability of resources (AVR) are strong predictors for mobile learning adoption as static

TABLE 3. Results of reliability and convergent validity analysis.

Variables	Cronbach's Alpha (α >0.7)	Average Variance Extracted (AVE>0.5)
Perceived Compatibility (PCM)	0.91	0.74
Perceived Awareness (PA)	0.87	0.73
Self-Efficacy (SE)	0.86	0.70
Perceived Ability to Use (PATU)	0.92	0.77
Multilingual Option (MLO)	0.79	0.68
Perceived Information Quality (PIQ)	0.92	0.75
Availability of Resources (AVR)	0.89	0.72
Perceived Functional Benefit (PFB)	0.90	0.73
Perceived Image (PI)	0.77	0.65
Perceived Trust (PT)	0.92	0.76
Perceived Security (PSE)	0.86	0.71
Perceived Uncertainty (PU)	0.83	0.69

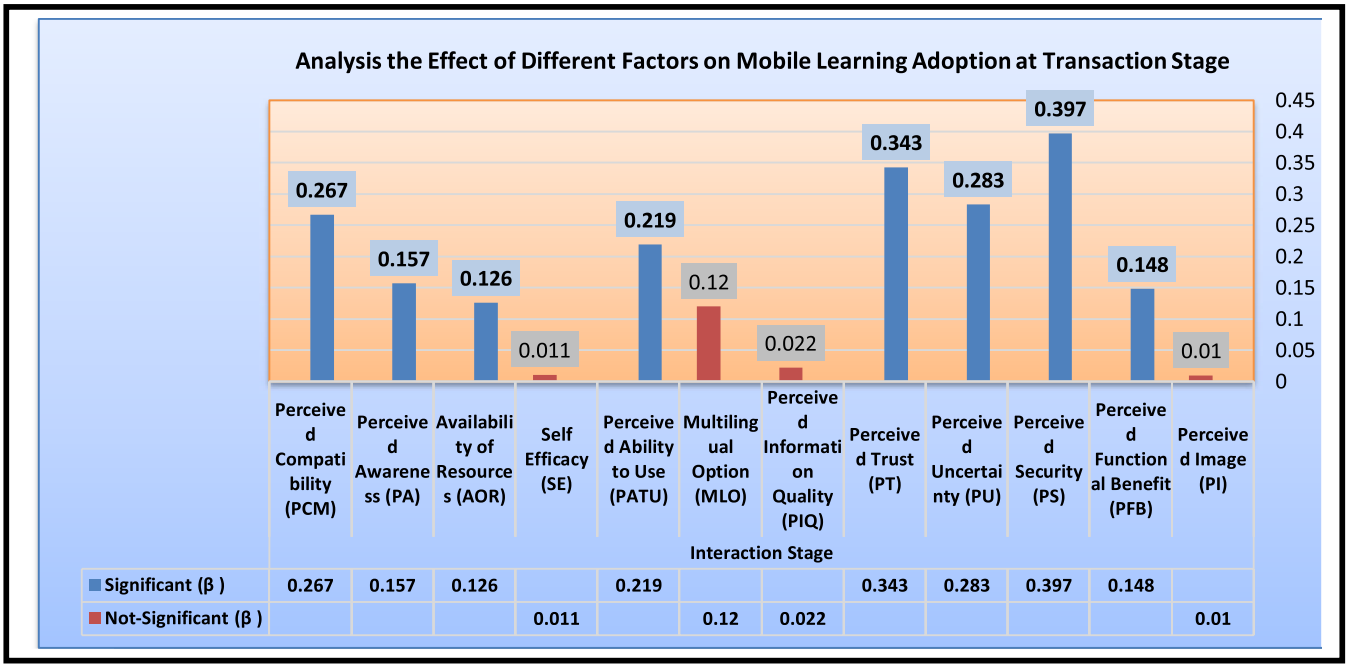

FIGURE 4. Results of path analysis for mobile learning adoption at transaction stage (MLA-T).

stage (MLA-S). While, the results found the effect of self-efficacy (SE), multilingual option (MLO) and perceived image (PI) on MLA-S were insignificant at 0.10 level. The seven significant variables PIQ, PFB, PT, PCM, PA, PATU and AVR explained 41.7% of variance in mobile learning services adoption at the static stage. Identifying users' perception about mobile learning adoption at different stages is an exploratory type study. Consequently, for this type of exploratory study, where users are responding based on their perception about any new technology, this percentage of variance explained by the independent variables is acceptable (Kline, 2005). This study was tried to propose a unique model that could not be completely exhaustive.

