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EVALUATING INSTRUCTIONAL VIDEO EFFECTIVENESS IN PROMOTING ACTIVE LEARNING BEHAVIOURS AMONG SPACE UTM STUDENTS

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ABSTRACT - Instructional videos are one of the essential visual teaching tools used by SPACE UTM students in supporting their learning. They vary depending on the course objectives set by the lecturers. In SPACE UTM context, the use of the multimedia design features in the video that promote active learning behaviours among students still remain scarcely explored. For that reason, this study delves into the seven instructional video design elements: length and structure, visual aids, on screen text, instructor presence, guiding messages and questions, examples and scenarios, and audio or delivery style that enhance learning engagement guided by the ICAP framework. A quantitative research design was employed using an online survey administered to SPACE UTM students through stratified random sampling resulting in 422 respondents. The instrument measured students' perceptions of instructional video design and their self-reported engagement across active, constructive, and interactive learning behaviours. Descriptive statistics, Pearson correlation analysis, and multiple regression analysis were used to summarise perceptions, examine relationships between video design elements and learning behaviours, and identify the strongest predictors of engagement respectively. The results indicate that students were reported to have positive perceptions of all design elements with mean scores ranging from 3.45 to 3.53 on a four point scale, while all design elements were positively and significantly correlated with all the ICAP learning behaviours with correlation coefficients ranging from 0.45 to 0.78. Through regression analysis, it is shown that instructional video design explained 57.0% of the variance in active learning, 55.5% in constructive learning, and 40.7% in interactive engagement, with guiding messages and questions and audio or delivery style as the most consistent predictors across engagement types. Overall, the findings have identified video design elements that promote ICAP learning behaviours and support institutional efforts in strengthening digital pedagogy within the institution.

Keywords: Instructional Video Design; ICAP Framework; Multimedia Learning; Malaysia Higher Education; SPACE UTM.

1. INTRODUCTION

It is common that instructional videos are used in higher education by all universities across the world to support hybrid and online teaching and learning [1], [2]. Students of SPACE UTM themselves use videos to support learning particularly in managing their lesson recaps and learning pace to understand detailed concepts taught in the class. Even though it is proven in some research that instructional videos are well known in helping students going through their learning process, not all videos are well-developed that could meet the styles and learners' needs.

Mayer's Cognitive Theory of Multimedia Learning (CTML) mentioned that students could acquire knowledge better when structured information aids strong comprehension of both verbal and visual understanding and its alignment with long term retention and cognitive load management [3]. The vital role in moulding learning impacts includes teacher conduct, text display, clear visual, learner autonomy, and instructional design itself as a whole.

In addition, Chi and Wylie's ICAP framework [4] connected and assessed students' engagement with their learning materials. The combination of multimedia learning principles adds another dimension to ICAP by providing a stand of deeper cognitive involvement to the utilisation of instructional videos.

Instructional videos are used on a large scale in hybrid and online courses at SPACE UTM especially courses that offer online distance learning, part-time courses for working students who rely on asynchronous learning. However, little is known about how the design of these videos influences students' ICAP in this context in SPACE UTM context. Video materials are produced using various approaches, and there is limited evidence on which design elements help students engage more effectively. This is vital to help in assisting video development, improving digital teaching and learning, and facilitating guidance to teaching and learning aids.

This study focuses on seven design elements which are length and structure, visual aids, on-screen text, instructor presence, guiding messages and questions, examples and scenarios, and audio or delivery style. The study examines how these elements relate to active learning behaviours and identifies the elements that best explain student engagement as described by the ICAP framework.

1.1 Literature Review

1.1.1 Instructional Videos Usage in Higher Education

As one of the well-known teaching and learning resources used worldwide, instructional video encourages students finding comfort in adjustability, self-directed study, and open learning access for different groups of students. Videos can establish relationships with students and enhance self-learning [5]. Interactive video used in universities around Malaysia has its contribution in enhancing

collaboration and supporting active participation through various courses. This improves student engagement which enriches the 21st century skills invested in Malaysia education [2]. The existence of digital education relies strongly on the teaching and learning design besides instructor readiness [6].

