The Influence on Mobile Learning: Mobile Learning Contents, Higher Education Institutes, and Communication Technology

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***Abstract*— In the present era, mobile learning has secured a better position in modern technology base learning paradigms. It surpasses other conventional learning methods because of ubiquity, mobility, attractive content, facilitated connectivity, and institutional engagements. The main objective of this study is to identify how mobile learning content, higher education institute, and communication technology factors influence learners and teachers when using sustainable mobile learning in higher education. Through the literature review, we developed three separate impact models i.e. mobile learning content, higher education institute, and communication technology with separate impact factors. We used pre and post usage survey questionnaires of 60 teachers and 60 learners to evaluate these models. Primarily, they were asked to fill the pre-usage questionnaire with their initial mobile learning experience. Then, they were allowed to use the modified Moodle mobile app and asked to fill the post-usage questionnaire. The results reveal that the most significant influencing factors are, ease of use in mobile learning content, and facilitating conditions for higher education institutes and communication technology models. Finally, we can conclude that users prefer to have easy to use mobile learning content with better service facilities in higher education institutes and communication technologies.**

Keywords*— *Mobile learning, Higher education, Mobile base teaching, Teacher perspectives, Learner perspectives

I. INTRODUCTION

Over the past decade, mobile learning (m-Learning) has been developing and m-Learning has received much attention because it facilitates the learner and teacher to pursue academic activities from a distance, on the way, or anywhere, at any-time [1]. On the other hand, the modern smartphone serves as a multi-purpose gadget that can act as a high-end mini-computer, telephone, or high-end camera which is ideal for learning. Today the number of smartphone users have grown unexpectedly and has now surpassed half of the world's population [2]. Also, the development of m-Learning apps are improving day by day. Similarly, plenty of free online courses offering mobiles, enable websites available (i.e., www.edX.org, www.mooc.org). They offer learners thousands of free courses in various disciplines in a bearable and bendable way to qualify the latest talents and to improve livelihood. A massive number of learners converge to these study programs as they are flexible in terms of time and location [3]. In-state or private sector higher education institutes (HEIs) are also now offering such online courses by considering factors such as technology advancement, the flexibility of learner and teacher, and shortage of time available for learner to pursue studies [4]. Some HEIs offer study programs in dual-mode which enable the learner to do academic activities both in class (i.e. lab experiments, exams, etc.) and out of class (i.e. joining video, chats, etc) in a flexible manner [5]. Hence, learning through a mobile device is a challenge for the learner. Similarly, providing teaching services through a mobile device is a challenge for HEIs as well. This is because, mobile applications require the need to comply with various factors such as screens size (i.e. smartphone, tabs, etc.), mobile platforms (iOS, Android, etc.), learner's satisfaction, learning items (i.e. video, audio, etc.). Therefore, various learner and teacher influencing factors in mobile learning content need to be considered at the app development stage. Moreover, HEIs need proper delivery of content and they have to consider various facts when providing teaching services to learners. Such as change the strategies suitable for off-campus learners, methods of conducting exams, what facilities should be given to learners and staff, their infrastructure capabilities and further improvements, staff development, etc. [6]. Furthermore, communication technology is the other vital factor as m-Learning is dependent on the internet facility other than the devices. Both learner and service provider require an optimal data connection for effective learning [7]. The main objectives of this study are investigating influencing factors for learner and teacher to (i) use mobile learning content, (ii) get service from HEI in m-Learning, (iii) use communication technology in m-Learning.