TABLE 4. Analysis of discriminant validity matrix.

Variables	PCM	PA	SE	PATU	MLO	PIQ	AVR	PFB	PI	PSE	PT	PU
Perceived Compatibility (PCM)	**0.89**											
Perceived Awareness (PA)	.445	**0.91**										
Self-Efficacy (SE)	.482	.377	**0.87**									
Perceived Ability to Use (PATU)	.473	.560	.439	**0.82**								
Multilingual Option (MLO)	.384	.445	.445	.473	**0.80**							
Perceived Information Quality (PIQ)	.566	.408	.482	.408	.377	**0.90**						
Availability of Resources (AVR)	.338	.502	.473	.445	.560	.377	**0.86**					
Perceived Functional Benefit (PFB)	.408	.384	.408	.408	.445	.560	.482	**0.81**				
Perceived Image (PI)	.502	.566	.502	.502	.482	.473	.473	.502	**0.88**			
Perceived Security (PSE)	.463	.338	.533	.445	.473	.377	0.772	.384	.502	**0.85**		
Perceived Trust (PT)	.560	.482	.455	.502	.408	.445	.566	.301	04.75	.408	**.088**	
Perceived Uncertainty (PU)	.473	.473	.459	.291	.502	.408	.338	.345	.421	.502	.560	**.092**

B. PATH ANALYSIS OF CAUSAL RELATIONSHIPS AT INTERACTION STAGE (MLA-I)

Figure 3 presents the analysis of the effect 12 constructs (PIQ, PFB, PT, PCM, PA, AVR, SE, PATU, MLO, PU, PSE and PI) on the adoption of mobile learning services at the interaction stage (MLA-I). The results in this study revealed that seven variables perceived compatibility (PC), perceived awareness (PA), perceived information quality (PIQ), availability of resources (AVR), perceived functional benefit (PFB), technological self-efficacy (SE) and perceived ability to use (PATU) explained 45.3% of variance of mobile learning adoption at the interaction stage. Also, other variables perceived trust (PT), perceived image (PI) and multilingual option (MLO), have not significant effect in adopting mobile learning services at the interaction stage. We also noted that some results are different in MLA-I in terms of the continuous effects of perceived compatibility (PC), perceived information quality (PIQ), availability of resources (AVR) and perceived functional benefit (PFB), unlike previous studies, PC, PIQ, PFB are the strongest predictors for MLA-I model. The results also showed that perceived security (PS) and perceived uncertainty (PU) have strong effect on perceived trust (PT) at interaction stage for mobile learning adoption.

C. PATH ANALYSIS OF CAUSAL RELATIONSHIPS AT TRANSACTION STAGE (MLA-T)

For the analysis of mobile learning adoption at transaction stage (MLA-T), a lot of variations from previous studies were revealed. First, variables of perceived compatibility (PC), perceived awareness (PA) perceived security (PS), perceived functional benefit (PFB), perceived uncertainty (PU) and perceived ability to use (PATU) are significant predictors for the adoption of mobile learning at the transaction stage. Second, these variables explained 57.5% of variance of mobile learning adoption at the transaction stage. Third, the results revealed that 4 variables PC, PA, PATU and PFB are the strongest factors for mobile learning adoption at all three stages. Fourth, perceived security (PS) is the strongest

predictor for the adoption of mobile learning services at this stage. Finally, there is strong relation between perceived security (PS) and perceived uncertainty (PU) with adoption of mobile learning through perceived trust (PT).

VI. DISCUSSION

So far, existing studies are mainly focused on determining the most critical factors for the adoption of mobile learning application services using traditional theories related to technology adoption models such as TAM, UTAUT, TRA and TPB and others [29], [30]. However, these studies have not considered the essential factors that play an important role in the adoption of mobile learning applications in different stages of mobile learning services such as static stage, interaction stage and transaction stage. Therefore, unlike previous studies, this research mainly focuses in predicting the main factors that affect users' adoption of mobile learning applications at the three main stages of mobile learning services (static stage, interaction stage and transaction stage). Findings of this study presents useful guidance for both researchers and practitioners to explain which critical factors should be considered at the three main stages of mobile learning application services adoption.

