ISSN No:-2456-2165

Smartphone Usability Framework towards Self-directed Learning in University of Dar es Salaam

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Abstract:- Smartphone technology is among the most powerful technological breakthroughs to the level that most of the world's adult population relies on it daily. Despite being initially considered as destruction to learners in their studies, the advent of Covid-19 made lecturers and learners reconsider their stance against smartphones as it was used to ensure learning goes on outside the confines of the university. This study focused on developing a smartphone usability features framework towards self-directed learning in University of Dar es Salaam. Quantitative research design and survey research method were adopted for this study. A sample size of 392 respondents was used and this was obtained through stratified and simple random sampling techniques. The study used a questionnaire as the data collection tool. Quality of the questionnaire was ensured through both validity and reliability. The data collected were analyzed using descriptive, exploratory and inferential data analysis. The findings on the smartphones platform usability feature depicted that the learners' smartphones are compatible with different software, high degree of sensitivity and can be connected to the internet and other devices to facilitate self-directed learning. This study recommends smartphones to be integrated to the learning process to enhance self-directed learning among learners.

Keywords:- *Smartphone; smartphone usability; sensitivity; compatibility; connectivity.*

I. INTRODUCTION

Smartphones are among the most powerful technological devices of all time and their varied features have made them a very important part of the everyday routine for almost every person. More than half of the world's adult population rely on smartphones in day-to-day life (Andrews, Ellis, Shaw, & Piwek, 2015) and this has since influenced a new generation of technology-related research. They are recognized as essential tool of work, entertainment, learning, teaching among other activities (Kifumbu, 2018). Modern classes cannot be confined with the traditional bricks and mortar walls, the access to these classes can be done from anywhere and smartphone technology makes it possible for the learners of 21st century to be engaged in learning while being mobile.

Traditionally perceived as a tool of disruption to the learners, lecturers who did not allow its use in their lectures, had to reconsider their stance as numerous benefits of smartphone use in the lectures were evident (Thomas, O'Bannon, & Bolton, 2013). Beside, with the advent of Covid-19 which called for social distancing, (Innocent & Masue, 2020) and learning from home, most lecturers and learners resorted to use of e-Learning technologies like smartphones to ensure learning goes on (Chaundary, Khadka, Lamichhane, Dhakal, & Das, 2022).

With its unique features and characteristics, smartphones' use can make learning and teaching more meaningful and richer (Papadakis, 2018). In fact, Google is the new and improved replacement of Encyclopedia for users as a result of smartphone at their fingertips through which everything is available to be searched at any time (Mahesh, Jayahari, & Bijlani, 2016). Clayton and Murphy, (2016) consider smartphones as a regular accessory for classroom purpose and accounts educators responsible for giving learners the awareness towards understanding the potential of smartphone use for learning rather than perceiving it as a classroom distractor. Additionally, its convenience, portability, comprehensive learning experience, multiple sources, multitasking, and environmental friendliness makes students prefer using smartphones as learning aids (Anshari, Almunawar, Shahrill, Wicaksono, & Huda, 2017). This study focused on developing a smartphone usability features framework towards self-directed learning in University of Dar es Salaam.

II. LITERATURE REVIEW

A. Smartphone use for Learning

According to Barron and Kaye (2020), the use of technology and smartphones in education has exploded, and it has changed to meet the needs and tastes of different generations. Smartphones have improved in terms of compatibility, touch Sensitivity, processing power, and internet connectivity, allowing them to be successfully integrated into both classrooms and self-directed learning environments.

There is a strong link between self-directed learning and technology (Candy, 2004). The results of the study conducted by Rashid and Asghar (2016) showed that technology use may have a positive impact on the Self-Directed Learning. According to Boholano, Jamon, Cajes, and Boholano, (2021), students can use their smartphones to assist them improve and grow their academic performance. Furthermore, twenty-first-century students are competent at utilizing new technologies, such as using their smartphone to look up answers to their assignments, quizzes, and other forms of assessments. This means that self-directed learning students will be able to find more information about their courses and acquire new skills through the use of smartphones, resulting in improved performance.