1.1.2 Video Design Elements based on Cognitive Theory of Multimedia Learning (CTML)

Video consists of narration, visuals, and text, allowing students to merge information using both channels. Students tend to participate actively and preserve information efficiently with developed video that adheres to CTML principles like segmentation, coherence, signalling, and modality [1], [2], [3]. There are seven instructional video design elements identified for this study that include length and structure, visual aids, on-screen text, instructor presence, guiding message and questions, examples and scenarios, and audio or delivery style. These elements represent the practical application of CTML principles and its used in other related empirical studies on instructional video design element explained as follows;

1.1.2.1 Length and Structure

Efficient video design improves learning using segmentation principles within CTML when detailed information is divided into smaller and purposeful parts [3] which retains students' attention and focus [7]. Segmented presentations are proven to have produced higher learning performance compared to endless ones [8].

1.1.2.2 Visual Aids

CTML's coherence and signalling principles mentioned that related visuals are helpful, acting as aids to enhance understanding but not irrelevant information [3]. Diagrams and relevant visuals help to direct attention making learners remember important ideas [9], [10].

1.1.2.3 On-Screen Text

On-screen text displayed near the related visuals in the video boosts learning outcomes according to spatial contiguity and signalling in CTML principles [3]. Captions and colour-coded highlights increase focus and comprehension [9]. Meanwhile, textual signals help learners identify and emphasise key information [11].

1.1.2.4 Instructor Presence

Talking-head videos, where instructors appear on-screen, increase student engagement and problem-solving attempts [1] also enhance clarity and motivation

[11]. [3] indicates that narration delivered through a human voice facilitates better cognitive processing.

1.1.2.5 Guiding Messages and Questions

Embedding guiding messages and questions within instructional videos encourages learners to reflect, apply new knowledge, and strengthens comprehension [3]. Pre-embedded interactive features such as questions and reflective pauses improve learner attention, sustain engagement, and self-monitoring [10], [12].

1.1.2.6 Examples and Scenarios

[3] worked-example principle supports the use of examples to promote understanding and knowledge transfer. Scenario-based explanations improve contextual learning and knowledge retention among higher-education students [2] where students experience a rich engagement in lessons [11].

1.1.2.7 Audio or Delivery Style

[1] modality principle highlights that audio clarity and tone delivery have stronger impacts on students' engagement and understanding than printed text alone. The importance of persistent, clear audio, and energetic narration styles are to retain students' focus and engagement [6], [9].

1.1.3 Active Learning and the ICAP Framework

The four levels of ICAP which are passive, active, constructive, and interactive are used as the root on how student engagement impacts the learning outcomes [4]. Students progress from passively obtaining information to actively processing it, then to using the information to construct their own meaning, and finally lead to engaging in collaborative learning. There are connections between motivation and perceived learning with constructive and interactive activities [13].

1.1.4 Linking Video Design Features to Active Learning Behaviours

Digital storytelling uses related stories as examples and incorporates emotion to help learners store and apply knowledge efficiently compared to the conventional-lecturer's teaching styles [13]. In Malaysia, active discussion and collaboration among peers are triggered with the existence of interactive video lessons [2].

Based on the reviewed literature, instructional video design elements grounded in CTML principles have been shown to influence students' cognitive processing and engagement levels. In parallel, the ICAP framework provides a structured understanding of how varying levels of engagement contribute to learning

outcomes. Together, these perspectives suggest that well-designed instructional videos are likely to promote active, constructive, and interactive learning behaviours among SPACE UTM students.

2. MATERIALS AND METHODS

2.1 Research Design

Quantitative research design is used in this research to evaluate the relationship between instructional video design and students' active learning behaviour based on CTML and ICAP frameworks. The independent variables used in this study were constructs drawn from CTML. Meanwhile, the dependent variables drew constructs from the ICAP framework for active learning behaviours.

2.2 Research Framework

The conceptual framework used in this study was mapped from Mayer's Cognitive Theory of Multimedia Learning (CTML) [3] and Chi and Wylie's ICAP framework [4]. The CTML principles were the groundwork of the independent variables' constructs for the seven instructional video design elements: length and structure, visual aids, on-screen text, instructor presence, guiding messages and questions, examples and scenarios, and audio or delivery style. Moreover, the dependent variables' constructs were derived from the ICAP framework, concentrating on the active learning behaviours across three engagement levels: active, constructive, and interactive.

