The Role of Compatibility and Task-Technology Fit (TTF): On Social Networking Applications (SNAs) Usage as Sustainability in Higher Education

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ABSTRACT This study aimed to alleviate the gap between the literature regarding the Social Networking Applications (SNAs) use for active collaboration and engagement as sustainability in higher education and task-technology-fit (TTF) and compatibility on their consequence on students' satisfaction and their performance impact its sustainability used in higher education. Although researchers have examined (SNAs) usage within multiple situations, the roles of (TTF) and compatibility as mediating variables have not been investigated through TAM model and constructivism theory on measuring education sustainability. Overall 602 students and researchers took part in this study, which were selected from public university. Using the method of structural equation modeling (SEM), we surveyed to discover the perception of students toward the (SNAs). Based on the results, the (SNAs) use for collaboration and engagement as sustainability in higher education, and TTF and compatibility positively impacted the student's learning performance on measuring education sustainability, and they were found to be completely pleased with the perceived ease of use and perceived usefulness. In conclusion, the role of TTF and compatibility presents positive influences performances related to sustainability for education; and both factors mediates associations among collaboration and engagement as sustainability in higher education, students' satisfaction on (SNAs) usage and students' performance related to sustainability for education. Therefore, their impact should be encouraged in learning processes in higher education institutions.

INDEX TERMS Social networking applications (SNAs) use, compatibility and task-technology fit (TTF), sustainability for education, structural equation modelling (SEM).

I. INTRODUCTION

Research community has placed divergent attention toward the implementation of (SNAs) in the curriculum of higher education with respect to teaching and learning purposes on measuring education sustainability. (SNAs) are the platform where students can join and interact under a social environment [1]. Gutmann *et al.* [2] in a study concluded an improved ubiquity and acceptance of digital learning resources by the undergraduate medical students (in particular mobile applications). In a study, Almaiah *et al.* [3] found that students are more keen to leverage the prospects of (SNAs) like Facebook, and others in supporting the teaching-learning

process as compared to other levels of education that are more inclined to use traditional approaches. Hence, this reveals that the (SNAs) technology is yet to become a mainstream technology to be adopted in education. In today's world, students have more opportunities to use new technologies than before [4].

Although (SNAs) is used by most of the students to keep in contact with their family members [5], this practical attitude establishes better opportunity for them to accept and gain knowledge to utilize (SNAs) in classes and research. Another justification for its use in the higher education is that the (SNAs) has been perceived as having tremendous effects on the educational experience of students. In addition to facilitating their academic transition from college to university level, it also affects the performance on measuring education

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sustainability of both the students and researchers [6]. The technology acceptance model (TAM) and constructivism theory was used in this study to implement (SNAs) in the higher education. However, both the theories have their own factors in elevating the quality of education via (SNAs). Constructivism theory considers interaction, engagement, and collaboration and engagement as sustainability in higher education (CE) as aspects that establish the use of (SNAs), whereas TAM considers using (SNAs), and students' satisfaction (SS), perceived usefulness (PU), perceived ease of use (PE) as core factors. Therefore, we considered to use these two theories and develop a theoretical framework with the help of survey results obtained from the student population of public university, and deduced the effectiveness of (SNAs) toward performance impact as sustainability in higher education.

The survey was conducted to gain the perception of the respondents toward (SNAs)'s application in enhancing performance impact as sustainability in higher education, and survey results were analyzed using structural equation modeling (SEM). The following sections discuss the preprocessing of the survey data, adoption of constructivism and TAM theories in the theoretical framework, and the effectiveness of (SNAs) with respect to the performance impact as sustainability in higher education in public university. Literature shows several studies related to models and frameworks showing the negative influence of (SNAs) on certain aspects of education such as students' collaboration and engagement and their performance impact as sustainability in higher education [7]. In addition, literature related to (SNAs) in institutions of tertiary education is scarce [8]. Therefore, in this study, we aimed to scrutinize the application of (SNAs) from student's perspective.

A. PROBLEM STATEMENT

The first part of the research' statement includes the insufficient investigation on (SNAs) usage for active collaboration and engagement as sustainability in higher education, with the corresponding interaction and constant factors as focused by the previous studies (e.g., [9], [10]. The second part correlates the insufficiency of instrument models application in measuring the related factors in one study [11], and the lack of examination of (SNAs) usage for collaboration and engagement as sustainability in education and involvement, with the interaction and perceptual factors [9], [10]. And the third part includes the ability to model acceptance of (SNAs) with constructivism theory as the potential model of constructs, with both interaction and perceptual factors present in the (SNAs) in the educational context [12]. Additionally, there are insufficient models for understanding the (SNAs) usage and its impact performance as sustainability in higher education [13]. Conversely, this study has shifted the focus to the social and task characteristics (compatibility and task-technology-fit). It is reflected in what Aldholay, Isaac, Abdullah, Alrajawy, & Nusari [14] mentioned that social and cultural characteristics are among the main issues in

the context of online learning adaption. Besides, [14] have touched in the importance of compatibility role in the field of information system, however, it was mainly a systematic literature review which resulted in a proposed conceptual model that has not been empirically tested.

Based on [15], actual use is insufficient to render a full description without including consideration of whether such technologies are a match with corresponding tasks, although [16] considered task technology fit as vital in research on the use of modern technologies in institutions. Such contradictory findings show that other aspects may be intervening in the associations, in accordance with the applications and contexts under study. For actual use and user satisfaction to positively affect personal performances on measuring education sustainability, these variables are initially required to process intervening aspects including task technology fit, a variable that can be defined as the extent to which technologies assist users in the performance on measuring education sustainability [17]. Almaiah *et al.* [18] discovered that task technology fit appreciably influences usage and the effect on performance on measuring education sustainability, while [19] established similar meaningful relationships. From a theoretical rationale, and from what is currently known to the researchers, this research is apparently one of the first to apply compatibility in terms of a mediation variable for relationships among overall quality and user satisfaction and real usage. It utilises task technology fit for mediating relationships among real usage and users' satisfaction in one case and the effect on performance on measuring education sustainability.

B. (SNAs) IN EDUCATION

Previous researchers have analyzed each (SNAs) tools which includes Facebook, MySpace, or Twitter as educational research for logical determination from the commonness of the term (SNAs) itself. Hence, (SNAs) platforms have not yet pervaded the field of education in the true sense. Tess's [20] experiment has concluded that most universities have the facilities and acceptance for the utilization of (SNAs); however, the teachers or instructors are not well trained for the purpose of instruction. The use of instructor, engagement of learner, and effect on academic achievement are the factors that have been considered in the previous studies of information and communication technology (ICT) usage for education sustainability [21], [22]. In another study, [23] analyzed the development and revision of (SNAs) strategy in the higher education, by considering the potential changes in (SNAs) field, academic freedom issues, and the premises of inter-operability with policies at the unit and campus levels. The study observed (SNAs) to be an important technology in enhancing the voice of students and improvement in the learning process. In another study by [3], students were found to be more susceptible in using Facebook and other (SNAs) platforms to strengthen the learning processes in comparison to others who are focused towards using conventional learning methods.
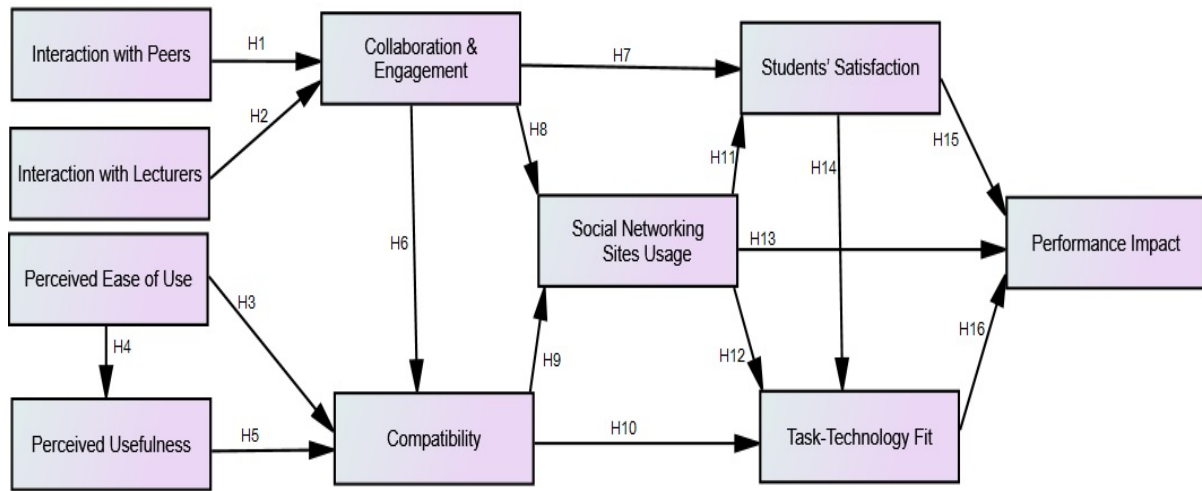
FIGURE 1. Research model and hypotheses.