As we mentioned in Introduction section, each stage of the three stages of mobile learning services (static stage, interaction stage and transaction stage) has different functional assignments and different characteristics from other phase in terms of operation, technology, type of services and security features. Due to these differences among these stages, hence, requirements and perceptions of users also potentially differ from stage to stage in forming their attitude towards the adoption of mobile learning services.

Based on the results of this study that showed each stage of the three stages, static, interaction, and transaction has different requirements in terms of system compatibility, security, information quality, awareness and trust. Also the results demonstrated that the requirements and perceptions of users towards the adoption and use of mobile learning in the three stages significantly differ. In the following sections, the discussion of the results are presented in details.

A. A COMPARISON OF THE EFFECT OF DIFFERENT FACTORS ON MOBILE LEARNING ADOPTION AT THE THREE MAIN STAGES: STATIC STAGE, INTERACTION STAGE AND TRANSACTION STAGE

Based on the findings analysis of this study, Table 5 and Figure 5 present a comparison of the most important factors for mobile learning services adoption at the three stages-static, interaction, and transaction.

At the static stage, the most significant factors affecting adoption of mobile learning services were perceived information quality (PIQ), perceived functional benefit (PFB) perceived trust (PT), perceived ability to use (PATU), perceived compatibility (PCM), perceived awareness (PA), and availability of resources (AOR). For example, to access and view important information through mobile learning application account, learners' awareness about benefits of this new service and how to achieve the functional benefits from this service are logically a driving forces for adoption of mobile learning services at the static stage. In addition, information accuracy, information availability from anywhere and accessibility at any time with expected efficiency via mobile learning application are the prime concerns of learners to motivate them to use this new application. Also, trust and system compatibility with their needs are also important for them at this stage of service. Figure 2 presents the results of the important factors of the mobile learning adoption at the static stage (MLA-S) model.

At the interaction stage, perceived compatibility (PC), perceived awareness (PA), perceived information quality (PIQ), perceived functional benefit (PFB), technological self-efficacy (SE) and perceived ability to use (PATU) are the most important factors in affecting users' adoption of mobile learning services. In this stage, students can communicate easily with instructors from anywhere regarding any queries using two-way communications such as e-mail and chat system instead of going to the instructor office physically. Then, the instructor can respond to their enquires in timely response with up-to-date and authentic information. Hence, the importance of perceived compatibility (PC), self-efficacy (SE) and perceived information quality (PIQ) in facilitating the two-way communications through responding the user's needs anywhere and anytime, this will create high compatibility among students to adopt mobile learning at this stage. Also, similar to static stage, information accuracy and availability is the key concern for students to use this mobile technology driven virtual environment.

In addition, perceived awareness (PA), perceived functional benefit (PFB), and perceived ability to use (PATU) are contributing factors in this stage. The results suggest that when students have the necessary knowledge about the benefits of use this new application, and they have ability to send any queries and receive service through the interaction with instructors by using mobile learning application, and perception of relative advantages for this new application, are significant predictors in order to increase students' adoption of mobile learning application at this stage.

The results also indicated that perceived trust (PT), perceived image (PI) and multilingual option (MLO), have not significant effect in adopting mobile learning services at the interaction stage. In past years, students has a prestige when they have and use mobile devices; however now in 2019, mobile devices like smart phones have become very common among people, hence, it has lost its conspicuous characteristic. Unlike static stage, the results showed that perceived security (PS) and perceived uncertainty (PU) have strong effect on perceived trust (PT) in interaction and transaction stages. Figure 3 and 4 presents the results of the important factors for the adoption of mobile learning services at the interaction stage (MLA-I) model and at the transaction stage (MLA-T) model.