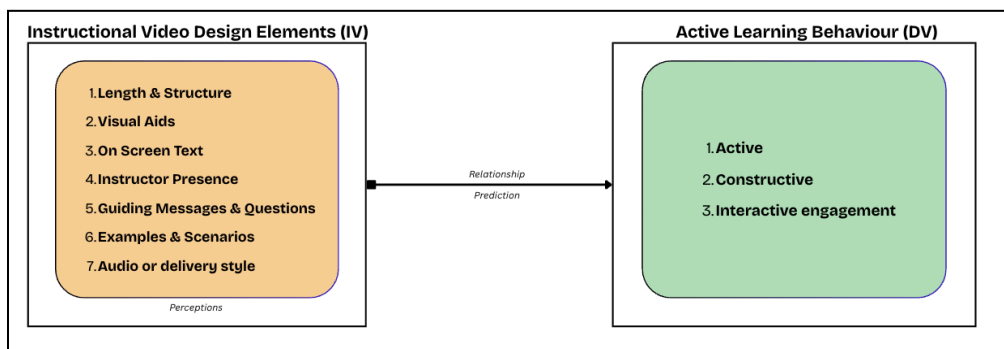


Figure 1. Conceptual Framework Integrating CTML and ICAP Frameworks

Based on the theoretical foundations of CTML and the ICAP framework, as well as empirical findings from prior studies on instructional video design, this study proposes the following hypotheses. These hypotheses aim to examine both the relationships and predictive influence of instructional video design elements on different levels of student engagement.

- H1: There is a significant relationship between instructional video design elements and active learning behaviours among SPACE UTM students.
- H2: Each instructional video design element significantly predicts students' active learning behaviour levels.
- H3: Guiding messages and questions, examples and scenarios, and instructor presence are the strongest predictors of constructive and interactive learning behaviours.

2.3 Population and Sampling

The population for this study consists of all active students enrolled in SPACE UTM programmes. Students should have experience of using instructional videos as part of their learning activities. A stratified random sampling approach was used to draw samples from this population that were considered representative of various study levels from different academic programmes. The distribution process includes inviting students to participate voluntarily through an online survey using Google form. SPACE UTM holds 4,939 students as its population number and minimum number of 354 students were drawn as the target samples based on Krejcie and Morgan's table [14] to ensure the stability of sample representativeness and sufficiency in the statistical analysis process.

2.4 Instrument Development

The development of questionnaires used in the survey were based on the explained conceptual framework drawn from CTML and ICAP theories. The survey instrument included 39 items and were divided into three sections: Section A, Section B, and Section C.

Section A: Collected data on students' demographic information. There are 4 items presented in this section.

Section B: Collected data on students' perceptions of the seven instructional video design elements derived from CTML. In this section, 26 items were used to collect the students' perception.

The seven instructional video design elements derived from CTML that acted as the independent variable in this research project are: length and structure (3 items), visual aids (3 items), on-screen text (4 items), instructor presence (5 items), guiding messages and questions (5 items), examples and scenarios (3 items), and audio or delivery style (3 items).

Section C: Collected data on students' three levels of active learning behaviour drawn from the ICAP framework where in this section, 9 items were presented.

Meanwhile, the three levels of active learning behaviours (ICAP) mentioned and acted as the dependent variable in this research are: Active Learning (3 items), Constructive Learning (3 items), and Interactive Engagement Learning (3 items).

Short descriptions were included before each section to ensure that students could interpret—instructional videos and active learning consistently. Passive behaviour was not included as a measured construct because it represented a lack of engagement and included simple observation without cognitive effort, making it unsuitable for item based measurement [4]. This approach supports the decision to measure only the three engagement levels that could be captured accurately in a questionnaire.

Items were generated through a combination of adopted, adapted and constructed statements. Adopted items were taken directly from prior research when found to be clearly aligned with the study constructs. Adapted items maintained the original meaning of previous work but were reworded to improve clarity and fit the context of SPACE UTM learners. Constructed items were developed by the researcher to address aspects not fully covered in existing instruments, supported by CTML and ICAP theories. This ensured that all constructs were adequately represented.

A four-point likert scale (Strongly Disagree, Disagree, Agree, Strongly Agree) was used for the pilot and actual study. The neutral option was removed to avoid bias and to obtain better insights of the study [15]. The suitability of the instrument's content was validated by an expert with an Educational Technology background related to the field of this study. The items were reviewed and checked for its relevance, clarity, and suitability. The pilot testing process was prepared to test the reliability of the validated instrument before conducting it on the actual study.