II. RESEARCH MODEL DEVELOPMENT AND HYPOTHESES

A. THEORETICAL BACKGROUND

This study used constructivism theory as an alternative to the traditional instructive models to improve the platform of education, possibly leading to positive enhancements in the education sector [24]. This approach makes individuals actively involved in the product construction [5]. It is also reported that the use of this theory helps to develop thinking skills especially the high-order ones such as critical thinking and problem solving [5]. In a study by Moafa *et al.* [7] it has been confirmed that the implementation of (SNAs) in the academics carry significant ability to improve the student's performance on measuring education sustainability and enrich the learning environment. This can be achieved by adding certain factors to the theoretical framework. Technology acceptance model (TAM) perspective is marked flexibly as it extends to other variables that aid in describing the approval of the technology [25], [26]. Task Technology Fit (TTF) is the degree to which a technology assists an individual in performing his or her portfolio of tasks; it can be broadly applied to any situation in which individuals use technology to accomplish specific tasks [27]. Therefore, the research model studies all aspects of constructivism (interaction with peers (INP), interaction with lectures (INL), collaboration and engagement on learning (CE)). TAM (perceived usefulness (PU), perceived ease of use (PE), (SNAs) use (SU), students' satisfaction (SS)). Finally, Task Technology Fit (TTF) and compatibility (CO) which affect the students' performance on learning (PI) as sustainability in higher education. See Figure 1.

B. INTERACTION WITH PEERS AND LECTURERS

Interaction is learning styles represent preferences for one mode of adaptation over others & Interaction learning is a pedagogical approach that incorporates social networking and urban computing with lecturers and

supervisors [28], [29]. Al-Rahmi *et al.* [30] suggested that (SNAs) is the perfect host for a mixed learning environment because it enhances relationships between the peers. They found that the learners admired interaction discussions in the virtual learning platform. It has been observed that certain tools of (SNAs) platforms like Facebook has a positive influence on students' engagement and learning experiences through the creation of effective platforms for such purposes. There also exists a high influence on learners' encouragement as it provides a simple and successful flow of thoughts among learning communities [3], [30].

H1: Significant relationship between INP and collaboration and engagement on learning.

H2: Significant relationship between INL and collaboration and engagement on learning.

C. COLLABORATION AND ENGAGEMENT AS SUSTAINABILITY IN HIGHER EDUCATION

Collaboration and engagement as sustainability in higher education is a situation in which two or more people learn or attempt to learn something together. Unlike individual learning, people engaged in active collaboration and engagement as sustainability in higher education capitalize on one another resources and skills [30], [31]. Collaborative peer learning has been found to facilitate the development of interaction skills, self-evaluation, self-motivation, critical thinking, and reflection among students [32]. Active collaboration and engagement as sustainability in education and motivating cognitive skills reflection and metacognition is an integral part of (SNAs) for active collaboration and engagement as sustainability in higher education in tertiary educational institutions [33]. Based on previous studies a higher level of learning can be achieved by incorporating (SNAs) in student assignments [34]. (SNAs) like Facebook as a medium of exchange promotes a safe and flexible learning space, that enhances active collaboration and engagement as

sustainability in higher education while making a strong interest among the students and their lecturers in a strong engaging manner [33], [35].

H6: collaboration and engagement on learning has a positive relationship with compatibility.

H7: collaboration and engagement on learning has a positive relationship with SS.

H8: collaboration and engagement on learning has a positive relationship with (SNAs) use.

D. PERCEIVED EASE OF USE

The extent to which a person believes that using the system will be free of effort [36]. According to TAM, perceived ease of use significantly impacts perceived usefulness, actual use, and behavioral attitude [36]. As for the relationship between the two factors, the perceived ease of use and perceived usefulness, [36] explains that perceived ease of use may antecede perceived usefulness, as opposed to being a parallel and direct determinant of use [26]. Based on unified theory of acceptance and the use of technology (UTAUT), [26] considered effort expectancy to encapsulate the concepts of perceived use (TAM/TAM2), complexity, and ease of use, where effort expectancy refers to the level of ease related to the information system (IS) use [26].

H3: perceived ease of use has appositive relationship with compatibility.

H4: perceived ease of use has appositive relationship with perceived usefulness.

E. PERCEIVED USEFULNESS

The extent to which a person believes that using the system will enhance his/her job performance [36]. As shown in the TAM model, perceived usefulness is considered the best predictor of IT use among users [26], [36]. Almaiah and Alyoussef [37] reported no relationship between perceived usefulness and attitude and (SNAs) use. In contrast, Bajaj and Nidumoulu [38] found that usefulness negatively impacts attitude toward use of IS [26].

H5: perceived usefulness has a positive relationship with compatibility.

F. COMPATIBILITY

In the information systems (IS) field, compatibility is considered as one of the fundamental antecedents to user adoption of new technology or application [39], [40] likewise, Premkumar [41] suggested that it was found to be an important determinant of IS innovation adoption. Compatibility is described as the intensity with which innovations are perceived to align with the current needs, values, and prior experiences of their probable adopters [42]. The literature in the internet and education field has yet to pay significance attention to this variable [43]. In other technology application [44] found that high compatibility leads to preferable adoption of mobile systems. In this research, the disposition is described as the intensity with which online learning technologies fit student beliefs, values, and lifestyles [40]. Wu *et al.* [45] discovered

that compatibility has an appreciable influence student's satisfaction via using (SNAs), whereas [39] established a meaningful relationship among usage and compatibility with regards to mobile learning programmers in Taiwan.

H9: compatibility has a positive relationship with (SNAs) use.

H10: compatibility has a positive relationship with task technology fit.

G. (SNAs) USE

With the use of (SNAs), learners can communicate, interactional collaborate, and engage in a social network [1], [46]. Pomerantz *et al.* [23] studied the development and recreation of (SNAs) policies through different fields of higher education, by considering the fast growing landscape of (SNAs), difficulty in academic freedom, and notions of interoperability with policies at the unit and campus levels into consideration. Higher education has drawn widespread focus from the researchers on the incorporation of (SNAs) activities for teaching and learning motive. Active collaboration and engagement as sustainability in higher education and motivating cognitive skills reflection and metacognition is primary feature of (SNAs) for active collaboration and engagement as sustainability in higher education [33]. Rapid growth in social-media applications, enhancement of event-awareness by social mining has become significantly important [11]. Previous researchers have demonstrated the success achieved in higher level of learning by the incorporation of (SNAs) for student assignments [34].

H11: (SNAs) use has a positive relationship with students' satisfaction.

H12: (SNAs) use has a positive relationship with task technology fit.

H13: (SNAs) use has a positive relationship with students' performance impact on learning.

H. STUDENTS' SATISFACTION

Students are successful in the learning and are pleased with their experience [47]. In relation to user's adoption of certain technologies and their satisfaction, two variables are considered critical and of a great importance: perceived usefulness and perceived ease of use. These variables are important as they can predict the users' satisfaction with respect a particular website [48] or a computer [36]. It has been reported that users' entertainment has a major role in predicting the success of any technology. As for the IS and products, the entertainment provided by this technology predicts the success as well as the adopting of this technology by the users [49]. Based on this, [50] recommended a way to enhance students' learning and satisfaction though involving all sorts of interaction within the online courses.

H14: students' satisfaction has a positive relation with task technology fit.

H15: students' satisfaction has a positive relation with students' performance impact on learning.

I. TASK TECHNOLOGY FIT

In this research, task technology fit is described as the intensity with which systems match interests, suit or fit tasks, and meet requirements [51]. Almaiah *et al.* [17] described the concept as the extent to which technologies assist users in their performance on measuring education sustainability. They similarly referred to the disposition as the extent to which a particular system is appropriate or fit for assisting in the completion of tasks, based on work requirements [17]. Regarding the use of technology in organisations, real use remains insufficient for rendering a full description without including task technology fit in full consideration that is if the technologies match with their corresponding tasks [15]. Several papers have examined the positive effects of task technology fit regarding usage behaviours. The well-regarded [11], [19] examined the positive effects of task technology fit on factors regarding IS effectiveness, including the effect on performance and the net advantages. Their findings are supported by much prior research that discovered a positive association among task technology fit and personal performances [16], [18]. This research will investigate the mediation effects of task technology fit on the association among real use and performance on measuring education sustainability as well as among user satisfaction and the effect on performance on measuring education sustainability, based on the direct and validated effects of real usage and user satisfaction on performance [52] and also the meaningful influence of task technology fit on performance on measuring education sustainability.

H16: task technology fit has a positive relation with students' performance impact on learning.