Fig. 1. Models association diagram

II. LITERATURE REVIEW

In m-Learning, mobile learning content is important for providing maximum service to learners. Therefore, researchers have been doing various studies to fulfill the various gaps in m-Learning and adopt emerging new trends. M-Learning applications provide various facilities for learners to carry on academic activities. These facilities can be grouped as facilitating conditions. In literature, various researches can be found associating with the facilitating conditions. Multimedia can be incorporated with content as an education tool. User interest, experience, and performance are prioritized when creating multimedia content for mobile devices. The learners' interest affects learning achievements [8]. Edutainment is considered as a new approach in m-learning

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serving learners' education through entertainment. In [9], the authors proposed an authoring tool for developing complex edutainment content with ease. It supports diverse pedagogical methods. Skilled users create edutainment items with the help of different concepts integrated into the authoring tool. Mobile-friendly Navigations are very important for retrieving learning content. Learners prefer to have simple menu items while short video guides are useful for effective navigation in mobile content. Difficulty scrolling through the device can affect the access of invisible content on the screen. Therefore, it is recommended to divide lengthy content into several manageable fragments [10]. One-click on a contact number or email address is an efficient way to communicate via mobile content [11]. Ease of use is another factor influencing the learner to pursue academic tasks with m-Learning. [12] investigated that user-friendly m-Learning content is most influential in pursuing academic activities using m-Learning. Flexible use of devices and collaborative connections with peers is important. However, learners' technical soundness is not important. Interactivity gains learner enthusiasm. Collaborative learning is a powerful learning mechanism to share learning content socially by peer groups [13]. Authentication is an important factor for educators and it certifies the accuracy, security, and ownership of the shared content. Proper authenticated content can't be modified by an unauthorized person. This enhances learners' belief in the learning content. Authenticate with security for content and user details, privacy with exposing personal data publicly, are restricting m-Learning usage. While content quality and trust are enhancing m-Learning [14].

HEIs are responsible for conducting m-Learning activities. Various research related to this is available in the literature. M-Learning activities of a HEI are done according to its m-Learning policy. United Nations Educational, Scientific, and Cultural Organization (UNESCO) presents guidelines for creating institutional policies for the optimal use of m-Learning. Because most of the existing policies were developed before the modern mobile era, some main ideas are proposed to include in policies such as educator and content development, better data connectivity, ensure own device usage, encourage health concerns, and awareness [15]. In [16], the author researched to explore changes and trends which uplifts m-Learning and gaining policymakers and researchers to act together to enhance m-Learning. HEI itself has various facilitating conditions that help m-Learning users. The authors [17] researched to compare facilitating conditions between two HEIs in developed and developing countries. They found that the facilitating conditions in developed countries were considered to be in a better position, but an all-time internet connection wasn't at an optimal state. Another research reveals that learners of a developing country have positive feelings for m-Learning, but they need better-facilitating conditions to have a satisfaction level of m-Learning [18]. In [6], the authors urge that most HEIs are unable to conduct m-Learning due to insufficient facilitating conditions, technical infrastructure, supporting staff, instructional or m-Learning content design, and policy.

Communication technology (CT) is vital form-Learning and various researches are being conducted for continuous development in CT. In m-Learning, learners, educators, and HEIs have to bear the cost of CT. M-Learning service providers can reduce costs by using cloud computing. Also, cloud computing enables institutes to upgrade learning systems and resources economically by selecting new packages with advanced learning services [19]. Reference [20] investigated that cost for the device and institutional data connection are unbearable for learners and recommended that institutional policy should address this matter. Connectivity is one of the main factors in m-Learning which needs to be researched further to improve its security, reliability, and robustness. In [7], the author explored that the download and upload speed, latency, jitter, and packet loss metrics in data connection in a HEI are fitting to m-learning service standards, but the average internet failure rate is high. So it is a burden for smooth m-Learning. Mobile cloud computing is one of the latest concepts associated with m-Learning. Therefore, a robust and secured data connection prevents hacking and losing data while storing and retrieving it [21].