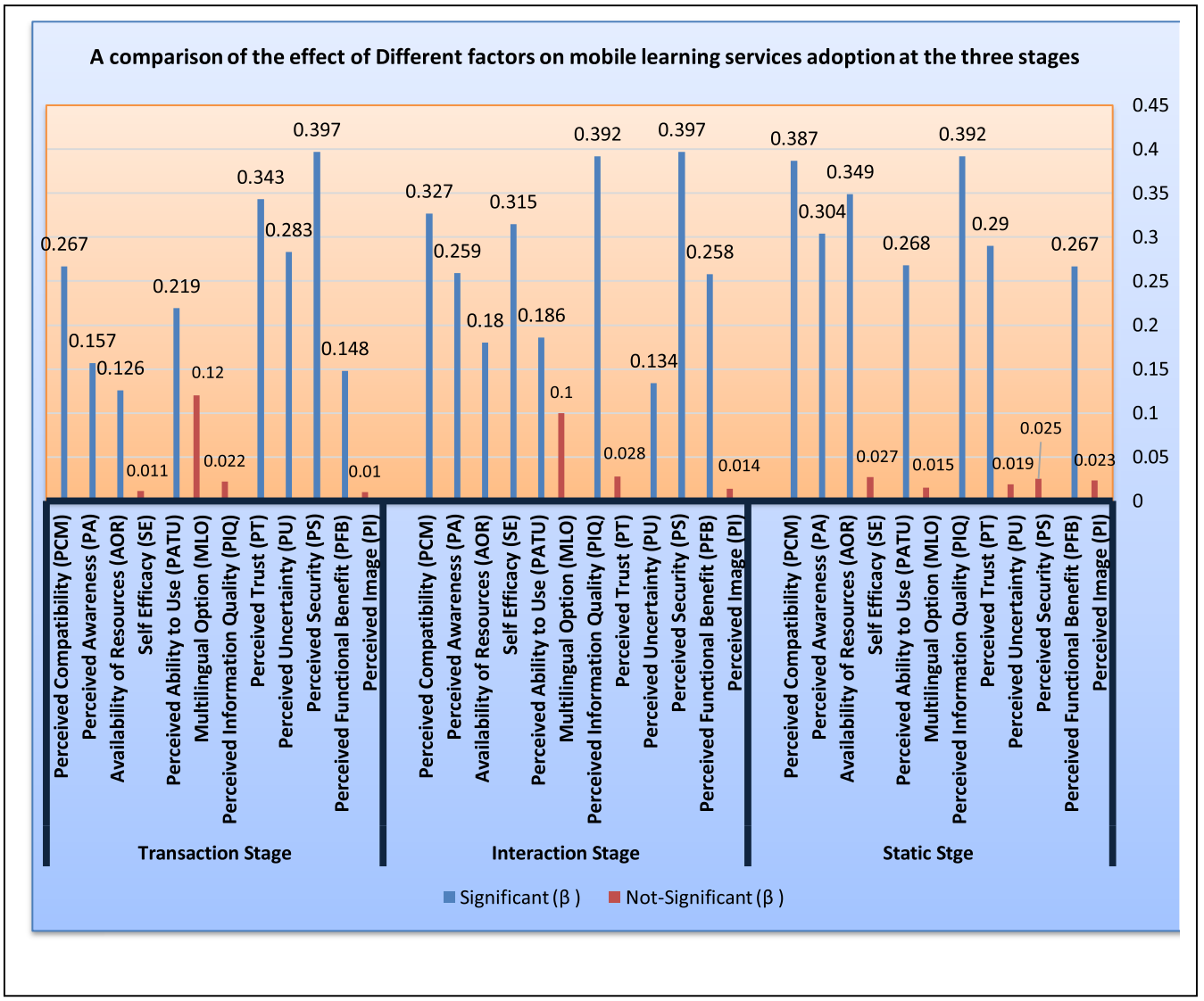

FIGURE 5. Results of a comparison of the different factors for mobile learning services adoption at the three stages- static, interaction, and transaction.

B. THEORETICAL AND PRACTICAL IMPLICATIONS

Although, there are many studies conducted that determine the adoption of mobile learning, little consideration has been paid to explore the main factors that influence the adoption of mobile learning applications at the three main stages of mobile learning services (static stage, interaction stage and transaction stage). In addition, existing literature do not have a comprehensive framework about important factors for adopting mobile learning services at static, interaction and transaction stages. Therefore, for theoretical and practical implications, this study is among the first on mobile learning adoption that provides useful guidance for both researchers and practitioners to explain which critical factors should be considered at the three main stages of mobile learning application adoption.