J. PERFORMANCE IMPACT AS SUSTAINABILITY IN HIGHER EDUCATION

Performance impact as sustainability in higher education is as a demonstration of a student's level of competence and mastery of a subject through completion of multiple assessment tests of competence in a particular domain on measuring education sustainability [53], [54]. Several studies have reported that (SNAs) have an important role in enhancing the students' engagement as well as in their achievements [55]. Learners' performance impact as sustainability in higher education has been found to be significantly improved by the use of (SNAs) in academics [29], [56]. It also has a positive influence on skill development [12] and improving cognitive skills [30], [57].

III. RESEARCH METHODOLOGY

Totally 602 undergraduate and postgraduate students volunteered in this study. The survey the primary tool of data collection was given manually to the respondents and was asked to fill them in order to obtain their feedback on (SNAs) networks and how they are used to the purpose of enhancing an active collaboration and engagement as sustainability in higher education, and their view of its influence on their satisfaction and learning performance on measuring education

sustainability. The survey asked the respondents to answer questions in relation to (SNAs) network. The survey results were analyzed using SEM. The survey items were evaluated with a 5-point Likert scale. The items were consists of TAM variables, interaction factors, and demographic items. The data collected from the survey were analyzed with IBM SPSS, and Structural Equation Modeling (SEM- Amos) was used as the primary statistical technique utilized in two steps; the first step constructed the validity of measurements, discriminant validity of the measures, convergent validity of the measurements, and second step consisted of analysis of the structural model. The approach was motivated by Hair & al., [58]. The following subsections provide details of the analysis, theoretical framework, and hypotheses, and the result of the (SNAs) influence on performance impact on measuring education sustainability.

A. VALIDITY OF THE DESIGNED QUESTIONNAIRE

The core objective of the survey used in the present study was to examine the credibility of (SNAs) for educational purposes for both learners and researchers within the institutions of tertiary education. In accordance with this and also to validate the quality, effectiveness, and completeness of the questionnaire, we validated the designed questionnaire using pilot test, which helped in the removal of glaring defects. The questionnaire consisted of 32 questions. These items were designed to extract different types of information such as literature review, need of using (SNAs), students' view on the relation between the various tools of (SNAs), and collaboration and engagement as sustainability in higher education. The students were also asked about the influence of (SNAs) on the performance impact on measuring education sustainability. Furthermore, the conviction on the effectiveness of this research as well as the validity of the structured questionnaire was tested via pilot and final test. The dependency was evaluated by using the preliminary basic statistical methods in SPSS 20 software for Windows. The relationship between performance impact as sustainability in higher education and collaboration and engagement as sustainability in higher education with respect to incorporation of (SNAs) was evaluated on measuring education sustainability. Other variables were also taken into consideration, such as interaction with lecturers, interaction with peers, and (SNAs) use. Cronbach's alpha result based on standardized items was observed to be 0.913. Table 1 represents the reliability coefficient (Cronbach's alpha) for all constructs of pilot and final tests: all factors were found to be reliable and acceptable. See Table 1.

B. DATA COLLECTION AND MEASUREMENT

Present study is a segment of research aimed at soliciting researchers' perspectives on the incorporation of (SNAs) for collaboration and engagement as sustainability in higher education which can enhance learners' and users' performance impact on measuring education sustainability. In this survey, both the open-and close-ended items were utilized, which

TABLE 1. Reliability coefficient for all constructs in pilot test and final test.

No.	Latent Variables	Code	Pilot Test	Final Test
1	Interaction with Peers	IN-P	0.929	0.913
2	Interaction with Lecturers	IN-L	0.861	0.872
3	Collaboration and engagement on learning	CE	0.913	0.907
4	Perceived Ease-of Use	PE	0.904	0.893
5	Perceived Usefulness	PU	0.890	0.879
6	Students Satisfaction	SS	0.867	0.911
7	(SNAs) Use	SU	0.848	0.817
8	Compatibility	CO	0.886	0.908
9	Task-Technology Fit	TTF	0.911	0.917
10	Performance impact on learning	PI	0.900	0.832

was the primary instrument of data collection. In particular, the questionnaire included 32 items designed to extract particular information from the participants. It consisted of several sections such as literature review, the need for (SNAs) use, researchers' view on (SNAs) tools for collaboration and engagement as sustainability in higher education, and the effect on performance on measuring education sustainability. The core purpose of the study was to solicit the perspectives of both students and researchers on the use of the different tools of (SNAs) platforms and its effect on their performance impact on measuring education sustainability. As for the number of items used for each variable, three items were used to measure interaction with peers and interaction with lecturers and they were adopted from previous studies [28], [29]. Three items were considered from the study of [31], [33] to measure collaboration and engagement as sustainability in higher education. Three items were adapted from [36] to test the influence of both perceived ease of use and perceived usefulness. Furthermore, three items were adapted from [49] to measure the idea behind the use (SNAs). Four items were adapted from [17] to measure TTF, and four items were adapted from Ifinedo (2012) to measure compatibility. Three items were adapted from [11] to measure researchers' satisfaction. As for the last construct, three items adapted from [59], [60] to measure performance impact on measuring education sustainability.

IV. DATA ANALYSIS AND RESULTS

In this study, a total of 602 participants responded to the questionnaires. In the first step of analysis, the respondents were classified according to their demographic data. Female respondents (n = 344, 57.1%) were found to be more than male respondents (n = 258, 42.9%). In addition, 410 respondents (68.1%) were from undergraduate level and 192 respondents (31.9%) were from postgraduate level. With respect to the ages of the respondents, 142 respondents (23.6%) were between the age 21–24 years, 196 respondents were in the age group of 25–30 years, 173 (28.7%) were in the age group of 30-35 years, and 91 respondents (15.1%) were

over 35 years of age. Most of the respondents (91.4%) were using (SNAs) for collaboration and engagement as sustainability in higher education to affect performance impact on measuring education sustainability, and the remaining (8.6%) did not do so. The three criteria that is, the AVE value of each construct ≥ 0.50, index among variables <0.80 [58], and square of AVE of each construct greater than the inter construct correlations (IC) related with the factor [61] (are the basis of discriminant validity) were evaluated. Additionally, the constructs, items and crematory factor analysis results with factor loading of ≥ 0.70 or over, were accepted, with Cronbach's Alpha ≥ 0.70 and composite reliability ≥ 0.70 [58].

A. MEASUREMENT MODEL ANALYSIS

The primary tool of analysis in this research was SEM along with the use of Amos 23 software to conduct confirmatory factor analysis (CFA). The total goodness-of-fit was evaluated by fit indices (IFI, RMR, $\chi 2$, df, $\chi 2$/df, CFI, TLI, and RMSEA). An acceptable overall model fit was obtained as initial CFA was conducted. Table 2 shows the results of measurement model. See Table 2, Figure 2, and Appendix.

In this study, to evaluate the discriminant validity three different criteria were used. One of these criteria is the correlation index between variables which is supposed to be not more than 0.80 [58]. The other two are the value of the average variance extracted (AVE) and the square root of AVE. The desired value of the former is equal to or greater than 0.5 for each construct, whereas the value should be more than the inter-construct correlations (ICs) linked with that factor [61]. As for the crematory factor analysis, the factor loading is preferred to be 0.5 or greater, whereas it should be ≥0.70 for Cronbach's alpha and ≥ 0.70 for the composite reliability [58]. See Table 3.

B. STRUCTURAL MODEL ANALYSIS

In order to test the structural framework, CFA was run as the second phase of the SEM. Table 4 illustrates the structural framework. The data shown in this table indicates the validity

TABLE 2. Summary of goodness fit indices.

