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Exploring disruptive power: Acceptance of digital technologies in mechanical engineering education among Ghanaian technical university teachers

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ABSTRACT

The paper examines the effect of perceived ease of use, user acceptance, and quality assurance practices on the acceptance of digital technology among mechanical engineering teachers in Technical Universities in Ghana. The paper adopts a quantitative research approach using a descriptive survey design. A sample of 167 mechanical engineering teachers was selected using stratified and simple random sampling techniques. Data was collected through a structured questionnaire that included demographic information and variables related to digital technology acceptance. The collected data were analyzed using structural equation modeling with the aid of SmartPLS 4 software. The study's findings reveal that perceived ease of use, user acceptance, and quality assurance practices significantly and positively influence mechanical engineering teachers' acceptance of digital technology. Specifically, the acceptance of quality assurance practices was found to have the strongest impact on technology acceptance among the three factors examined. The study focused on mechanical engineering teachers in Ghana's Technical universities, limiting the generalizability of the findings to other educational contexts. Future research should consider expanding the sample size and including participants from different educational institutions and other disciplines. This study contributes to the existing literature on digital technology acceptance by examining the specific context of mechanical engineering education in Ghana. The findings also contribute to the broader discourse on digital skills development and closing the digital divide in educational settings.

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INTRODUCTION

The disruptive effect of digital technologies has transformed industries across the globe, as well as how we work, communicate, and acquire knowledge. Integrating digital technologies and platforms in mechanical engineering education has led to innovative pedagogical approaches, enhanced learning, and improved student performance. These technologies comprise computer-aided design (CAD) software, simulation tools, Virtual Reality (VR), and Augmented Reality (AR) applications (Hajirasouli et al., 2023). These technological advancements can disrupt conventional methods of teaching within the field of mechanical engineering as educators strive to adjust to the

requirements of the modern engineering industry by incorporating technological innovations to construct more interactive and stimulating environments for learning (Menon & Suresh, 2022). Digital technologies possess a disruptive capacity as they have the potential to overturn established norms and modes of cognition (Alkhabra, 2022). The process involves challenging conventional methods and introducing innovative strategies for accomplishing objectives and attaining academic targets (Alkhabra, 2022). The willingness of educators to embrace novel digital tools is a critical factor in fully harnessing their transformative capabilities within mechanical engineering classrooms (Basaran & Yalman, 2020).

In Ghanaian technical Universities, where mechanical engineering education is a fundamental component, the utilization and proficient integration of digital technologies by educators are imperative considerations. The benefits of digital technologies are widely acknowledged. However, there needs to be more research regarding the factors that drive the integration of digital technologies by Technical University educators in their teaching within the Ghanaian context. To harness the transformative capabilities of digital technologies in the realm of mechanical engineering education (Onofrei & Ferry, 2020), it is imperative to have a comprehensive understanding of these mechanisms.

The ease with which individuals perceive digital tools as usable is a significant determinant of their adoption (Alowayr, 2022). The level of ease that educators experience in adopting and utilizing these tools has a notable impact on their willingness to integrate them into their instructional practices (Alowayr, 2022). The effectiveness and robustness of integrating digital technologies are significantly contingent upon user acceptance, encompassing factors such as perceived usefulness and satisfaction (Kashive et al., 2020). The acceptance and sustained integration of digital technologies in educational environments is contingent upon implementing quality assurance measures, such as reliability, functionality, and technical assistance (Chukwuedo et al., 2023).

The paper examines the use of digital technology by mechanical engineering educators in Technical Universities in Ghana and determines the factors influencing this practice. The potential impact of these technologies on mechanical engineering programs in Ghana was unveiled by examining the disruptive potential. Furthermore, the findings of this paper provide valuable insights for policymakers, educational institutions, and engineering training programs on how to harness the disruptive capabilities of digital technology effectively.

Theoretical Framework and Literature Review

Theoretical Framework

The paper employed the Technology Acceptance Model (TAM), The Unified Theory of Acceptance and Use of Technology (UTAUT), and The Innovation Diffusion Theory (IDT). These theories offer significant contextual information for comprehending the factors that impact educators' attitudes toward adopting and using technologies within the Technical Universities in Ghana.