2.5 Data Collection Procedure

The data collection procedure started with pilot study involving 60 UTM students to assess internal consistency and item clarity. Each construct was tested through Cronbach's alpha and its reliability achieved values above 0.70 which indicates good reliability [13]. The whole instrument was reliable at 0.981 which indicated that the items were internally consistent, suitable, and ready to use for the actual data collection. The survey was distributed online to SPACE UTM students through email, Whatsapp groups, and eLearning platforms using Google Form for both pilot & actual study. The participation of the study was voluntary. Students were informed on the purpose of the study and also the confidentiality assurance of participation. Meanwhile, 422 respondents were collected for the actual study from 1st December 2025 until 14th December 2025.

2.6 Data Analysis

The Statistical Package for the Social Sciences (SPSS) was used to analyse data gathered. Descriptive statistics (mean and standard deviation): Summarised student perceptions of video design and active learning behaviour. Inferential statistics (Pearson's correlation and multiple regression): Tested the relationship strength and direction between variables using a correlation analysis. Meanwhile, regression analysis verified which design elements most profoundly foresaw active, constructive, and interactive engagement among SPACE UTM students.

3. RESULTS AND DISCUSSION

3.1 Descriptive Statistics Analysis

The students' perceptions regarding instructional video design elements used and their active learning behaviours were assessed using Descriptive Analysis.

In general, the results shown in Table 1 gave positive perceptions for all instructional video design elements with mean ranges from 3.45 to 3.53. Examples and Scenarios showed the highest mean score ($M = 3.53$, $SD = 0.54$), followed by Instructor Presence ($M = 3.52$, $SD = 0.52$) and Audio or Delivery Style ($M = 3.51$, $SD = 0.55$).

There were also high levels of students' engagement in active learning behaviours recorded where Constructive Learning got the highest mean score ($M = 3.52$, $SD = 0.54$), followed closely by Active Learning ($M = 3.52$, $SD = 0.55$), and then Interactive Engagement Learning ($M = 3.39$, $SD = 0.66$).

Table 1. Descriptive Statistics throughout CTML and ICAP Constructs ($n = 422$)

Constructs	Items	Mean	Standard Deviation
Independent Values (IV)			
Length and Structure	3	3.4463	0.59080
Visual Aids	3	3.5063	0.57053
On Screen Text	4	3.4887	0.54818
Instructor Presence	5	3.5199	0.51921
Guiding Messages and Questions	5	3.4626	0.54661
Examples and Scenarios	3	3.5316	0.53677

Constructs	Items	Mean	Standard Deviation
Audio or Delivery Style	4	3.5071	0.55404
Dependent Values (DV)			
Active Learning	6	3.5158	0.55344
Constructive Learning	4	3.5231	0.54400
Interactive Engagement Learning	5	3.3877	0.66285

3.2 Correlation Analysis

Pearson correlation analysis was conducted to examine the relationships between instructional video design elements and students' active learning behaviours. The results indicated that all instructional video design elements were positively and significantly correlated with active, constructive, and interactive learning behaviours. All correlations were statistically significant at the 0.01 level as shown in Table 2.

Table 2. Correlation Analysis between CTML Constructs and ICAP Constructs ($n = 422$)

Video Design Element	Active Learning	Constructive Learning	Interactive Engagement
Length and Structure	0.585**	0.596**	0.529**
Visual Aids	0.564**	0.567**	0.453**
On-Screen Text	0.582**	0.587**	0.539**
Instructor Presence	0.660**	0.663**	0.516**
Guiding Messages and Questions	0.701**	0.687**	0.577**
Examples and Scenarios	0.680**	0.655**	0.563**
Audio or Delivery Style	0.693**	0.681**	0.576**

*Note: ** Correlation is significant at the 0.01 level (two tailed)*

Overall, the strength of the relationships ranged from moderate to strong, with correlation coefficients ranging from $r = 0.453$ to $r = 0.783$. The strongest associations with Active Learning behaviours among the instructional video design elements were Guiding Messages and Questions, Examples and Scenarios, and Instructor Presence. In particular, Guiding Messages and Questions showed a strong positive relationship with Active Learning ($r = 0.701$), Constructive Learning ($r = 0.687$), and Interactive Engagement Learning ($r = 0.577$).

Instructor Presence was also strongly correlated with all three engagement dimensions, especially with Constructive Learning ($r = 0.663$) and Active Learning ($r = 0.660$). Similarly, Examples and Scenarios exhibited strong positive relationships with Active Learning ($r = 0.680$) and Constructive Learning ($r = 0.655$).