| Type of measure	Acceptable level of fit	Value
Chi square ($\chi2$)	≤ 3.5 to 0 (perfect fit) and (ϱ >0.01)	916.562
Normed Chi square ($\chi2$)	Value should be greater than1.0 and less than 5.0	2.514
Root-Mean Residual (RMR)	Close to 0 (perfect fit)	0.024
Incremental Fit Index (IFI)	Value should be equal to or greater than 0.90.	0.973
Tucker Lewis Index (TLI)	Value should be equal to or greater than 0.90.	0.968
Comparative Fit Index (CFI)	Value should be equal to or greater than 0.90.	0.974
Root mean square error of approximation (RMSEA)	Value below 0.10 indicates a good fit and below 0.05 is deemed a very good fit.	0.033
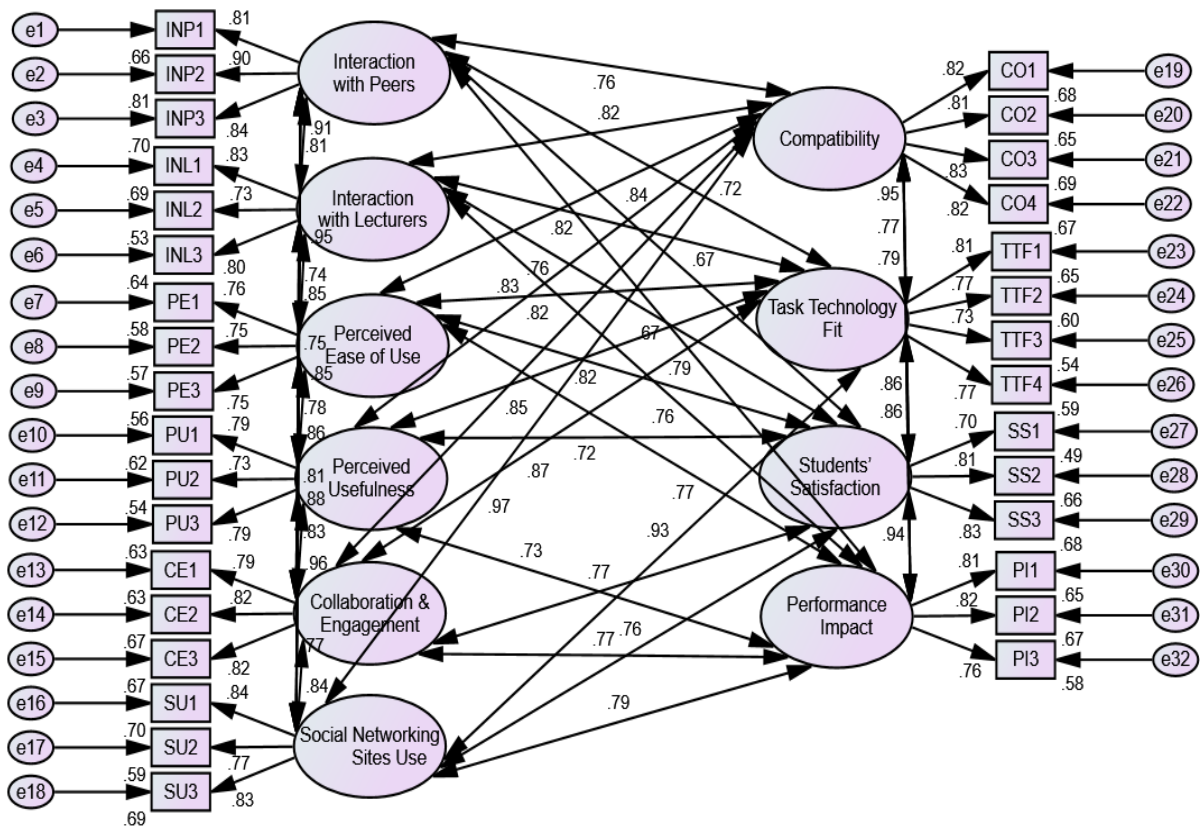
FIGURE 2. Measurement model.

of this framework as well as its suitability to test the hypotheses of this study (see Figure 3 and Figure 4).

Figure 3 and 4 represents the hypotheses between the eight key constructs and the obtained results indicated that all sixteen hypotheses were accepted. Table 4 denotes the values of the unstandardized coefficients and the standard errors of the structural model that indicated that the major statistics of the model are significant, and thus indicating the model validity and the hypotheses testing results.

C. RESULTS OF HYPOTHESIS TESTING

Both the framework and the hypotheses are supported by these results illustrating the various relationships between the variables of the framework. Table 4 illustrates the

unstandardized coefficients as well as the standard errors of the structural framework by providing the required parameters. The table confirms that the (SNAs) use positively affects the performance impact on measuring education sustainability. They also provide support for all hypotheses through the responses of all the 602 respondents. See Table 4.

As shown in Table 4 and Figure 3, results show that there is a significant relationship between interaction with peers and collaboration and engagement as sustainability in higher education ($\beta = 0.634$, t = 18.471, p < 0.001). This finding indicates the importance of sharing ideas among students through using (SNAs). Also, the show that there is a significant relationship between the interaction with lectures and collaboration and engagement as sustainability in higher

TABLE 3. Discriminant validity.

	SS	INP	INL	CE	PU	PI	PE	TTF	CO	SU
SS	0.887									
INP	0.629	0.874								
INL	0.591	0.482	0.821							
CE	0.617	0.660	0.465	0.901						
PU	0.729	0.589	0.470	0.861	0.910					
PI	0.753	0.735	0.516	0.745	0.767	0.809				
PE	0.707	0.662	0.552	0.882	0.683	0.675	0.806			
TTF	0.565	0.702	0.639	0.519	0.691	0.567	0.605	0.893		
CO	0.612	0.532	0.576	0.623	0.712	0.620	0.652	0.549	0.931	
SU	0.707	0.488	0.457	0.607	0.688	0.676	0.679	0.638	0.529	0.895

Note: SS, students' satisfaction; INP, interaction with peers; INL, interaction with lecturers; SU, (SNAs) use; CE, collaboration and engagement on learning; CO, compatibility; TTF, Task-Technology Fit; performance impact on learning (PI).
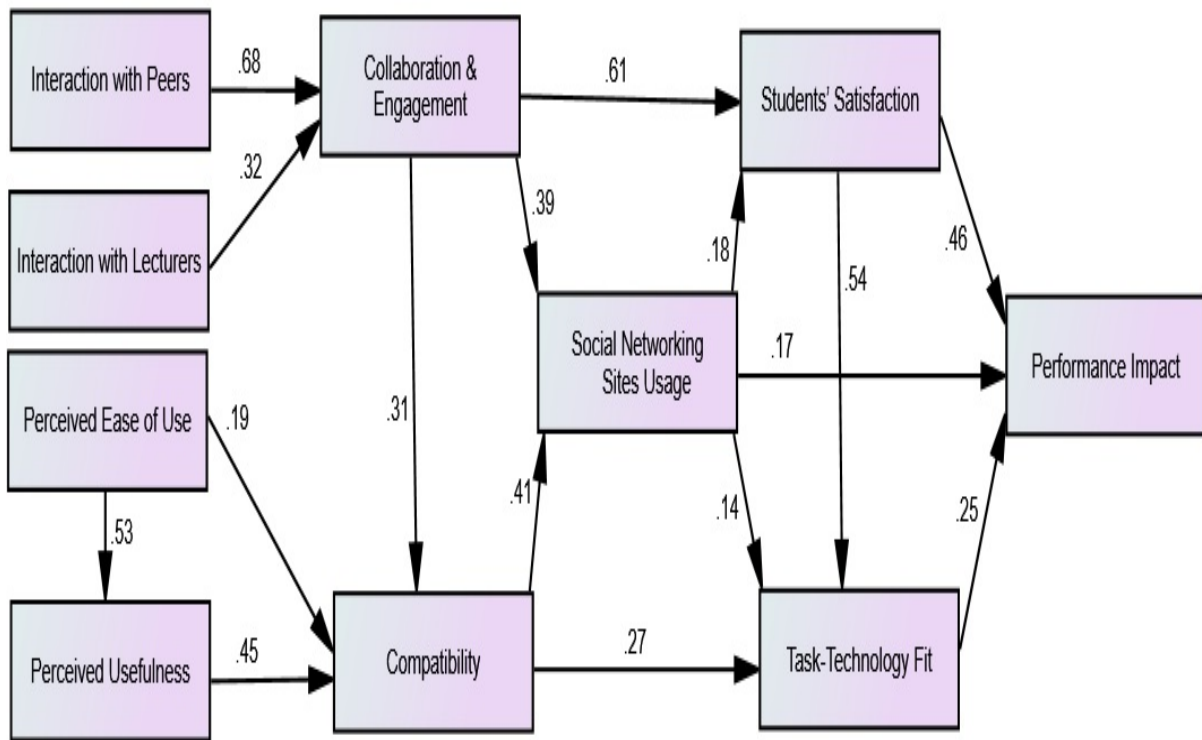

FIGURE 3. Research model path values results.