III. IMPACT MODELS AND HYPOTHESES

The impact models for mobile learning content, higher education institute, and communication technology are proposed for describing the impact factors for teachers and learners to use mobile learning content, higher education institute, and communication technology inapplicable and sustainable mobile learning framework in higher education. According to literature, five observed variables are identified as impact factors in the proposed model for mobile learning content i.e. Facilitation conditions, Ease of Use, Interactivity, Authenticate, and Device independence- three observed variables are identified as impact factors in the proposed model for higher education institutes i.e. Policy, Facilitating conditions, and Acceptance of change, and three observed variables are identified as impact factors in the proposed model communication technology i.e. Cost, Connectivity, and Facilitating conditions. The operationalization of proposing these models as follows. First identified more than fifty effective factors for mobile learning content, higher education institute, and communication technology by studying the previously done mobile learning related researches. Then each effective factor is categorized under observed variables of each impact model by considering their similarities.

A. The impact model for mobile learning content

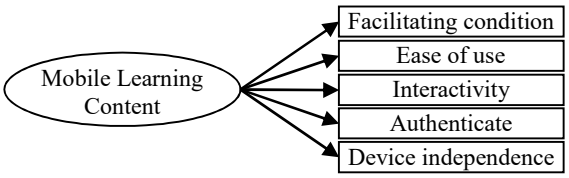

Fig. 2. Proposed impact model for mobile learning content adoption

1) Facilitation Conditions: Multimedia content creation is prioritized by interest, experience, and performance of the user, and the learner interest affects learning achievements [8]. Complex edutainment content integrates different pedagogical methods and concepts [9]. In mobile navigations, simple menu items and video guides are useful, and tables make troubles. In content, three clicks and manageable fragments are recommended, and Pdf documents are less useful. Thinner and classified content, word limitation, highlighted keywords, and lite images are preferred for quick information retrieval. The same font style maintains neatness and enhances learner's sensitive linkage with the content. Bold fonts with appropriate indentation emphasizes specific content. Hyperlink headings are properly alerted what receive by clicking it [10].

H11: Facilitation Conditions of the mobile learning content have an impact on teacher and learner to adopt applicable and sustainable mobile learning systems.

2) Ease of Use: User-friendly mobile learning content is most influential for a learner to carry on academic activities using m-Learning. Other important factors for a learner to use m-Learning are flexible use of devices and easy collaborative peer connection [12]. Easy to use m-Learning style makes for better satisfaction, optimal learning performance, and minimal cognitive loads [22]. Also, the maximum usability level is obtained with learning curiosity in m-Learning groups [23]. Usability includes the understandability, learnability, operability, and attractiveness of learning content.

H12: Ease of Use of mobile learning content affects teachers and learners to adopt applicable and sustainable mobile learning systems.

3) Interactivity: Collaborative learning can be a powerful learning mechanism that utilizes individual mobile devices and share learning content socially among peers [24]. Interactive video-based learning in collaborative environments is a learning approach that gains less cognitive loading, high productive learning, and study enthusiasm [25].

H13: Interactivity of mobile learning content affects teachers and learners to adopt applicable and sustainable mobile learning systems.

4) Authenticate: Authenticate certifies the accuracy, security, and ownership of shared mobile learning content. Proper authenticated content prevents unauthorized alternations leads to enhancing belief for the learning content. Authenticate related factors such as security for content and user details, privacy-related matters such as exposing personal data publicly, are reasoning for restricting m-Learning usage. While content qualify and trust enhance the usage of m-Learning [14].

H14: Authentication of mobile learning content affects teachers and learners to adopt applicable and sustainable mobile learning systems.

5) Device independence: Responsiveness is important for screen size restriction. In, app designing, there are different device factors to be considered such as platform, screen size, technical feasibilities, and mobile technologies. Also, such designs are essential to suit learning styles and behaviors, and network properties on the learners' side [26]. Also, content adjustable with screen and holding style, fully occupied screen, simpler use, static or unsupportive application removal, platform-independent support application availability, and device-independent course instructions are important for device compatibility [10].

H15: Device independence of mobile learning content affects teachers and learners to adopt applicable and sustainable mobile learning systems.