This research made a significant contribution, through proposing an integrated model namely, MLAM model, that allow researchers to investigate new factors contributing the adoption of mobile learning services adoption at the three different stages. Unlike previous studies, most researchers studied mobile learning adoption from other models such as TAM, TAM2, UTAUT etc. [28], [29], while less attention was accorded to the MLAM model in the mobile learning context. Therefore, the researcher proposed MLAM model in order to cover all aspects of mobile learning application services adoption.

Moreover, this study can be a great reference for researchers, which will enable them to get better acquainted with the key aspects of the mobile learning services adoption in Jordanian universities, through the findings of this study. Therefore, all solutions and technical issues with regards to the implementation of mobile learning services are easily understandable, making them useful, more effective, and reliable. The findings indicated how the users trust the

TABLE 5. Results of a comparison of the different factors for mobile learning services adoption at the three stages- static, interaction, and transaction.

Factors	Impact of factors on mobile learning services adoption at the three stages		
	Static stage	Interaction stage	Transaction stage
Perceived Compatibility (PCM)	**Significant (√) (β=0.387**)**	**Significant (√) (β=0.327**)**	**Significant (√) (β=0.267*)**
Perceived Awareness (PA)	**Significant (√) (β=0.304**)**	**Significant (√) (β=0.259*)**	**Significant (√) (β=0.157*)**
Availability of Resources (AVR)	**Significant (√) (β=0.349**)**	**Significant (√) (β=0.118*)**	**Not-Significant (√) (β=0.126*)**
Self-Efficacy (SE)	**Not-Significant (×) (β=0.027)**	**Significant (√) (β=0.315**)**	**Not-Significant (×) (β=0.011)**
Perceived Ability to Use (PATU)	**Significant (√) (β=0.268*)**	**Significant (√) (β=0.186*)**	**Not-Significant (√) (β=0.219*)**
Multilingual Option (MLO)	**Not-Significant (×) (β=0.015)**	**Not-Significant (×) (β=0.010)**	**Not-Significant (×) (β=0.012)**
Perceived Information Quality (PIQ)	**Significant (√) (β=0.392*)**	**Significant (√) (β=0.392**)**	**Not-Significant (×) (β=0.022)**
Perceived Trust (PT)	**Significant (√) (β=0.0290*)**	**Not-Significant (×) (β=0.028)**	**Significant (√) (β=0.343**)**
Perceived Uncertainty (PU)	**Not-Significant (×) (β=0.019)**	**Significant (√) (β=0.134*)**	**Significant (√) (β=0.283*)**
Perceived Security (PS)	**Not-Significant (×) (β=0.025)**	**Significant (√) (β=0.397**)**	**Significant (√) (β=0.397**)**
Perceived Functional Benefit (PFB)	**Significant (√) (β=0.267*)**	**Significant (√) (β=0.258*)**	**Significant (√) (β=0.148*)**
Perceived Image (PI)	**Not-Significant (×) (β=0.023)**	**Not-Significant (×) (β=0.014)**	**Not-Significant (×) (β=0.010)**
Value of R^2 at three stages	**R^2 = 0.417**	**R^2 = 0.453**	**R^2 = 0.575**

mobile learning application based on a significant correlation between the perceived security and perceived uncertainty and perceived trust factors with adoption of mobile learning, and hence universities should exploit this advantage by providing accurate, clear, complete and current information, and to open online communication 24/7 with students, to answer all their inquiries regarding any learning services via mobile learning application. Such a policy will enhance students' satisfaction and increase confidence in the service provider. Furthermore, the quality of information, compatibility, availability of resources and perceived security factors will provide greater reliability in order to perform online learning activities through the mobile learning application. Although there is no issue with regard to the system security, according to the case study, the mobile application designers should ensure more advanced security standards through laws and legislations, to maintain a positive relationship with users.