education ($\beta = 0.262$, t = 8.652, p < 0.001). This finding indicates the importance of sharing ideas with lecturers through (SNAs). According to Table 4, there is a significant relationship between perceived ease of use and compatibility ($\beta = 0.153$, t = 4.687, p < 0.001). And, the results show that there is a significant relationship between perceived ease of use and perceived usefulness ($\beta = 0.553$, t = 15.522, p < 0.001). Similarly, results show that there is a significant relationship between perceived usefulness and compatibility ($\beta = 0.349$, t = 10.187, p < 0.001). Thus, TAM factors

representative by hypothesis 3, 4 and 5 were supported and significant relationship with compatibility through using (SNAs). Next hypothesis the relationship between collaboration and engagement as sustainability in higher education with compatibility ($\beta = 0.289$, t = 7.328, p < 0.001). Therefore, hypothesis number 6 was supported and significant. Results show that there is a significant relationship between collaboration and engagement as sustainability in higher education with students' satisfaction ($\beta = 0.659$, t = 17.824, p < 0.001). Therefore, hypothesis number 7 was supported
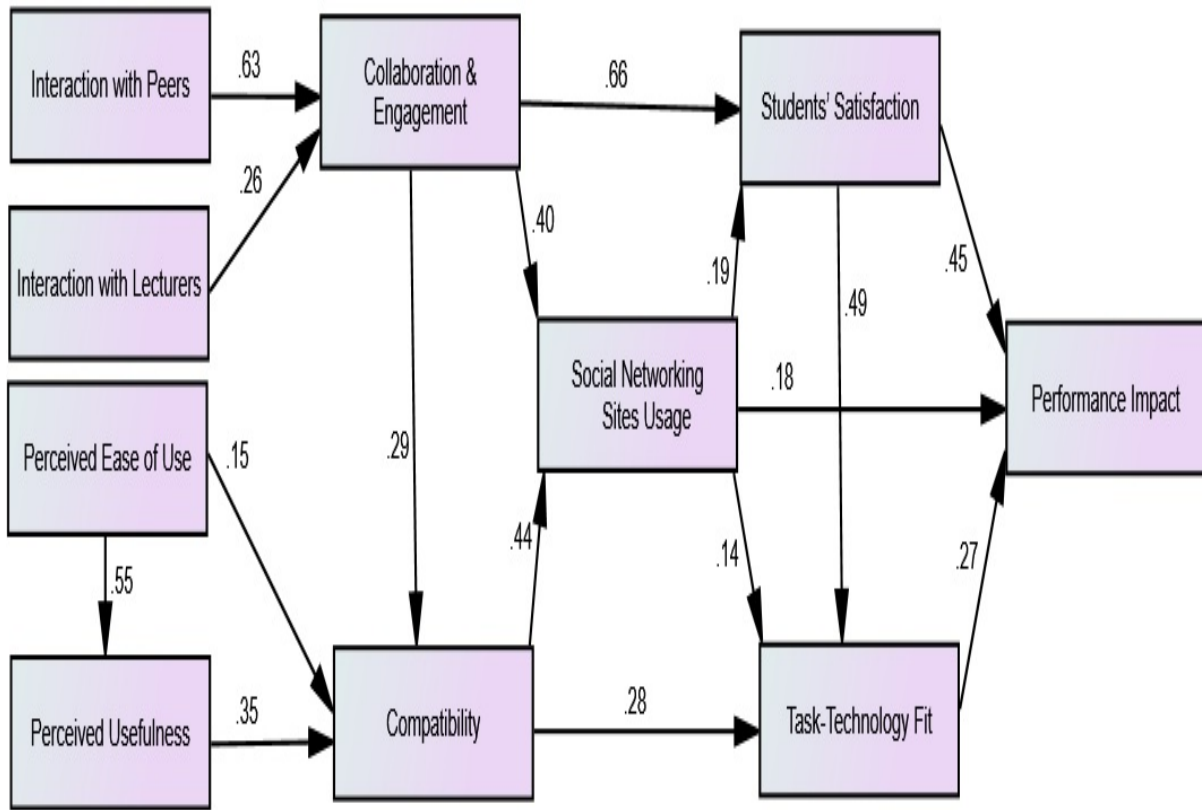
FIGURE 4. Research model hypothesis testing results.

TABLE 4. Hypothesis testing results.

H	Independent	Relationship	Dependent	Estimate	SE	CR	P	Result
H1	INP	⟶	CE	.634	.034	18.471	***	Supported
H2	INL	⟶	CE	.262	.030	8.652	***	Supported
H3	PE	⟶	CO	.153	.033	4.687	***	Supported
H4	PE	⟶	CO	.553	.036	15.522	***	Supported
H5	PU	⟶	CO	.349	.034	10.187	***	Supported
H6	CE	⟶	CO	.289	.039	7.328	***	Supported
H7	CE	⟶	SS	.659	.037	17.824	***	Supported
H8	CE	⟶	SU	.395	.038	10.528	***	Supported
H9	CO	⟶	SU	.437	.040	11.005	***	Supported
H10	CO	⟶	TTF	.282	.036	7.810	***	Supported
H11	SU	⟶	SS	.190	.037	5.153	***	Supported
H12	SU	⟶	TTF	.135	.033	4.161	***	Supported
H13	SU	⟶	PI	.176	.033	5.362	***	Supported
H14	SS	⟶	TTF	.491	.030	16.232	***	Supported
H15	SS	⟶	PI	.445	.039	11.460	***	Supported
H16	TTF	⟶	PI	.272	.042	6.462	***	Supported

Note: CR, critical ratio or t-value; ***$p < 0.001$; **$p < 0.001$

and significant. Moreover, relationship between collaboration and engagement as sustainability in higher education with using (SNAs) ($\beta = 0.395$, t $= 10.528$, p < 0.001).

Therefore, hypothesis number 8 was supported and significant. The ninth hypothesis was also found to be significant with a positive relation between compatibility and (SNAs)

use ($\beta = 0.437$, t $= 11.005$, p < 0.001). Similarly, a positive relationship was also detected between compatibility and task technology fit ($\beta = 0.282$, t $= 7.810$, p < 0.001). Therefore, hypothesis number 10 was supported and significant. A positive relationship was found between (SNAs) use and students' satisfaction ($\beta = 0.190$, t $= 5.153$, p < 0.001).

Therefore, hypothesis number 11 was supported and significant. And, a positive relationship was found between (SNAs) use and task technology fit (β = 0.135, t = 4.161, p < 0.001). Therefore, hypothesis number 12 was supported and significant. Similarly, a positive relationship was found between (SNAs) use and students' performance impact on measuring education sustainability (β = 0.176, t = 5.362, p < 0.001). Therefore, hypothesis number 13 was supported and significant. The next hypothesis the relationship between students' satisfaction and task technology fit (β = 0.491, t = 16.232, p < 0.001). Therefore, hypothesis number 14 was supported and significant. The students' satisfaction was found to be significantly related to students' performance impact on measuring education sustainability (β = 0.445, t = 11.460, p < 0.001). Therefore, hypothesis number 15 was supported and significant. Finally, the relationship between task technology fit and students' performance impact was significant with (β = 0.272, t = 6.462, p < 0.001). Therefore, hypothesis number 16 was supported. All hypotheses go in line with some of the previous related research [17], [26], [32], [36], [40], [43], [57].

V. DISCUSSION AND IMPLICATIONS

The result provides insight perception about the learning performance of the postgraduate students and their interaction within group, with supervisors, and their engagement, (SNAs) use, perceived ease of use, perceived usefulness, active collaboration and engagement as sustainability in higher education and satisfaction on measuring education sustainability. The incorporation of (SNAs) provides active collaboration and engagement as sustainability in higher education and engagement which can aid the students to work in groups and to effectively complete their task. (SNAs) can also allow flow of information and clarified instructions between the students and their lecturers/supervisors. These results are parallel with those of previous studies where it has been reported that the (SNAs) use significantly influence the learning performance on measuring education sustainability [5], [12], [29]. The primary purpose of the study was to investigate the (SNAs) use within the educational environment. Results were found to be positive and relationship was proved to be positive between interaction and collaboration and engagement as sustainability in higher education leading to a better level of performance impact on measuring education sustainability. Other variables such as the perceived ease of use were found with significant effect on the (SNAs) use as well as on the satisfaction of using this technology. Other studies support the findings of this study which report a beneficial impact of the use of (SNAs) on learners [8], [46].

Based on the findings of this study, all the proposed hypotheses were approved and supported which contradicts with other previous studies which claimed negative effect of (SNAs) on students' performance impact on measuring education sustainability [7], [21]. In contrast, the findings of this study were found to be in-line with the results of other studies that reported increasing levels of academic achievement, collaboration, and knowledge sharing in online courses compared to face-to-face and traditional courses [22], [57], [59]. In spite of the beneficial impact of (SNAs) via collaboration and engagement as sustainability in higher education, it is still reported that this technology is still underused in classrooms and is rarely involved in traditional classes [3]. As mentioned by [62], there is an increasing tendency to use social internet networks and various multimedia contents for the purpose of exchanging information. In a study, [63] revealed the regular use of (SNAs) for mobile communication and internet as a new trend which have the possibility to classify mobile learning.

Majority of the respondents (550, 91.4%) of this study desired to use the tools of (SNAs) for the purpose of collaboration and engagement as sustainability in higher education saying that it would be a fruitful addition through which they can communicate with their classmates and other learners. Only 52 (8.6%) respondents reported that they did not use the tools of (SNAs) any more. Therefore, this study recommends that tools of (SNAs) such as Facebook and Blog should be integrated in the universities' learning environment. (SNAs) should be used by lecturers and instructors as to enhance the process of learning by improving collaborative communication. Meanwhile, researchers are required to assess the use of this technology by both students and researchers and how can this enhance the performance impact on measuring education sustainability. In addition, instructors should be aware of the benefit this technology brings to the various academic activities leading to better levels of performance impact on measuring education sustainability.