The TAM is a widely utilized conceptual framework to comprehend individuals' responses to innovative technologies (Davis, 1989; Samartha et al., 2022). Per the TAM, the primary determinants that impact individuals' inclination towards embracing innovative technology are the technology's perceived usefulness and ease of use (Davis, 1989). The theory of perceived utility in technology pertains to the belief that its usage would enhance performance or productivity. In contrast, perceived simplicity of use pertains to the perspective that its implementation is uncomplicated (Gefen & Larsen, 2017). The TAM has been employed in various academic domains, such as mechanical engineering education, to examine how students react to and utilize innovative technology tools.

The UTAUT is another pertinent theory underpinning the current study, which is generally used to study individuals' adoption of innovative technologies. The UTAUT theory is an extension of the TAM model, which integrates many concepts to provide a comprehensive framework for understanding technology adoption and use (Alowayr, 2022). The UTAUT theory comprises performance expectation, effort expectation, social influence, and enabling circumstances (Chang, 2012). The theory centers on the influence of individuals' social and environmental contexts on their propensity to embrace novel technological innovations (Chang, 2012). The UTAUT model provides

a comprehensive framework for examining the extent to which educators in the field of mechanical engineering are embracing digital tools, taking into account the broader social and organizational context.

Finally, IDT serves as a supplementary framework to the TAM and the UTAUT in comprehending the process of digital technology adoption within educational settings. The IDT is a theoretical framework that examines how novel concepts are disseminated from their originators to the end-users (Sahin, 2006). This paper emphasizes the attributes of the invention, the effectiveness of the channels used to disseminate it, the impact of social networks, and the perceived advantages and disadvantages associated with implementing the innovation (Dibra, 2015). Mechanical engineering instructors have utilized IDT to examine the distribution patterns and factors that influence the adoption of digital technology in education (Anthony Jnr et al., 2020). These theories provide practical frameworks for comprehending the pervasive use of digital technologies in mechanical engineering education. The theories shed light on the complex interrelationship among individuals' perceptions of the efficacy, ease of use, societal influence, and innovation of digital tools for educational purposes.

Literature Review and Hypothesis Development

The widespread adoption of digital technology can be attributed to its perceived ease of use. The perceived ease of use among educators significantly influences their willingness to integrate these tools into their instructional practice (Davis, 1989). Previous studies rooted in the TAM and the UTAUT have established a positive correlation between perceived ease of use and technology adoption (Vlachogianni & Tselios, 2022). Based on the discussion, we proposed that H1: Perceived ease of use positively influences digital technology acceptance.

The degree of acceptance by users plays a significant role in determining the success and robustness of digital technology adoption (Acheampong & Acheampong, 2020). Studies utilizing the TAM and UTAUT have evidenced that the acceptance of technology by users has a positive link with its adoption (Gyaase et al., 2013; Mugambi, 2019). We, therefore, theorized that H2: User acceptance positively influences digital technology acceptance.

The adoption and continued utilization of digital technologies within educational settings is contingent upon implementing quality assurance measures that ensure their reliability, efficacy, and provision of technical assistance (Sucu & Çakiroğlu, 2022). Although there is limited research on the subject, the existing literature suggests that implementing quality assurance practices has a positive influence on adopting technology (Sucu & Çakiroğlu, 2022; Vlachogianni & Tselios, 2022). The hypothesis is thus formulated as H3: Quality assurance practices positively influence digital technology acceptance.

RESEARCH METHOD

This article adopts a quantitative and descriptive survey approach to examine the influence of perceived ease of use, user acceptance, and quality assurance practices on digital technology acceptance.

Participants

The study's target population comprises 294 mechanical engineering teachers in the ten (10) Technical universities in Ghana. The choice of 294 teachers in the field of mechanical engineering constitutes a substantial and inclusive target, encompassing individuals who possess first-hand knowledge of instructing and implementing digital technology within the educational setting.