With the smartphone, self-directed learners can collaborate and share the ideas. A study conducted by Ruvuta (2016) found that there is a strong relationship between usage of smartphones and self-directed learning at higher learning institution. Smartphones aid university students in communication, information access and sharing, engagement, and collaboration learning, allowing them to become self-directed learners, according to the study. The study also revealed that students use their smartphones to share information with their peers and friends via social media apps, e-mails, and Bluetooth. Learners can also use their smartphones to participate in group conversations, which aids in the acquisition of new information.

B. Smartphone Features that Support Self-directed Learning

It is necessary to look at the technical aspects of the smartphone being used by the student. These aspects can relatively have a contribution to the way the student uses the smartphone to learn and in turn affect their experience. The author B-Abee (2020) identified these characteristics which include the device’s internet connectivity, functionality, Compatibility, Sensitivity and screen size. Moreover, Anshari, Almunawar, Shahrill, Wicaksono, and Huda, (2017) revealed that due to reasons of its convenience, portability, comprehensive learning experience, multiple sources, multitasking, and environmental friendliness, students use smartphones as a learning aid. The other features of a smartphone include the phone function, camera, and mobile apps which offer different functionality.

C. Connectivity

In self-directed learning, the phone's capacity to connect to the internet is critical. Internet is required for accessing learning materials via a learning management system and looking for materials on the internet. Learners will be able to gain clarity on concepts they were unclear about from the learning resources by browsing. According to Kifumbu (2018) connectivity and bandwidth need to be considered when developing eLearning.

D. Compatibility

The capability of smartphones to accommodate a variety of applications is defined by their functionality. Many innovative applications have been created to make it easier to utilize smartphones as sensors, detect, and monitor a wide range of objects (Dzamesi, Akyina, Manu, & Danso, 2019). The functionality of a smartphone can be enhanced by downloading one of the many apps available from the app store. Many educational applications are available for free download, while others need purchase or payment of a subscription. As a result of this, it became clear from the comments that students are utilizing a variety of additional apps tailored to their studies or needs (B-Abee, 2020). Self-directed learning will be effective if a student's smartphone has the necessary capabilities to allow them to download programs that will aid their learning.

E. Portability

In self-directed learning, the students take responsibility for their learning process (Bosch, 2017) and they can learn from any place at any time. In her study of adoption and use of smartphone by students of higher learning in Tanzania, Kifumbu (2018) noted that, smartphone adoption is mostly attributed to the unique advantages of mobility and internet access, but portability varies by phone. Existing mobile phones come in a variety of sizes, some of which are tiny enough to carry and move around with, allowing learners to learn at any time and any place.

F. Screen size

Smartphones come in a variety of screen sizes. The larger the device's screen, the more comfortable the user would be while learning**.** According to Kifumbu (2018) on the study of adoption and use of smartphones by students of higher learning institutions in Tanzania, the screen size was mentioned by the study as a factor that influences smartphone learning. Because of the small size of the mobile screen, the author discovered that students can accidentally operate on something they don't require because of the poor resolution, color, and contrast.

III. RESEARCH METHODOLOGY

This study was based on the post positivist worldview, which advocates for knowledge generation through smart observation and measurement (Creswell & Crewell, 2017), of smartphone usability features towards self-directed learning with reference to learners in University of Dar es Salaam. Based on the Quantitative research design, this study adopted a survey method to enable the researcher to collect discrete data values using questionnaires (Asenahabi, 2019). The questionnaires enabled the reseacher to collect the required data from many people within a relatively short period of time.

A simple random sampling technique was used to collect data about smartphone usability features among students who are enrolled at the University of Dar es Salaam and use eLearning technologies to study. There were 19,650 learners in University of Dar es Salaam as at 2022 (UDSM, 2022).