Overall, the complete hypotheses are confirmed by the outcomes from the study, which however contradict most of the previous studies that have reported the regular use of (SNAs) leading to low learning performance on measuring education sustainability [7], [21]. But there are some studies which are consistent with this study [8], [30], [54] and showed a significant impact on student learning performance on measuring education sustainability. It is remarkable that most of the postgraduate students responded positively to their courses through (SNAs), particularly in collaboration and information exchange, in comparison to face-to-face courses. Actual use and user satisfaction also have a meaningful effect on TTF. This follows, for once students believe (SNAs) use to be necessarily of help in completing academic tasks, in that the method fits the ways in which they learn things and usage and satisfaction consequently rises, such enhanced conditions should eventually translate into improved performance on measuring education sustainability. Similarly, it was established that TTF meaningfully affects performance on measuring education sustainability, a finding that corresponds with that of other studies [16], [18], [19].

A. THEORETICAL IMPLICATIONS OF RESEARCH

The outcomes of this research confirm the potential of (SNAs) influence for collaborating learning on students' satisfaction and their performance impact on measuring

education sustainability. The results also revealed that satisfaction, perceived ease of use, perceived usefulness of (SNAs) among students' effects positively to their collaboration and engagement as sustainability in higher education, and finally, their performance impact on measuring education sustainability. In addition, the results also showed that group discussion with peers are important to students and researchers as this could result in quality outcome of the group. Such activities may enable the students to generate ideas and opinions positively in group discussions and during interaction with their supervisors/instructors. The examination of collaboration and engagement as sustainability in higher education through (SNAs) use by TAM and social constructivism theory was also validated by the outcomes of the study. The overall active collaboration and engagement as sustainability in higher education through (SNAs) improves the learning activities of students and facilitates group discussions.

The results indicate the improved performance impact on measuring education sustainability of postgraduate students and the relationship with their interaction with peers, lecturers, their collaboration and engagement as sustainability in higher education, (SNAs) use, perceived usefulness, perceived ease of use, and their satisfaction. The use of (SNAs) generates an environment that is indicated by the active collaboration and engagement as sustainability in higher education which can aid the students to work in groups, to accomplish tasks.

Additionally, the online active collaboration and engagement as sustainability in higher education has indicated to have an improved effectiveness than the face-to-face collaboration and engagement as sustainability in higher education [12], as evidenced by the research skills development through the previous and ideas-exchange among students. Students obtain their required resources/information's from their peers as well as from their supervisors by using (SNAs). However, when compared, the empirical evidence suggested that students on campus needed more support in utilizing complementary (SNAs) active collaboration and engagement as sustainability in higher education options in comparison with face-to-face conferences, and also, lecturers may have positive roles in supporting the students while incorporating the use of (SNAs) in assisting brief questions, solutions and coordination [64], [29]. Based on the outcomes of this study, the use of (SNAs) has shown to effectively develop a positive and a learning conducive environment that is invaluable for the engagement, learning, and the teaching experience.

This research contributes to the literature by proposing a model that integrates constructivism and TAM-the integration of which verified the effectiveness in understanding the following; a) active collaboration and engagement as sustainability in higher education through (SNAs) and its effect on the students' satisfaction in universities, b) effect of (SNAs) use on the performance impact on measuring education sustainability of students in universities, and c) (SNAs) and other related technologies based theoretical model development.

The primary objective of the study was to uncover the influence of (SNAs) use on collaboration and engagement as sustainability in higher education and to show how this contributes in enhancing the students' performance impact on measuring education sustainability. The theory of constructivism is used and utilized to guide this objective. This study proves the positive influence of (SNAs) on collaboration and engagement as sustainability in higher education within the education sector in higher education. The contribution of this study is not only restricted on the use of constructivism theory in investigating the use of (SNAs), but it also provides insights into this field of research and adds to the body of knowledge. Moreover, combining both TAM and the theory of constructivism is a strong point of this study. This is true because this combination has been rarely used to study how education is influenced by (SNAs) addressing collaboration and engagement as sustainability in higher education in particular. TTF and compatibility variables for the purpose of creating a rigid model for use in newer contexts. This use of TTF and compatibility as mediating constructs is apparently one of the first attempted within the context of local (SNAs) usage.

B. PRACTICAL IMPLICATIONS OF RESEARCH

Since TTF and compatibility together mediate relationships among user satisfaction, actual usage, and academic performance on measuring education sustainability, it is vital for university management to integrate (SNAs) usage in their learning strategies, while evaluating what features align best with the users' needs, values, and lifestyles in the (SNAs) usage. In this research, we present three major practical contributions. It is recommended that these contributions help in the field work and assist the various users of the different tools of (SNAs). First, the idea of positive influence on educational outcome presented in collaboration and engagement as sustainability in higher education and performance impact on measuring education sustainability is likely to motivate students for using (SNAs). The incorporation of various tools of (SNAs) such as Facebook, Blogs, and YouTube can provide much benefit for students. Second, instructors and supervisors can provide the students with the needed help for improving the performance impact on measuring education sustainability of students by the use of (SNAs) for the purpose of achieving collaboration and engagement as sustainability in higher education. Third, institutions of higher education have the responsibility of encouraging (SNAs) use for educational purposes and not just instructing them to so. That can be done through workshop and raising the awareness of the many befits of it. Tertiary educational institutions will have the advantage of making use of this technology within their learning process. With the availability of resources, this has the benefit of raising the satisfaction of students and that would be positively reflected on their performance impact on measuring education sustainability. This is extremely important for research students who are always in need of resources and can make use of collaboration and engagement as

sustainability in higher education to have a better outcome and improve their performance impact on measuring education sustainability. The result of this research implicates that:

Incorporation of (SNAs) tools for collaboration and engagement as sustainability in higher education must promote students in utilizing the applications of (SNAs) for improving their performance on measuring education sustainability. Moreover, the lecturers/supervisors can guide students by replying to the students' queries, sharing knowledge and ease with which to obtain information that improve learning and research skills of students and researchers respectively.

Institutions are motivated to select students who are volunteering to use (SNAs) tools for collaboration and engagement as sustainability in higher education instead of forcing them to do so. Further, the institutes can use all the components and tools of (SNAs) during their learning process.

The technology and the resources are both crucial in students to use (SNAs) tools. Students should utilize these technological resources around them to become capable of learning and improving their performance on measuring education sustainability.

C. LIMITATIONS OF THIS RESEARCH

Although, this study concluded with interesting finding, it still has limitations in some areas. First, this study had limited sample size, which was taken from one population in a public university. This is a limitation since the findings might not apply to other settings like private institutions, school teachers, or armies. Moreover, the research is also limited in the range of investigation. In other words, some factors were only explored for their influence of the students' performance impact on measuring education sustainability which ignores other essential factors such as enjoyment, motivation, service quality, and others. However, this study has generated fascinating findings along with certain limitations. The sample size was limited to only one university; thus, the outcomes of this research fails to reflect the response of other sectors including private institutions, school teachers, or armies. Some other drawbacks include uses of only questionnaires and no other qualitative data. The questionnaires are dependent of students' perceptions, which might differ with teachers'. Future studies can replicate this methodology in other countries having cultural variety by overcoming these limitations.

D. FUTURE RESEARCH

The limitation of this study opens the door for further research to fill in the gaps. It is recommended that future research expands the range of data collection to include other universities or private educational institutions of higher education. Regarding the factors examined, future research can learn from this work and put more factors under investigation since there are plenty of factors influencing collaboration and engagement as sustainability in higher education and have an impact on performance impact on measuring

education sustainability. Mixed research approach can be used in future studies to increase multiple ways of looking and social development theory may be collaborated with the interaction model provide more scope for the teaching profession [13], [65], [66]. This study suggests certain factors such as enjoyment and motivation among others. The following points summarize recommendations for future research:

- Investigating the various ways by which students can utilize the (SNAs) to enhance collaboration and engagement as sustainability in higher education and increase their performance on measuring education sustainability.
  - Explore the effectiveness of utilizing different tools of (SNAs) in collaboration and engagement as sustainability in higher education and how they contribute to knowledge sharing among its users.
- Examining the effectiveness of using technology in the developing countries and their role in collaboration and engagement as sustainability in higher education.

VI. CONCLUSION

This research recommends the reconstruction of (SNAs) platform as a tool to contribute towards performance impact on measuring education sustainability. It is recommended that instructors utilize the social nature of the (SNAs) in order to develop the performance impact on measuring education sustainability and learning of students positively. Hence, this research is essential, as it has analyzed respondents from among students and researchers in improving the performance impact on measuring education sustainability through (SNAs) using two theories, that is, constructivism theory and TAM. Furthermore, present study has also provided the theoretical framework that concerns performance impact on measuring education sustainability and it will be a kick-start in demonstrating the reliability of those theories in (SNAs) toward improved performance impact on measuring education sustainability. Therefore, this research offers noteworthy findings to other institutions as development of the framework and its validity to improve performance impact on measuring education sustainability, which is able to increase the key performance indicator of the institutions.