The paper sampled 167 mechanical engineering teachers using a finite sample size determination formula. Stratified and simple random sampling techniques were employed to obtain a representative sample of the participants for the study. A combination of stratified and simple random sampling techniques was employed to ensure a statistically significant sample (Hendrycks et al., 2019). Implementing this sampling strategy enhances the generalizability of the sample and ensures the inclusion of educators from various technical universities in the research. Additionally,

the individual participants were selected using simple random sampling within each stratum, thereby mitigating potential bias and enhancing the generalizability of the findings (Bell et al., 2022). The demographic profile of the mechanical engineering teachers is presented in Table 1. Table 1 presents the demographic information on gender, age, educational level, marital status, and working experience of the mechanical engineering teachers in the Technical Universities in Ghana.

Table 1. Participant's Profile

Profile	Category	*f*	%
Gender	Male	105	65.6
	Female	55	34.4
Age	25-35	22	13.8
	36-45	42	26.2
	46-55	56	35.0
	56-66	34	21.2
	Above 65	6	3.8
Education Level	Bachelor	19	11.8
	Master's	63	39.4
	PhD	78	48.8
	Divorce	3	1.9
Martial Status	Married	92	57.5
	Single	34	21.2
	Widowed	31	19.4
Working	< 10 years	26	16.3
Experience	10-15 years	38	23.8
	16-20 years	28	17.5
	21-25 years	33	20.6
	Above 25 years	35	21.8

Source: Field Data (2023)

Instrumentation and Measures

The paper employed a structured questionnaire segmented into parts to collect quantitative data from the participants. The first part of the questionnaire dwells on participants' demographic information, such as age, gender, educational level, marital status, and working experience. The second part of the questionnaire covers Digital Technology Acceptance (DTA), Perceived Ease of Use PEU), User Acceptance (UA), and Quality Assurance Practices (QAP). Digital technology acceptance is the dependent variable measured with six (6) items adapted and modified (Alowayr, 2022). Besides perceived ease of use, user acceptance was measured with five (5) items adapted and modified (Ahmad, 2018). User acceptance was measured with two (2) items, and quality assurance practices were measured with five (5) items. The variables are rated on a five-point Likert Scale ranging from strongly agree, denoting 5, to disagree, signifying one strongly.

A pilot study was conducted with 31 participants who volunteered as educators in Technical Universities. The Cronbach alpha results showed that the questionnaire's items are reliable and consistent in measuring the study's variables. The Cronbach alpha coefficients obtained were DTA = 0.934, PEU = 0.828, UA =0.817, and QAP = 0.926.

Data Collection Procedures

Prior permission was sought from the management of the technical Universities, and the participants sampled also consented to be part of the study before the link to the questionnaire uploaded on the Google Forms was sent to their emails and WhatsApp numbers. Completed responses were downloaded in a Microsoft Excel sheet after six weeks of sending the links. Out of the 167 questionnaires administered, 160 responses were received.

Data Analysis

The paper employed Structural Equation Modelling (SEM) analysis using SmartPLS 4 software. SEM was used to assess the relationship between the variables. The reliability, convergent validity, and discriminant validity were pre-tested. Reliability and convergent validity were assessed using Cronbach's alpha, composite reliability (rho_c), and average variance extracted (AVE). Cronbach's alpha measure of internal consistency and reliability indicates the extent to which the items within each construct consistently measure the underlying concept. The composite reliability measure (rho_c) evaluates the reliability of a construct by examining the correlation among its constituent indicators (Hair et al., 2019). The average variance extracted (AVE) denotes the mean proportion of variance accounted for by the indicators of the construct. The HTMT ratio was employed to evaluate the discriminant validity of the constructs (Khan et al., 2019).

FINDINGS AND DISCUSSION

Results

Reliability and Validity of Results

The paper used measurement model assessment techniques to examine various measures such as convergent validity, discriminant validity, indicator reliability, and construct validity, as shown in Table 2. The loadings of all indicators exceeded 0.70, suggesting a statistically significant association between the indicators and the latent constructs they represent. The latent constructs were found to possess reliability coefficients, namely Cronbach's alpha and composite reliability values, exceeding the threshold of 0.70.

The AVE (Average Variance Extracted) metric was employed to assess the convergent validity of the study. In Table 3, the heterotrait-monotrait ratio of correlations (HTMT) coefficient was employed to assess the discriminant validity of the constructs, which aims to ascertain the extent to which they are distinct from one another in measurement. The paper shows the reliability and accuracy of the measuring framework by employing diverse evaluation techniques. The indicators are robust, and the constructs' reliability and the measurement model's convergent and discriminant validity were confirmed, ensuring data accuracy and validity.