The researcher employed a formula by Taro Yamane (1967) to calculate the sample size. A confidence level of 95 % was assumed.

$$n = \frac{N}{1+N(e^2)}$$

$$n = \frac{19650}{1+19650\times(0.05)^2} = 392.02$$

= 392 learners

n = Sample size; N is the population sample size and e is the level of precision – 0.05.

ISSN No:-2456-2165

Stratified proportional allocation method was used to divide the students based on their year of study, from year one to year four so as to get a representative sample from each year of study. Simple random sampling was used so as to give each student an equal chance to take part in the study.

A 27-item questionnaire with a Five-point Likert scale ranging from Strongly Disagree {1} to Strongly Agree {5} was used. To ensure the quality of the data collection tool, validity was attained through both internal validity and external validity. Reliability was ensured by carrying out a pilot study at Ardhi University and performing an internal consistency reliability test. The internal consistency of the data collection instrument was analyzed using Cronbach's alpha, where Cronbach's alpha value was 0.951.

This study used descriptive, exploratory and inferential data analysis (Asenahabi & Ikoha, 2021). Descriptive data analysis was used to summarize data elements to describe what happened in the sample. In contrast, exploratory data analysis was used for visualization and studying the data set. Exploratory Factor Analysis was used to extract constructs and indicators that converged in them.

IV. DATA ANALYSIS AND DISCUSSIONS

This section illustrates the data analysis process and results of the collected data.

A. Response Rate

For this investigation, a sample of 392 respondents was used. The sampled respondents were given questionnaires. 326 completed surveys, or 83%, were gathered in total.

B. Demographic information

This study analyzed the gender and level of education of the respondents. Table 1 depicts the summarized data.

- Gender of respondents

In this study, 47.2% of the respondents were male, 48.2% were female and 4.6% of the respondents preferred not to mention their gender.

- Level of Education

16% of the respondents in University of Dar es salaam are pursuing postgraduate courses while 84% are doing undergraduate courses. This implies that the majority of the students in university of Dar es salaam are doing undergraduate courses.

Table 1: Demographic Information

Variable	**Category**	**Frequency N = 326**	**Percentage (%)**
Gender	Male	154	47.2
	Female	157	48.2
	Prefer not to say	15	4.6
Level of education	Postgraduate	52	16.0
	Undergraduate	274	84.0

C. Smartphone Ownership

The study set out to determine whether students were utilizing their personal smartphones for academic purposes. Table 2 - smartphone ownership displays the results.

Table 1: Smartphone ownership

	Frequency	**Percent (%)**
I use my own smartphone	318	97.5
I use someone's smartphone	8	2.5
Total	**326**	**100.0**

The findings in Table 2 displays that 97.5% of the respondents use their own smartphones for study while 2.5% of the respondents use other people’s smartphones. This implies that almost all the students in the University of Dar es Salaam own smartphones.

D. Time Spent while learning using Smartphone

The researcher collected data on the time spent by the respondents to learn by using their smartphones. The findings are summarized on Figure 1 - Time spent while learning using smartphone.