Furthermore, important factor was discovered through the proposed model for mobile learning adoption, which related to training and awareness sessions. The findings suggest that universities need to pay attention to awareness sessions as a means to motivate students and instructors to use mobile learning application, and to use the mobile social media applications to promote the importance of mobile learning in future. Finally, the findings also suggest that technological self-efficacy is found to be a significant predictor of mobile

TABLE 6. Measurement items.

Construct	Items	Sources
Perceived Compatibility (PCM)	1. The mobile learning application is appropriate for my needs.	[7], [22]
	2. The mobile learning application fits well with the way that I like to get learning services.	
	3. I like virtual interaction with mobile learning application better than personal interaction with physical offices.	
	4. The mobile learning application fits well with the way that I like to interact.	
Perceived Awareness (PA)	5. I am aware of mobile learning application.	[22], [23]
	6. I know the benefits of using mobile learning application.	
	7. I have gone through training programs about the overall features of mobile learning application	
	8. I have known through social media about the overall features of mobile learning application	
Self-Efficacy (SE)	9. I have qualifications to use and operate a mobile learning application.	[22], [23]
	10. I have qualifications to use and operate mobile learning application via the internet.	
	11. I have skills in using mobile learning applications.	
	12. I am confident of using mobile learning applications.	
Perceived Information Quality (PIQ)	13. Information provided at the mobile learning application is up-to-date.	[7]
	14. Information provided at the mobile learning application is easy to understand.	
	15. The mobile learning application provides all relevant information necessary to fulfil my needs.	
	16. The mobile learning application provides accurate information about the services it provides.	
	17. The mobile learning application clearly provides the policies of the university related to the functions of the application.	
	18. The mobile learning application provides sources of related additional information.	
Availability of Resources (AVR)	19. I have adequate mobile internet connection to use mobile learning application from anywhere.	[7], [23]
	20. The Internet connection I use through my mobile phone is not costly.	
	21. I always have access to a high-speed Internet connection from anywhere through mobile phone to use mobile learning.	
Perceived Ability to Use (PATU)	22. Learning to interact with mobile learning services application is easy for me.	[22], [23]
	23. It is easy to navigate mobile learning services application.	
	24. Interactions with mobile learning services application are clear and understandable.	
	25. I can easily do my learning activities while using the mobile learning services application.	
Perceived Security (PSE)	26. Mobile learning application is safe to interact with for financial purposes.	[7], [23]
	27. Mobile learning application protects information about my account information.	
	28. Mobile learning application does not share my personal information with other sites.	
Perceived Image (PI)	29. Users who use mobile learning application have a high profile.	[22], [23]
	30. Users who use mobile learning application have more prestige than those who do not.	
	31. Interacting with mobile learning application enhances a person's social status.	
Multilingual Option (MLO)	32. Availability of native language (Mother language) option on mobile learning application could help to perform tasks better.	[22], [23]
	33. Availability of native language (Mother language) option on mobile learning application could make performing tasks easier.	
	34. Without getting the native language option (Mother language), I cannot understand my tasks on mobile learning application.	
Perceived Functional Benefit (PFB)	35. It is important to use mobile learning application from anywhere convenient for me.	[22], [23]
	36. It is important to use mobile learning application at any time convenient for me.	
	37. Using mobile learning application enhances overall efficiency of my desired tasks.	
Perceived Trust (PT)	38. The mobile learning application is, overall, reliable.	[7]
	39. What I do through this mobile learning application is guaranteed.	
	40. The mobile learning application is reliable	
	41. The university takes full responsibility for any type of insecurity during interaction/transaction at the mobile learning application.	
	42. Legal and technological policies of the mobile learning application adequately protect me from problems on the internet.	
Perceived Uncertainty (PU)	43. Interaction with mobile learning application is unmanageable due to the absence of direct personnel.	[22], [23]
	44. Interaction in the mobile learning t application as an virtual environment is uncomfortable.	
	45. Outcome from the interaction with mobile learning application is uncertain due to the absence of direct personnel.	

TABLE 7. Measurement items.