Table 2. Reliability and Convergent Validity

Items	Loadings	t-statistics	p-values	Cronbach's alpha	Composite Reliability (rho_c)	Average Variance Extracted (AVE)
DTA1	0.795	39.570	< 0.001			
DTA2	0.833	59.424	< 0.001	0.954	0.963	0.814
DTA3	0.788	44.536	< 0.001			
DTA4	0.819	46.809	< 0.001			
DTA5	0.767	38.669	< 0.001			
DTA6	0.859	55.568	< 0.001			
PEU1	0.874	56.370	< 0.001			
PEU2	0.870	56.687	< 0.001	0.934	0.947	0.696
PEU3	0.890	46.553	< 0.001			
PEU4	0.722	25.850	< 0.001			
PEU5	0.796	47.362	< 0.001			
UA1	0.750	33.539	< 0.001	0.956	0.979	0.958
UA2	0.756	37.679	< 0.001			
QAP1	0.810	45.442	< 0.001			
QAP2	0.843	56.279	< 0.001	0.924	0.936	0.677
QAP3	0.835	54.996	< 0.001			
QAP4	0.814	49.376	< 0.001			

Note: DTA: Digital technology acceptance, PEU: Perceived ease of use, UA: User acceptance, QAP: Quality assurance practices

Table 3. HTMT Results for Discriminant Validity

Constructs	DAT	PEU	UA	QAP
DAT	-			
PEU	0.573	-		
UA	0.480	0.584	-	
QAP	0.204	0.750	0.160	-

Note: DTA: Digital technology acceptance, PEU: Perceived ease of use, UA: User acceptance, QAP: Quality assurance practices

Structural Models Result on Predictors of Digital Technology Acceptance

Several tests were conducted to examine the structure of digital technologies. The effectiveness of the model in terms of explanation and prediction was assessed. The presence of collinearity was deemed insignificant, as indicated by the AVIF value of 1.518 for blocks and the AFVIF value of 1.840 for complete collinearity. The precision of the model was assessed by analyzing the standardized root mean square residual (SRMR). The Q2 value indicated that the model had a predictive significance greater than zero when applied to the sample. The results presented in Figure 1 and Table 4 indicate that the adoption of digital technologies can be attributed to three main factors, namely user acceptability, quality assurance practices, and perceived ease of use, which collectively explain 56.1% of the variation observed in digital technology acceptance by educators in the Technical University in Ghana.

Table 4. Effects of User Acceptance, Quality Assurance Practices and Perceived Ease of Use on Digital Technology Acceptance

Paths	*β*	*SE*	*t*-statistics	*p*-values	f^2
PEU => DTA	0.303	0.142	2.128	0.033**	0.103
UA => DTA	0.284	0.143	1.991	0.047**	0.090
QAP => DTA	0.448	0.081	5.552	0.000***	0.447

Note: * p < 0.10; ** p < 0.05; *** p < 0.001, Q^2 value is 0.313; SRMR = 0.072, AVIF – 1.518, AFVIF = 1.840