B. Higher Education Institute

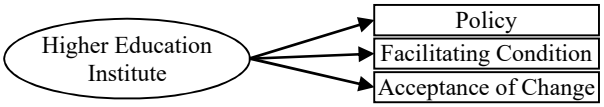

Fig. 3. Proposed impact model for Higher Education Institute adoption

1) Policy: Guidelines for creating institutional policies to optimal use of m-Learning in education are, educator development, content development, better data connectivity, ensure own device usage, encourage health concerns and awareness [15].

H21: Learning policy in the higher education institute affects teachers and learners to adopt applicable and sustainable mobile learning systems.

2) Facilitating conditions: Sufficient facilitating conditions such as technical infrastructure, supporting staff, instructional or m-Learning content design, and institutional policy for conducting m-Learning [6]. HEIs in developed countries need to maintain better technical facilities though they have decent m-Learning [17]. HEIs in developing countries need to maintain better-facilitating conditions though their learners are fit for m-Learning [18].

H22: Facilitating conditions in the higher education institute affects teachers and learners to adopt applicable and sustainable mobile learning systems.

3) Acceptance of Change: The resistance to change is a burden for adopting m-Learning [14]. Through the mobile game experience, educators identified the importance of m-Learning and they accepted smartphones as a tool in learning [27]. Consent of administrators in HEIs is important for m-Learning even though a well-prepared policy is implemented, and both learners and teachers prefer to carry on mobile-based academic activities. Therefore, admins are required to have a positive attitude toward m-Learning [28]. Systems require the fullest support from staff effective learning [29].

H23: Acceptance of Change in the higher education institute affects teachers and learners to adopt applicable and sustainable mobile learning systems.

C. Communication Technology

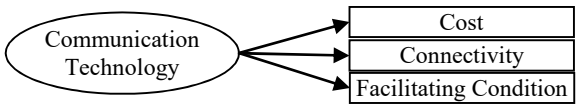

Fig. 4. Proposed impact model for Communication Technology adoption

1) Cost: Cloud computing can reduce m-Learning infrastructure service costs and it enables HEIs to upgrade services economically [19]. The institutional policy can solve cost-related problems in m-Learning such as cost for device and data [20].

H31: Cost for communication technology affects teachers and learners to adopt applicable and sustainable mobile learning systems.

2) Connectivity: Unstable data connection is a challenge for m-Learning activities. Sometimes geographical situations are the reason for this. Also download and upload speed, latency, jitter, and packet loss metrics are the network-related properties that need to be adhered to, with values recommended for m-Learning [7]. Mobile cloud computing-related services need robust and secured data connection to prevent hacking, losing data while storing and retrieving in m-Learning [21].

H32: Connectivity in communication technology affects teachers and learners to adopt applicable and sustainable mobile learning systems.

3) Facilitating Conditions: Communication technology is expected assistance for m-Learning facilities such as awareness, sharing, and facilitate technology (i.e. Wi-Fi). Learners expect assistance for Wi-Fi in a difficult-free environment [30]. HEIs need to provide cutting edge facilities such as mobile cloud computing to their learners. Mobile

cloud computing enables smart devices to connect cloud mobile database system stored when require. Then this connection reduces internal storage and memory requirements [21].

H33: Facilitating conditions in communication technology affect teachers and learners to adopt applicable and sustainable mobile learning systems.

IV. System Functions and Architecture

In this study, we implemented the proposed impact models for applicable and sustainable mobile learning using a modified Moodle mobile application (MMA). MMA is the mobile version of the Moodle open-source learning management system(LMS). It uses open source technologies such as HTML, PHP, JavaScript, ionic, and Cordova/PhoneGap framework [31]. Developing a new plugin or using the existing Moodle plugin for new functionality in MMA requires enabling mobile support for them by developing special PHP files in each plugin [32]. The mobile version of Moodle utilizes REST and HTTPS protocols, and web service API to communicate with a Moodle server through a JSON response, while HTTPS requests help for file movements.