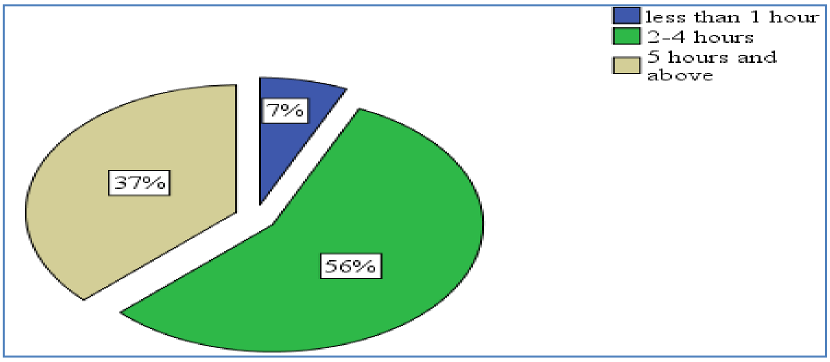

Fig. 1: Time spent while learning using smartphone

ISSN No:-2456-2165

From Figure 1, majority of the respondents (56%) claimed that they spend 2-4 hours to learn by using their smartphones in a day, an average (37%) of the respondents pointed out that they spend five (5) hours and above studying using their smartphones and very few (7%) of the respondents claimed that they use less than an hour to study using their smartphones in a day. This implies that most of the university students are learning using their smartphones.

E. Exploratory Factor Analysis

The research aimed to evaluate the smartphone usability features towards self-directed learning in university of Dar es Salaam. Twenty-seven (27) distinct indications were given to the respondents to score their level of agreement with using a scale ranging from Strongly agree (1) to Strongly disagree (5). The responses were summarized and analyzed to extract principal components and their corresponding indicators using exploratory factor analysis.

F. Construct extraction

The researcher used the Kaisen criteria, the Scree plot, and parallel analysis to determine the number of components that needed to be extracted.

Table 3 shows the data after analysis using Kaisen criteria. Four components have eigen value greater than one.

Table 3: Smartphone Usability Features Total Variance Explained

	Initial Eigenvalues		
	Total	**% Of Variance**	**Cumulative %**
1	12.023	44.531	44.531
2	1.951	7.224	51.756
3	1.493	5.529	57.285
4	1.115	4.131	61.416
5	.948	3.512	64.928

- *Extraction Method: Principal component Factoring.*

The scree plot was the researcher's second method for figuring out how many components needed to be extracted as depicted on Figure 2.

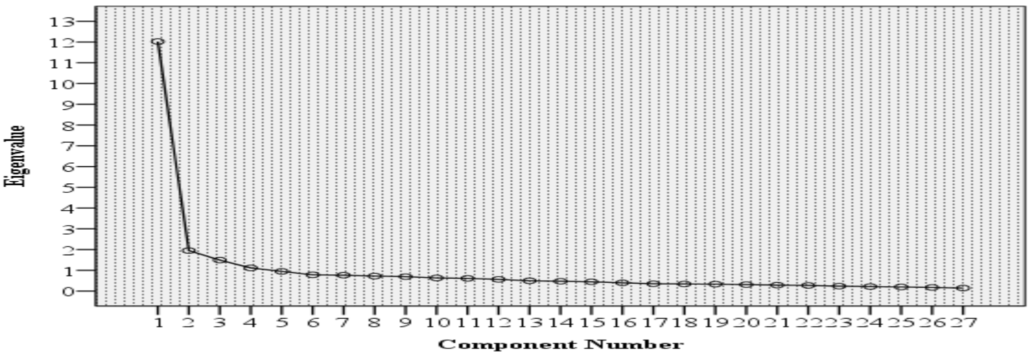

Fig. 2: Smartphone Usability Features Scree Plot

Figure 2 depicts that the first bend appears on the second component, this implies that there is only one construct which can be extracted.

Table 4 summarizes the results of the parallel analysis, which was the third method used for determining the number of components.

Table 4: Smartphone Usability Features parallel analysis

Component	Random Eigen Value	Standard Deviation
1	1.662	0.0521
2	1.574	0.0472
3	1.406	0.0385
4	1.274	0.0300
5	1.198	0.0249

The values produced using Kaisen criterion in Table 4 were compared with the random eigenvalues produced using parallel analysis in Table 3. The comparison showed that the first three (3) Kaisen criterion values are higher than those of the parallel analysis. The parallel analysis' fourth value is higher than the Kaisen criteria's fourth value. The first three components produced using Kaisen criterion were kept, while the rest were eliminated. This suggests that the three components were used in this study.