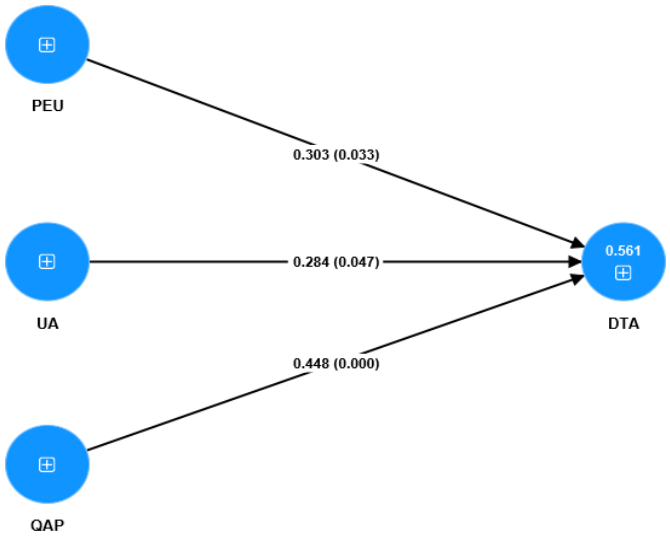

Figure 1. Structural Model Predicting Lecturers' Digital Technology Acceptance

The following findings were established: perceived ease of use has a significant positive effect on digital technology acceptance (β = 0.303; SE = 0.142; t = 2.128; p = 0.033; f2 = 0.12). The relationship between quality assurance practice and digital technology acceptance is significant and positive (β = 0.448; SE = 0.081; t = 5.552; p = 0.000; f2 = 0.447). Finally, Lastly, the relationship between user acceptance and digital technology acceptance (DTA) is statistically significant and

positive (β = 0.284; SE = 0.143; t = 1.991; p = 0.047; f2 = 0.10). Based on the findings, the three hypotheses were accepted. This suggests that as mechanical engineering educators perceive technology to become more user-friendly, their acceptance of digital technology upsurges. Besides, higher user acceptance is associated with greater digital technology acceptance among mechanical engineering educators in Ghanaian Technical Universities. Moreover, implementing effective quality assurance practices leads to higher acceptance of digital technology among mechanical engineering educators in Ghanaian Technical Universities.

Discussion

The paper established a significant positive relationship between the perceived ease of use and the acceptance of digital technology. The finding is consistent with prior studies based on the TAM and UTAUT, which emphasize the importance of individuals' perception of a technology's ease of use in their adoption behavior (Davis, 1989; Gefen & Larsen, 2017). Mechanical engineering educators exhibit a greater propensity to adopt digital technology when they perceive it as simple. The argument suggests that initiatives aimed at improving the perceived ease of use of digital tools can favor their adoption by educators in the field of mechanical engineering.

The proposition that the acceptance of users positively impacts the acceptance of digital technology is in line with previous research that has employed the TAM and UTAUT. These frameworks underscore the significance of user acceptance in the technology adoption process (Gyaase et al., 2013; Mugambi, 2019). The pivotal role of technology adoption by users, particularly educators, cannot be overstated in the effective integration and utilization of digital tools in educational environments. The correlation between user acceptance and digital technology acceptance suggests that cultivating a favorable attitude and perception toward digital tools among mechanical engineering instructors can enhance their acceptance and adoption.

Quality assurance practices have a direct impact on the acceptance of digital technology. The extant body of literature indicates that adopting technology can be positively influenced by implementing quality assurance practices (Sucu & Çakiroğlu, 2022; Vlachogianni & Tselios, 2022). This finding underscores the significance of guaranteeing reliability, effectiveness, and technical assistance when incorporating digital technologies into the educational system. Implementing efficient quality assurance techniques can augment the adoption and integration of digital technologies within the instructional environment of mechanical engineering teachers.

CONCLUSION

The findings of this research indicate that the acceptance of digital technology among mechanical engineering lecturers is significantly and positively influenced by perceived ease of use, quality assurance practices, and user acceptance of quality assurance practices, which have the greatest impact on teachers' adoption of digital technologies. The findings of this study hold significant ramifications for diverse stakeholders, such as developers of technology, policymakers in the field of education, and educators themselves. The paper emphasizes the importance of technology developers prioritizing user-friendly digital tool design. Prioritizing and enhancing perceived ease of use is imperative to augment educators' acceptance and adoption of digital technologies. Educational policymakers and administrators must consider incorporating efficient quality assurance measures. The enhancement of acceptance and utilization of digital tools among lecturers can be achieved by ensuring their reliability, efficacy, and technical support. The pivotal role played by teachers significantly influences the acceptance and adoption of digital technology. The results underscore the significance of fostering a constructive mindset and outlook regarding technological instruments. The provision of professional development opportunities and support programs can serve as a means of augmenting the digital literacy of educators and their capacity to integrate digital tools into pedagogical practices effectively.

Nevertheless, it is crucial to recognize the limitations of this research. The study was carried out with a particular focus on mechanical engineering education within Technical Universities in Ghana. Hence, the extent to which the results can be applied to other disciplines, fields, or educational

settings may be limited. Future studies should explore associations within diverse educational settings to provide a more all-encompassing understanding.

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