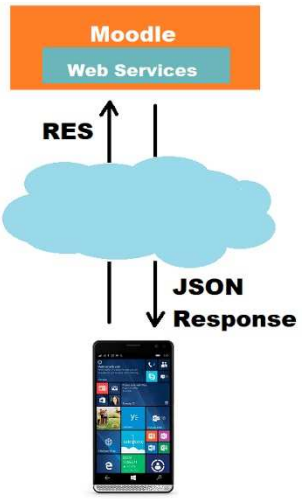

Fig. 5. Moodle mobile data exchanging mechanism

As MMA uses both features in the device and mobile operating system, it has two different versions for android and iOS. It consists of a web container included core libraries, plugins, and PhoneGap JS Plugins. All the app functions such as upload, participation, content, add a note, add content, chat, forum, etc., are done through plugins. We developed a few functionalities (i.e. PDF annotation, Games, Checklist, Hot question, etc.) [33] to the MMA by developing Moodle support files for existing plugins available for Moodle LMS.

V. Methodology

Exactly 60 learners and 60 teachers in the Faculties of Science, Commerce & Management, Social Sciences, and Humanities of the University of Kelaniya participated in this study. In this survey, three different survey questionnaires were developed for the three impact models i.e., mobile learning content, higher education institute, and communication technology. In this research, the same questionnaires were used in both pretest and post-test surveys. In the questionnaire for the mobile learning content impact model, 20 questions were used under five different dimensions i.e., facilitating conditions, ease of use, interactivity, authentication, and device independence. In the questionnaire for the higher education impact model, 12 questions were used under 3 different dimensions i.e., policy, facilitating conditions, and acceptance of the change. In the questionnaire for the communication technology impact model, 6 questions were used under 3 different dimensions i.e., cost, connectivity, and facilitating conditions. The five-point Likert scale ranging from -10 – strongly disagree, -5 – disagree, 0 – neutral, 5 – agree and 10 – strongly agree was used in the questionnaires. Initially, users were asked to respond to the three pre-test survey questionnaires of three impact models. Next, they were given the modified Moodle mobile app to work on for a few days. Finally, they were asked to respond to post-test questionnaires. From the above responses, 120 pairs of pre and post responses were selected for analysis. Mean values of bar charts and Anderson-Darling Normality Test were used as primary data analysis while the paired sample t-test and the correlation model with Pearson correlation coefficient were developed as advance data analysis.

VI. Results and Discussion

In the primary data analysis, Anderson-Darling Normality (ADN) test was conducted to overall post-test survey responses with the following data conversion on Likert scales (see table I).

TABLE I. Likert Scale Data Conversion

Questionnaire Answers	Value
Strongly Disagreed	-10
Disagreed	-5
Neutral	0
Agree	5
Strongly Agree	10

TABLE II. Likert Mean Interpretation

Likert Mean	Interpretation
Less than -5	The proposed system strongly rejected by the university education community
Between -5 and 0	The proposed system normally rejected by the university education community
0	Neutral
Between 0 and 5	The proposed system normally accepted by the university education community
Greater than 5	The proposed system strongly accepted by the university education community

TABLE III. Overall Post Responses

Model	Mean	P-value	Confidence Interval
ML content	6.4437	<0.005	6.2516, 6.6359
Higher Education Institutes	6.0000	<0.005	5.7425, 6.2575
Communication Technology	5.9097	<0.005	5.5328, 6.2866

The overall post responses mean in each model are within the confidence interval and P value <0.005. This implies that the university teachers and learners strongly accepted the mobile learning content in m-Learning, and are strongly satisfied with the facilities provided by the HEI and communication technology (see table II and III). The data set is normally distributed and can apply a parametric test on the data set. Means of each attribute of post responses for three models were calculated (see table IV).