G. Suitability of data for factor analysis

To determine if the sampled data is suitable for factor analysis, the Kaiser-Meyer-Olkin measure of sampling adequacy and Bartlett's test of sphericity were used. Table 5 - Smartphone Features KMO and Bartlett's Test describes the appropriateness.

Table 5: Smartphone Features KMO and Bartlett's Test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.928
Bartlett's Test of Sphericity	Approx. Chi-Square	5478.990
	Df	351
	Sig.	.000

The Kaiser-Meyer-Olkin Measure of Sampling Adequacy value is 0.928 based on Table 5 - KMO and Bartlett's Test. This suggests that the underlying factors can account for 92.8% of the variability. However, the significant (p) result for the Bartlett's test of sphericity is 0.000, which is less than 0.05. Therefore, data can be subjected to factor analysis since there is a significant Bartlett's test of sphericity value and a KMO value of greater than 0.6.

H. Factor Extraction

How the indicators map on the components is seen in the Rotated Component Matrix. Table 6 displays the results of this study's analysis.

Table 6: Smartphone Usability Features rotated component matrix

	Component		
	1	**2**	**3**
I can download different learning applications	.759		
My phone responds very fast to inputs	.740		
I can interact with the software I installed	.706		
The content visibility of the documents is clear	.703		
I can use my phone to read, edit and handle computer files easy	.689		
I can easily install software on my phone	.677		
I enjoy studying using my smartphone	.641		
I can comfortably carry my phone to anywhere	.630		
I rarely seek for assistance when using my smartphone in studying	.628		
I can use my phone conveniently when learning	.621		
I'm comfortable learning using my smartphone	.617		
It is flexible	.598		
I feel comfortable with the size of my smartphone	.583		
It is easy to move from one document to another while studying		.785	
The speed of smartphone is enough when studying		.772	
Studying using my smartphone is mentally stimulating		.708	
I feel in command with my smartphone while reading		.685	
I easily manipulate my smartphone to do what I want while studying		.679	
This smartphone has always done what I expect while studying		.671	
The way content is presented on the screen is clear and understandable		.616	
I can easily navigate through different pages of the document when using smartphone		.482	
I can access learning materials in LMS or from the internet			.760
I buy internet bundles using my smartphone			.668
I can connect other devices using Bluetooth technology			.654
My smartphone can connect to Wi-Fi			.625
I can use my phone to view documents and images easy			.529
Learning with smartphone is satisfying			.448
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.			
Rotation converged in 7 iterations.			

The principal component analysis extraction method and Varimax with Kaiser normalizing rotation were used for the analysis of Table 6, with the rotation converging after seven (7) iterations. Thirteen (13) indicators converged in the first component based on the data analysis.

The loading coefficients for these indicators were: "I can download different learning applications," with a loading coefficient of 0.759; "my phone responds quickly to inputs," with a loading coefficient of 0.79; "I can interact with the software I installed," with a loading coefficient of 0.706; "the content visibility of the documents are clear," with a loading coefficient of 0.703; "I can use my phone to read, edit, and handle computer files easily," with a loading coefficient of 0.689; 'I can comfortably carry my phone to anywhere' with the loading coefficient of 0.630; 'I rarely seek for assistance when using my smartphone in studying' with the loading coefficient of 0.628; 'I can use my phone conveniently when learning' with the loading coefficient of 0.621; 'I'm comfortable learning using my smartphone' with the loading coefficient of 0.617; 'It is flexible' with the loading coefficient of 0.598 and 'I feel comfortable with the size of my smartphone' with the loading coefficient of

ISSN No:-2456-2165

0.583. These indicators all point to one characteristic that has to do with how compatible the smartphone is. As a result, the first element was renamed "Compatibility". Therefore, the compatibility construct had an average loading factor of (0.759 + 0.740 + 0.706 + 0703 + 0.689 + 0.677 + 0.641 + 0.630 + 0.628 + 0.621 + 0.617 + 0.598 + 0.583) / 13 = 0.661