REFERENCES

[1] F. A. Moafa, K. Ahmad, W. M. Al-Rahmi, N. Yahaya, Y. B. Kamin, and M. M. Alamri, "Develop a model to measure the ethical effects of students through social media use," *IEEE Access*, vol. 6, pp. 56685–56699, 2018.

[2] J. Gutmann, F. Kähbeck, P. O. Berberat, M. R. Fischer, S. Engelhardt, and A. Sarikas, "Use of learning media by undergraduate medical students in pharmacology: A prospective cohort study," *PLoS ONE*, vol. 10, no. 4, Apr. 2015, Art. no. e0122624.

[3] M. A. Almaiah, M. M. Alamri, and W. Al-Rahmi, "Applying the UTAUT model to explain the Students' acceptance of mobile learning system in higher education," *IEEE Access*, vol. 7, pp. 174673–174686, 2019.

[4] M. A. Almaiah, M. A. Jalil, and M. Man, "Extending the TAM to examine the effects of quality features on mobile learning acceptance," *J. Comput. Edu.*, vol. 3, no. 4, pp. 453–485, Dec. 2016.

[5] N. S. A. Rahman, M. S. Othman, and W. Al-Rahmi, "Exploring the use of social media tools among students for teaching and learning purpose," *J. Theor. Appl. Inf. Technol.*, vol. 91, no. 1, p. 49, 2016.

[6] E. Dahlstrom, P. Grunwald, and D. M. Boor Vockley, "The ECAR national study of students and information technology in higher education," EDU-CAUSE Center Anal. Res. (ECAR), Boston, MA, USA, Tech. Rep. 5, 2011.

[7] F. A. Moafa, K. Ahmad, W. M. Al-Rahmi, N. Alias, and M. A. M. Obaid, "Factors for minimizing cyber harassment among university students: Case study in Kingdom Of Saudi Arabia (KSA)," *J. Theor. Appl. Inf. Technol.*, vol. 96, no. 6, p. 51, 2018.

[8] W. M. Al-Rahmi, N. Alias, M. S. Othman, I. A. Ahmed, and A. Saged, "Social media use, collaborative learning and students' academic performance: A systematic literature review of theoretical models," *J. Theor. Appl. Inf. Technol.*, vol. 95, pp. 5399–5414, Jul. 2017.

[9] M. A. Almaiah, "Acceptance and usage of a mobile information system services in university of jordan," *Edu. Inf. Technol.*, vol. 23, no. 5, pp. 1873–1895, Sep. 2018.

[10] M. A. Almaiah and A. Al Mulhem, "Analysis of the essential factors affecting of intention to use of mobile learning applications: A comparison between universities adopters and non-adopters," *Edu. Inf. Technol.*, vol. 24, no. 2, pp. 1433–1468, Mar. 2019.

[11] D. Y. Lee and M. R. Lehto, "User acceptance of YouTube for procedural learning: An extension of the technology acceptance model," *Comput. Edu.*, vol. 61, pp. 193–208, Feb. 2013.

[12] N. Alalwan, W. M. Al-Rahmi, O. Alfarraj, A. Alzahrani, N. Yahaya, and A. M. Al-Rahmi, "Integrated three theories to develop a model of factors affecting Students' academic performance in higher education," *IEEE Access*, vol. 7, pp. 98725–98742, 2019.

[13] W. M. Al-Rahmi, N. Yahaya, U. Alturki, A. Alrobai, A. A. Aldraiweesh, and A. Y. B. Omar Alsayed Kamin, "Social media-based collaborative learning: The effect on learning success with the moderating role of cyberstalking and cyberbullying," in *Proc. Interact. Learn., Environ.*, 2020, pp. 1–14.

[14] M. A. Almaiah and O. A. Alismaiel, "Examination of factors influencing the use of mobile learning system: An empirical study," *Educ. Inf. Technol.*, vol. 24, no. 1, pp. 885–909, Jan. 2019.

[15] D. L. Goodhue and R. L. Thompson, "Task-technology fit and individual performance," *MIS Quart.*, vol. 19, no. 2, pp. 213–236, Jun. 1995.

[16] J. D'Ambra, C. S. Wilson, and S. Akter, "Application of the task-technology fit model to structure and evaluate the adoption of E-books by academics," *J. Amer. Soc. Inf. Sci. Technol.*, vol. 64, no. 1, pp. 48–64, Jan. 2013.

[17] M. A. Almaiah, A. Al-Khasawneh, and A. Althunibat, "Exploring the critical challenges and factors influencing the E-learning system usage during COVID-19 pandemic," *Edu. Inf. Technol.*, May 2020. May vol. 24, p. 1.

[18] M. A. Almaiah, M. A. Jalil, and M. Man, "Preliminary study for exploring the major problems and activities of mobile learning system: A case study of Jordan," *J. Theor. Appl. Inf. Technol.*, vol. 93, no. 2, pp. 580–594, 2016.

[19] P. Glowalla and A. Sunyaev, "ERP system fit—An explorative task and data quality perspective," *J. Enterprise Inf. Manage.*, vol. 27, no. 5, pp. 668–686, Sep. 2014.

[20] P. A. Tess, "The role of social media in higher education classes (real and virtual)—A literature review," *Comput. Hum. Behav.*, vol. 29, no. 5, pp. A60–A68, Sep. 2013.

[21] R. Junco, "Too much face and not enough books: The relationship between multiple indices of facebook use and academic performance," *Comput. Hum. Behav.*, vol. 28, no. 1, pp. 187–198, Jan. 2012.

[22] W. M. Al-Rahmi, A. I. Alzahrani, N. Yahaya, N. Alalwan, and Y. B. Kamin, "Digital communication: Information and communication technology (ICT) usage for education sustainability," *Sustainability*, vol. 12, no. 12, p. 5052, Jun. 2020.

[23] J. Pomerantz, C. Hank, and C. R. Sugimoto, "The state of social media policies in higher education," *PLoS ONE*, vol. 10, no. 5, May 2015, Art. no. e0127485.

[24] M. A. Almaiah and Y. Nasereddin, "Factors influencing the adoption of e-government services among jordanian citizens," *Electron. Government, Int. J.*, vol. 16, no. 3, p. 236, 2020.

[25] M. M. H. Goode and L. C. Harris, "Online behavioural intentions: An empirical investigation of antecedents and moderators," *Eur. J. Marketing*, vol. 41, nos. 5–6, pp. 512–536, Jun. 2007.

[26] V. Venkatesh and F. D. Davis, "A theoretical extension of the technology acceptance model: Four longitudinal field studies," *Manage. Sci.*, vol. 46, no. 2, pp. 186–204, Feb. 2000.

[27] P. Melzer, *A Conceptual Framework for Task and Tool Personalisation in IS Education a Conceptual Framework for Personalised Learning*. Cham, Switzerland: Springer, 2019, pp. 47–76, .

[28] Y. Liu, "Developing a scale to measure the interactivity of Websites," *J. Advertising Res.*, vol. 43, no. 2, pp. 207–216, Jun. 2003.

[29] W. M. Al-Rahmi, N. Yahaya, M. M. Alamri, N. A. Aljarboa, Y. B. Kamin, and F. A. Moafa, "A model of factors affecting cyber bullying behaviors among university students," *IEEE Access*, vol. 7, pp. 2978–2985, 2019.

[30] W. M. Al-Rahmi, A. Aldraiweesh, N. Yahaya, and Y. B. Kamin, "Massive open online courses (MOOCS): Systematic literature review in Malaysian higher education," *Int. J. Eng. Technol.*, vol. 7, no. 4, pp. 2197–2202, 2018.

[31] H.-J. So and T. A. Brush, "Student perceptions of collaborative learning, social presence and satisfaction in a blended learning environment: Relationships and critical factors," *Comput. Edu.*, vol. 51, no. 1, pp. 318–336, Aug. 2008.

[32] F. Altnay-Aksal and Z. Altnay-Gazi, "Technology as mediation tool for improving teaching profession in higher education practices," *EURASIA J. Math., Sci. Technol. Edu.*, vol. 13, no. 3, pp. 803–813, Feb. 2017.

[33] W. M. Al-Rahmi, N. Yahaya, A. A. Aldraiweesh, U. Alturki, M. Alamri, M. S. Bin Saud, Y. B. Kamin, A. A. Aljeraiwi, and O. A. Alhamed, "Big data adoption and knowledge management sharing: An empirical investigation on their adoption and sustainability as a purpose of education," *IEEE Access*, vol. 7, pp. 47245–47258, 2019.

[34] P. A. Ertmer, T. J. Newby, W. Liu, A. Tomory, J. H. Yu, and Y. M. Lee, "Students' confidence and perceived value for participating in cross-cultural wiki-based collaborations," *Educ. Technol. Res. Develop.*, vol. 59, no. 2, pp. 213–228, Apr. 2011.