TABLE IV. Means of Each Attribute in the Post-Test Survey

Model	Attribute	Mean
Content	Facilitation Conditions	5.719
	Ease of Use	7.021
	Interactivity	6.406
	Authenticate	6.635
	Device independence	6.438
Higher Education Institutes	Policy	5.365
	Facilitating Conditions	7.333
	Acceptance of change	5.302
Communication Technology	Cost	5.646
	Connectivity	5.708
	Facilitating Conditions	6.375

According to the results in table IV, the mean values of each attribute is greater than 5. This denotes that the university community accepted the mobile learning content, services provided by HEI and Communication technology in m-Learning with the modified MMA. Likewise, the attributes of each proposed model in mobile learning for teachers and learners were accepted.

As the data set is normally distributed (ADN test results) and number of data sets exceed 30, the paired sample t-test (parametric test) was applied to pre and post-data sets as an advance analysis. The hypothesis was set as follows in this test (see equation (1)).

$H_{X0} : \mu = 0$ VS $H_{X0} : \mu > 0$; where x=1,2,3 (1)

Where, H_{10}=Mobile learning content is not facilitated/ease of use/interactivity/authenticate/device independence for teacher and learner to adopt applicable and sustainable mobile learning.

H_{20} =HEI is not supported by policy/facilitated/acceptance of change for teachers and learners to adopt applicable and sustainable mobile learning.

H_{30}=Communication technology is not supported by cost/connectivity/facilitating conditions for teachers and learners to adopt applicable and sustainable mobile learning.

TABLE V. PAIRED SAMPLE T-TEST RESULTS

Model	Attribute	Mean	P-value
ML Content	Facilitation Conditions	5.719	0.000
	Ease of Use	7.021	0.000
	Interactivity	6.423	0.000
	Authenticate	6.423	0.000
	Device independence	6.438	0.000
Higher Education Institutes	Policy	5.365	0.000
	Facilitating Conditions	7.333	0.000
	Acceptance of change	5.335	0.000
Communication Technology	Cost	5.646	0.000
	Connectivity	5.708	0.000
	Facilitating Conditions	6.375	0.000

According to the paired sample t-test results, (see table V) p-value of each factor equal to 0.000 (<0.005). This implies that the Hx0 is rejected and Hx1 is accepted. Also that the mean value is greater than zero. Therefore, the results of the paired sample *t*-test denote that, each impact factor of three impact models have a positive effect on teacher and learner to adopt applicable and sustainable m-Learning.

Finally, the Pearson correlation coefficient was calculated to describe the correlation in the proposed impact models. The weight and counts were used for students' responses and the below rules were used to interpret the correlation coefficients (see Table VI)

TABLE VI. CORRELATION COEFFICIENT INTERPRETATION RULES

Correlation coefficient	Positive	Negative
0.0 – 0.3	No correlation	No correlation
0.3 – 0.5	Week positive correlation	Week negative correlation
0.5 – 1.0	Strong positive correlation	Strong negative correlation

$H_{X0}: \rho = 0$ vs $H_{X1} : \rho \neq 0$ where x=1,2,3 (2)

The above hypotheses tests were applied with p-values and these hypotheses were rejected at 0.05 significant levels when the test p-values were less than 0.05. The Pearson correlation coefficient test between student responses weight and counts calculated using MINITAB computer application for windows and results were summarized in Table VII.

TABLE VII. PEARSON CORRELATION COEFFICIENT TEST RESULTS

Model	Variable	Correlation	p-value
ML Content	Facilitation Conditions	0.907	0.034
	Ease of Use	0.916	0.029
	Interactivity	0.905	0.034
	Authenticate	0.896	0.040
	Device independence	0.892	0.042
Higher Education Institutes	Policy	0.904	0.035
	Facilitating Conditions	0.910	0.032
	Acceptance of change	0.907	0.034
Communication Technology	Cost	0.925	0.024
	Connectivity	0.931	0.021
	Facilitating Conditions	0.932	0.021

According to the test results, each p-value is less than 0.05 and denotes that the H_{X0} is rejected and H_{X1} is accepted. Therefore, it implies that each impact factor of three impact models have positive effects on teacher and learner to adopt applicable and sustainable m-Learning.