Eight (8) indications converged to the second component. The indicators were: ' It is easy to move from one document to another while studying' with the loading coefficient of 0.785; 'The speed of smartphone is high when studying' with the loading coefficient of 0.772; 'Studying using my smartphone is mentally stimulating' with the loading coefficient of 0.708; 'I feel in command with my smartphone while reading' with the loading coefficient of 0.685; 'I easily manipulate my smartphone to do what I want while studying' with the loading coefficient of 0.679; 'This smartphone has always done what I expect while studying' with the loading coefficient of 0.671; 'The way content is presented on the screen is clear and understandable' with the loading coefficient of 0.616 and 'I can easily navigate through different pages of the document when using smartphone' with the loading coefficient of 0.482. These indicators pertain to the smartphone's Sensitivity. As a result, the second factor was renamed "Sensitivity". Therefore, the sensitivity construct had an average loading factor of (0.785 + 0.772 + 0.708 + 0.685 + 0.679 + 0.671 + 0.616 + 0.482) / 8 = 0.675

Six (6) indications converged to the third component. The indicators were: 'I can access learning materials in LMS or from the internet' with the loading coefficient of 0.760; 'I buy internet bundles using my smartphone' with the loading coefficient of 0.668; 'I can connect other devices using Bluetooth technology' with the loading coefficient of 0.654; 'My smartphone can connect to Wi-Fi' with the loading coefficient of 0.625; 'I can use my phone to view documents and images easy' with the loading coefficient of 0.529 and 'Learning with smartphone is satisfying' with the loading coefficient of 0.448. The six (6) indicators all point to a feature of the smartphone's ability to connect to the internet. Consequently, the third construct was renamed "Connectivity". The connectivity construct had an average loading factor of (0.760 + 0.668 + 0.654 + 0.625 + 0.529 + 0.448) / 6 = 0.614.

The weights of the factor loadings were calculated by evaluating the ratio of each factor loading to the total factor loading, as illustrated in Table 7. Based on the analysis, the constructs and their respective factor loadings and weights are indicated in Table 7 – Smartphone Usability Factor Loadings and Weights.

Table 7: Smartphone Usability Factor Loadings and Weights.

Smartphone usability features	**Loading**	**Weight**
Compatibility	0.661	0.339
Sensitivity	0.675	0.346
Connectivity	0.614	0.315
Total factor loading	1.95	1.000

Based on this analysis, the smartphone usability can be attributed to three features as illustrated in Figure 3 – Smartphone usability features framework.

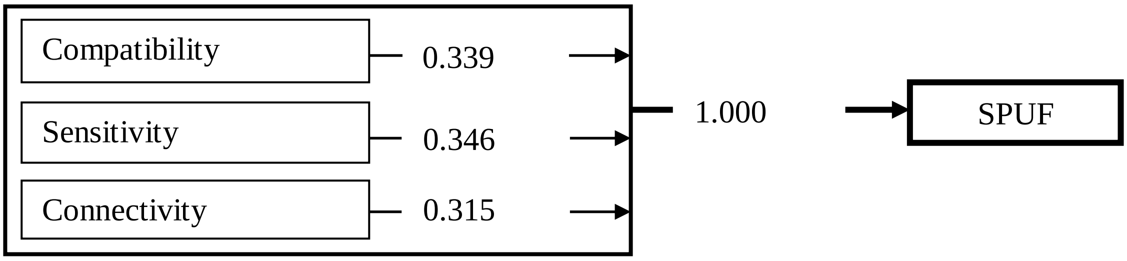

Fig. 3: Smartphone Usability Features Framework

V. CONCLUSION

Learners can use smartphones to access learning resources of any form, read and re-read at any time, collaborate and share ideas with others and hence support self-directed learning. With smartphones, learning can still take place either synchronously or asynchronously. Smartphones can be attributed to three usability features: compatibility, sensitivity and connectivity.

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