Constructs	Items	Stages Description
Mobile Learning Adoption at Static stage (MLA-S)	46. To view/access account related information, I like to use mobile learning application in future.	Decision to adopt and use mobile learning application to access and check important information such as registration courses, date and time of courses, course grades, fees, university announcements, exam dates, assignments, and financial status.
	47. To download forms for account related functions, as the user requires, I like to use mobile learning application in future.	
Mobile Learning Adoption at Interaction stage (MLA-I)	48. To contact/make query/e-mail, I use mobile learning application.	Decision to adopt and use mobile learning application to interact easily with instructors from anywhere regarding any queries using two-way communications such as e-mail and chat system. Then, instructors through mobile learning application can respond to their queries in timely response with up-to-date and authentic information.
	49. To contact/make query/e-mail, I like to use mobile learning application in future.	
	50. To get learning service, I use mobile learning application.	
	51. To get customer service, I like to use mobile-government application in future.	
Mobile Learning Adoption at Transaction stage (MLA-T)	52. To pay fees, as the user requires, I use mobile learning application.	Decision to accept and use mobile learning application to open virtual classes, download the course materials, evaluate the homework and get the students' profiles from the system. Students are able to register in the virtual classes, add and delete new courses, answer the quizzes and pay registration fees by connecting with their bank accounts through self-service technology, virtual interactions, security levels and tasks confirmation.
	53. To pay fees, as the user requires, I like to use mobile learning application in future.	

learning adoption. Accordingly, this study confirms the findings of the previous research on the importance of IT skills among students and instructors, and those who suffer from such skills should be paid attention to remove any barriers that prevent the successful adoption of mobile learning application.

VII. CONCLUSION

The current research mainly focused on adoption of mobile learning application services based on the three stages namely: static (where users can only use mobile learning applications by their accounts for accessing and checking their important information such as registration courses, date and time of courses, course grades, fees, university announcements, exam dates, assignments, and financial status), interaction (where students and instructors through mobile learning application can download, fill and upload the required forms, update their information, download learning courses and upload assignments. Also, students through mobile learning application can communicate easily with instructors from anywhere regarding any queries using two-way communications such as e-mail and chat system), and transaction (where users can able to open virtual classes, download the course materials, evaluate the homework and get the students' profiles from the system. The application also allows faculty members to upload documents, homework and notes during the class. On the other hand, students are able to register in the virtual classes, add and delete new courses, answer the quizzes and pay registration fees by connecting with their bank accounts).

Since each stage of the three stages of mobile learning services (static stage, interaction stage and transaction stage) has different functional assignments and different characteristics from other phase in terms of operation, technology, type of services and security features. Due to these differences among these stages, hence, requirements and perceptions of users also potentially differ from stage to stage in forming their attitude towards the adoption of mobile learning services. Based on the results of this study that showed each stage of the three stages, static, interaction, and transaction has different requirements in terms of system compatibility, security, information quality, awareness and trust. In addition, the results demonstrated that the requirements and perceptions of users towards the adoption and use of mobile learning in the three stages significantly differ.

This research adds important contributions to existing research into mobile learning services adoption through the following results. First, at the static stage, the most significant

factors affecting adoption of mobile learning services were perceived information quality (PIQ), perceived functional benefit (PFB) perceived trust (PT), perceived ability to use (PATU), perceived compatibility (PCM), perceived awareness (PA), and availability of resources (AVR). Second, at the interaction stage, perceived compatibility (PC), perceived awareness (PA), perceived information quality (PIQ), perceived functional benefit (PFB), technological self-efficacy (SE) and perceived ability to use (PATU) are the most important factors in affecting users' adoption of mobile learning services. In addition, perceived awareness (PA), perceived functional benefit (PFB), and perceived ability to use (PATU) are contributing factors in this stage. The results suggest that when users have the necessary knowledge about the benefits of use this new application, and they have ability to send any queries and receive service through the interaction with customer service by using mobile learning application, and perception of relative advantages for this new application, are significant predictors in order to increase students' adoption of mobile learning services at this stage.

The results also indicated that perceived trust (PT), perceived image (PI) and multilingual option (MLO), have not significant effect in adopting mobile learning services at the interaction stage. Finally, variables of perceived compatibility (PC), perceived awareness (PA) perceived security (PS), perceived functional benefit (PFB), perceived uncertainty (PU) and perceived ability to use (PATU) are significant predictors for the adoption of mobile learning at the transaction stage.

APPENDIXES

APPENDIX A

See Table. 6.

APPENDIX B

See Table. 7.

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