[35] R. R. V. Rasiah, "Transformative higher education teaching and learning: Using social media in a team-based learning environment," *Procedia—Social Behav. Sci.*, vol. 123, pp. 369–379, Mar. 2014.

[36] Davis, F. D, "Perceived usefulness, perceived ease of use, and user acceptance of information technology," *MIS Quart.*, vol. 13, pp. 319–340, Apr. 1989.

[37] A. MA and A. IY, "Analysis of the effect of course design, course content support, course assessment and instructor characteristics on the actual use of E-learning system," *IEEE Access*, vol. 7, pp. 171907–171922, 2019.

[38] M. A. Almaiah and M. A. Jalil, "Investigating students' perceptions on mobile learning services," *JIM*, vol. 8, no. 4, pp. 31–36, 2014.

[39] Y. G. Shawai, "Malay language mobile learning system (MLMLS) using NFC technology," *Int. J. Edu. Manage. Eng.*, vol. 8, no. 2, pp. 1–7, Mar. 2018.

[40] M. A. Almaiah, M. Jalil, and M. Man, "Empirical investigation to explore factors that achieve high quality of mobile learning system based on students' perspectives," *Eng. Sci. Technol., Int. J.*, vol. 19, no. 3, pp. 1314–1320, Sep. 2016.

[41] M. A. Almaiah and A. Al Mulhem, "A conceptual framework for determining the success factors of e-learning system implementation using Delphi techniqu," *J. Theor. Appl. Inf. Technol.*, vol. 96, no. 17, pp. 1–15, Sep. 2018.

[42] M. M. Alamri, M. A. Almaiah, and W. M. Al-Rahmi, "Social media applications affecting Students' academic performance: A model developed for sustainability in higher education," *Sustainability*, vol. 12, no. 16, p. 6471, Aug. 2020.

[43] E. W. Rogers, *Diffusion of Innovations*. New York, NY, USA: The Free Press, 1995.

[44] M. Chang, W. Cheung, and V. Lai, "Literature derived reference models for the adoption of online shopping," *Inf. Manage.*, vol. 42, no. 4, pp. 543–559, May 2005.

[45] J.-H. Wu and Y.-M. Wang, "Measuring KMS success: A respecification of the DeLone and McLean's model," *Inf. Manage.*, vol. 43, no. 6, pp. 728–739, Sep. 2006.

[46] A. K. M. N. Islam and N. Azad, "Satisfaction and continuance with a learning management system," *Int. J. Inf. Learn. Technol.*, vol. 32, no. 2, pp. 109–123, Mar. 2015.

[47] W. M. Al-Rahmi, N. Yahaya, M. M. Alamri, I. Y. Alyoussef, A. M. Al-Rahmi, and Y. B. Kamin, "Integrating innovation diffusion theory with technology acceptance model: Supporting students' attitude towards using a massive open online courses (MOOCs) systems," *Interact. Learn. Environments*, pp. 1–13, Jun. 2019.

[48] J. C. Moore, "A synthesis of sloan-c effective practices," *Online Learn.*, vol. 13, no. 4, pp. 84–94, Feb. 2019.

[49] C. Greenhow and B. Robelia, "Old communication, new literacies: Social network sites as social learning resources," *J. Comput.-Med. Commun.*, vol. 14, no. 4, pp. 1130–1161, Jul. 2009.

[50] H.-B. Kim, T. Kim, and S. W. Shin, "Modeling roles of subjective norms and eTrust in customers' acceptance of airline B2C eCommerce Websites," *Tourism Manage.*, vol. 30, no. 2, pp. 266–277, Apr. 2009.

[51] H. H. Chang and I. C. Wang, "An investigation of user communication behavior in computer mediated environments," *Comput. Hum. Behav.*, vol. 24, no. 5, pp. 2336–2356, Sep. 2008.

[52] W.-S. Lin and C.-H. Wang, "Antecedences to continued intentions of adopting e-learning system in blended learning instruction: A contingency framework based on models of information system success and task-technology fit," *Comput. Edu.*, vol. 58, no. 1, pp. 88–99, Jan. 2012.

[53] L. Culibrk, C. A. Croft, and S. J. Tebbutt, "Systems biology approaches for Host–Fungal interactions: An expanding multi-omics frontier," *OMICS, A J. Integrative Biol.*, vol. 20, no. 3, pp. 127–138, Mar. 2016.

[54] L. W. T. Schuwirth and C. P. M. Vleuten, "A plea for new psychometric models in educational assessment," *Med. Edu.*, vol. 40, no. 4, pp. 296–300, Apr. 2006.

[55] W. M. Al-rahmi, M. S. Othman, and L. Mi Yusuf, "Using social media for research: The role of interactivity, collaborative learning, and engagement on the performance of students in malaysian post-secondary institutes," *Medit. J. Social Sci.*, vol. 5, p. 15, Sep. 2015.

[56] W. M. Alenazy, W. Mugahed Al-Rahmi, and M. S. Khan, "Validation of TAM model on social media use for collaborative learning to enhance collaborative authoring," *IEEE Access*, vol. 7, pp. 71550–71562, 2019.

[57] A. M. Helou, "The influence of social networking sites on students' academic performance in malaysia," *Int. J. Electron. Commerce Stud.*, vol. 5, no. 2, pp. 247–254, Dec. 2014.

[58] T. P. Alloway and R. G. Alloway, "The impact of engagement with social networking sites (SNSs) on cognitive skills," *Comput. Hum. Behav.*, vol. 28, no. 5, pp. 1748–1754, Sep. 2012.

[59] J. F. Hair, M. Sarstedt, C. M. Ringle, and J. A. Mena, "An assessment of the use of partial least squares structural equation modeling in marketing research," *J. Acad. Marketing Sci.*, vol. 40, no. 3, pp. 414–433, May 2012.

[60] W. Mugahed Al-Rahmi, M. Shahizan Othman, and L. Mi Yusuf, "Effect of engagement and collaborative learning on satisfaction through the use of social media on malaysian higher education," *Res. J. Appl. Sci., Eng. Technol.*, vol. 9, no. 12, pp. 1132–1142, Apr. 2015.

[61] M. A. Almaiah, "Alamri proposing a new technical quality requirements for mobile learning applications," *J. Theor. Appl. Inf. Technol.* vol. 96, p. 19, Oct. 2018.

[62] C. Fornell and D. F. Larcker, "Evaluating structural equation models with unobservable variables and measurement error," *J. Marketing Res.*, vol. 18, no. 1, pp. 39–50, Feb. 1981.

[63] M. P. Cuéllar, M. Delgado, and M. C. Pegalajar, "Improving learning management through semantic Web and social networks in e-learning environments," *Expert Syst. Appl.*, vol. 38, no. 4, pp. 4181–4189, Apr. 2011.

[64] W. M. Al-Rahmi, N. Yahaya, M. M. Alamri, N. A. Aljarboa, Y. B. Kamin, and M. S. B. Saud, "How cyber stalking and cyber bullying affect Students' open learning," *IEEE Access*, vol. 7, pp. 20199–20210, 2019.

[65] S. Hrastinski and N. M. Aghaee, "How are campus students using social media to support their studies? An explorative interview study," *Edu. Inf. Technol.*, vol. 17, no. 4, pp. 451–464, Dec. 2012.

[66] I. C. Tsai, "The importance and satisfaction of collaborative innovation for strategic entrepreneurship," *EURASIA J. Math., Sci. Technol. Edu.*, vol. 2015, 12, pp. 569–582.

[67] M. Alksasbeh, M. Abuhelaleh, M. A. Almaiah, A. J. Mohamed, and A. A. Karaka, "Towards a model of quality features for mobile social networks apps in learning environments: An extended information system success model," *iJIM*, vol. 13, no. 5, p. 75, 2019.

[68] A. MA and A. Al-Khasawneh, "Investigating the main determinants of mobile cloud computing adoption in university campus," *Educ. Inf. Technol.*, vol. 24, pp. 1–21, Jan. 2020.

[69] M. A. Almaiah, A. Al-Khasawneh, A. Althunibat, and S. Khawatreh, "Mobile government adoption model based on combining GAM and UTAUT to explain factors according to adoption of mobile government services," *Int. J. Interact. Mobile Technol. (iJIM)*, vol. 14, no. 03, p. 199, Feb. 2020.

[70] M. A. Almaiah, M. M. Alamri, and W. M. Al-Rahmi, "Analysis the effect of different factors on the development of mobile learning applications at different stages of usage," *IEEE Access*, vol. 8, pp. 16139–16154, 2020.

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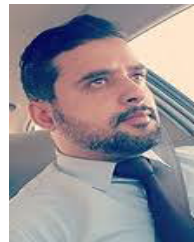
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