3.3 Regression Analysis

To determine which instructional video design elements significantly predicted active learning behaviours in students, multiple regression analysis was conducted. Active learning, Constructive learning, and Interactive engagement learning were separated and grouped as three regression models which then tested as the dependent variables. Meanwhile, all the seven instructional video design elements were treated concurrently as predictors for each regression model. The results are as shown in Table 3.

3.3.1 Predictors of Active Learning

The result showed that the Active Learning regression model was statistically significant ($F(7, 414) = 80.855, p < 0.001$). This further highlighted that the variance result for active learning was at 57.0% (Adjusted $R^2 = 0.570$). Guiding Messages and Questions appeared as the strongest predictor of Active Learning ($\beta = 0.265, p < 0.001$). This was then followed by Audio or Delivery Style ($\beta = 0.247, p < 0.001$) and Examples and Scenarios ($\beta = 0.144, p = 0.018$). Meanwhile, other elements did not make a significant distinctive contribution.

3.3.2 Predictors of Constructive Learning

Meanwhile, the Constructive Learning regression model was also significant, displaying results at $F(7, 414) = 75.948, p < 0.001$, justifying 55.5% of the variance result (Adjusted $R^2 = 0.555$). Guiding messages and questions ($\beta = 0.241, p < 0.001$), audio or delivery style ($\beta = 0.235, p < 0.001$), and instructor presence ($\beta = 0.124, p = 0.046$) were significant predictors.

3.3.3 Predictors of Interactive Engagement Learning

Lastly, the Interactive Engagement Learning regression models were also statistically significant at $F(7, 414) = 42.229, p < 0.001$ which portrayed variance

result at 40.7% (Adjusted $R^2 = 0.407$). Audio or delivery style was the strongest predictor of interactive engagement ($\beta = 0.245$, $p < 0.001$), followed by on-screen text ($\beta = 0.180$, $p = 0.004$), guiding messages and questions ($\beta = 0.171$, $p = 0.016$), and length and structure ($\beta = 0.166$, $p = 0.006$).

Table 3. Regression Analysis Predicting Active Learning Behaviours ($n = 422$)

Instructional Video Design Element	Active Learning (β)	AL Sig. (p)	Constructive Learning (β)	CL Sig. (p)	Interactive Engagement (β)	IE Sig. (p)
Length and Structure	0.060	0.238	0.098	0.059	0.166 **	0.006
Visual Aids	0.058	0.253	0.056	0.281	-0.061	0.310
On Screen Text	0.004	0.943	0.026	0.623	0.180 **	0.004
Instructor Presence	0.080	0.19	0.124 *	0.046	-0.085	0.234
Guiding Messages and Questions	0.265 **	<.001	0.241 **	<.001	0.171 *	0.016
Examples and Scenarios	0.144 *	0.018	0.075	0.226	0.112	0.116
Audio or Delivery Style	0.247 **	<.001	0.235 **	<.001	0.245 **	<.001
R²	0.578		0.562		0.417	
Adjusted R²	0.570		0.555		0.407	
F value	80.855 **		75.948 **		42.229 **	

Notes: β = standardised regression coefficient, * $p < 0.05$, ** $p < 0.01$.

3.4 Discussion

The findings indicate that *guiding messages and questions* are the most consistent predictors across all ICAP engagement levels. This suggests that instructional prompts embedded within videos play a crucial role in encouraging learners to actively process information rather than passively consume content. From a theoretical perspective, this aligns with the signalling and generative processing principles of the Cognitive Theory of Multimedia Learning (CTML), where structured guidance helps direct learners' attention and supports deeper cognitive

engagement [1]. Previous studies have also shown that embedded questions and reflective prompts enhance learner attention, comprehension, and self-regulation [10], [12].

In addition, *audio or delivery style* emerged as another strong predictor across active, constructive, and interactive learning behaviours. This highlights the importance of clear narration, appropriate pacing, and conversational tone in sustaining student engagement. According to CTML's modality and personalisation principles, well-designed audio reduces cognitive load and enhances understanding by allowing learners to process information more efficiently [1]. This finding is consistent with earlier research which emphasises that high-quality narration improves both engagement and retention in video-based learning environments [9]. Furthermore, *instructor presence* was found to significantly influence constructive learning. The presence of an instructor, particularly in talking-head formats, may foster a sense of connection and social presence, which encourages students to engage more deeply with the content. This aligns with prior studies suggesting that visible instructors enhance motivation, clarity, and problem-solving engagement [1], [11], which are essential components of constructive learning within the ICAP framework [4].