Also, each variable's correlation is greater than 0.5 and close to 1. According to the correlation interpretation rules, (see table VII) each latent variable of each impact model is strongly correlated with their observed variables. Finally, the proposed impact models with correlations were depicted in Fig. 6, 7, 8. The results reveal that the most significant factor for teachers and learners to use ML content in m-Learning is the ease of use, and to get services from HEI and communication technology are facilitating conditions.

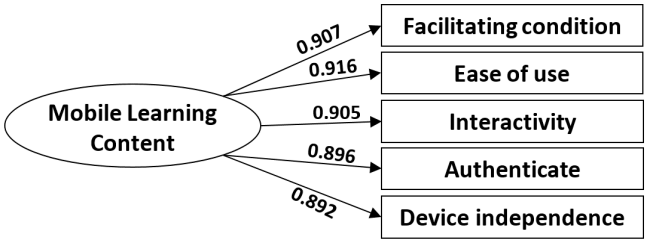

Fig. 6. Proposed impact model for ML content with correlations

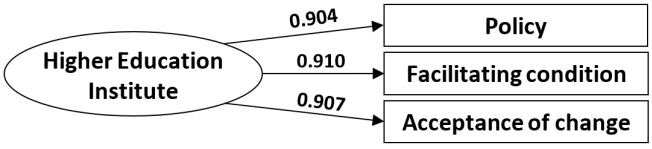

Fig. 7. Proposed impact model for HEI with correlations

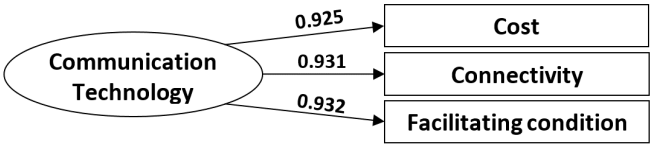

Fig. 8. Proposed impact model for CT with correlations

All impact factors of each model have higher correlation values close to 1. We can assume these correlation values which are close to one and mutually similar values to each factor. In this study, we used MMA which has very useful facilities and we also develop new features through plugins which help learner and teacher [33]. Since MMA has good facilitating conditions learners and teachers have a positive attitude to respond to questions asked under the factors in the m-learning content model such as facilitation conditions, ease of use, interactivity, authenticate, device independence [33]. Since we did this study in the learning environment at a leading state university, the learners and teachers were

strongly satisfied with learning conditions and they made positive responses to questions asked under the factors - policy, facilitation conditions, acceptance of change in the HEI impact model. However, we can't assume a similar output from other learning environments in different HEIs. In this study, most of the time learners and teachers used university Wi-Fi facilities. Therefore, they were able to work smoothly with the app and they had a positive attitude towards communication technology. However, these results are subjected to change in other learning environments.

VII. Conclusion and Implications

The main purpose of this study is to identify the factors that impact learner and teacher when using mobile learning content, higher education institute, and communication technology for applicable and sustainable mobile learning in higher education. Three different impact models were developed based on the literature review i.e. mobile learning content, higher education institute, and communication technology. In this study, 60 students and 60 teachers were asked to participate and they were able to use a modified Moodle mobile app. Anderson darling test and paired sample *t*-test were used to analyze the data. According to the survey results, the university community strongly accepted the mobile learning system which integrates the proposed impact models. The most significant factor of the mobile learning content model is 'ease of use' while 'facilitating condition' is the most significant factor of the other models, higher education institute and communication technology. However, the rest of the other observed variables of each impact model are also significant as they received close correlation values.

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