Similarly, *examples and scenarios* demonstrated a strong relationship with active and constructive learning behaviours. This may be attributed to their ability to contextualise abstract concepts, allowing learners to relate new information to real-world situations. From the perspective of CTML, this supports the worked-example principle, where structured examples facilitate knowledge transfer and deeper understanding [3]. Prior research has also shown that scenario-based learning enhances contextual understanding and engagement among higher education students [2], [11].

Overall, these findings reinforce the idea that instructional video design is not merely a technical process but a pedagogical strategy that directly influences student engagement. By aligning video design elements with established learning theories such as CTML [3] and ICAP [4], educators can better support different levels of cognitive engagement and enhance the effectiveness of digital learning environments.

Based on the findings, all proposed hypotheses are supported. H1 is supported as all instructional video design elements show significant positive relationships with active learning behaviours. H2 is also supported, as multiple regression analysis indicates that selected design elements significantly predict different levels of student engagement. In particular, guiding messages and questions, audio or delivery style, and examples and scenarios emerged as key predictors. Furthermore, H3 is partially supported, as guiding messages and questions and instructor presence significantly influence constructive learning, while audio or delivery style plays a stronger role in predicting interactive engagement. These results highlight that while

several design elements contribute to engagement, their influence varies across different levels of the ICAP framework.

3.5 Limitations of Study

Despite the meaningful findings, several limitations should be acknowledged. First, this study relies on self-reported data, which may be influenced by respondents' perceptions and may not fully reflect their actual learning behaviours. In addition, the study measures students' perceived engagement rather than directly assessing their learning performance or knowledge acquisition. Future research could extend this work by incorporating objective measures such as pre-test and post-test assessments to evaluate students' understanding before and after engaging with instructional videos. This would provide deeper insight into the actual effectiveness of video design elements in improving learning outcomes.

4. CONCLUSION

Overall, SPACE UTM students demonstrate high levels of active and constructive learning behaviours when using instructional videos, with limited progression towards interactive engagement behaviour. The findings highlight the importance of specific video design elements in supporting meaningful learning behaviours. These results provide practical guidance for improving instructional video design to enhance student engagement in digital learning environments.

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REFERENCES

- [1] P. J. Guo, J. Kim, and R. Rubin, "How video production affects student engagement: An empirical study of MOOC videos," in *Proc. 1st ACM Conf. Learning at Scale (L@S)*, Atlanta, GA, USA, 2014, pp. 41–50, doi: 10.1145/2556325.2566239.
- [2] M. Mohd Dahlan, N. Halim, N. Kamarudin, F. Ahmad, H. Zainal, A. Hussin, and M. Yahya, "Connecting classrooms: Empowering higher education in Malaysia through interactive video learning," *International Journal of Religion*, vol. 5, pp. 110–117, Jan. 2024, doi: 10.61707/99sj3p10.
- [3] R. E. Mayer, *Multimedia Learning*, 2nd ed., Cambridge: Cambridge University Press, 2002.

- [4] M. T. H. Chi and R. Wylie, "The ICAP framework: Linking cognitive engagement to active learning outcomes," *Educational Psychologist*, vol. 49, no. 4, pp. 219–243, 2014, doi: 10.1080/00461520.2014.965823.
- [5] D. Ø. Østereng, "I believe in video! An interpretative phenomenological analysis of video as an educational resource," *Discourse and Communication for Sustainable Education*, vol. 13, no. 2, pp. 133–149, 2022, doi: 10.2478/dcse-2022-0023.
- [6] S. A. Garba, Y. Byabazaire, and A. H. Busthami, "Toward the use of 21st-century teaching-learning approaches in Malaysian schools within the context of Asia," *International Journal of Emerging Technologies in Learning (iJET)*, vol. 10, no. 4, pp. 72–79, 2015, doi: 10.3991/ijet.v10i4.4717.
- [7] C. J. Brame and K. E. Perez, "Effective educational videos: Principles and guidelines for maximizing student learning from video content," *CBE—Life Sciences Education*, vol. 15, no. 4, p. es6, 2016, doi: 10.1187/cbe.16-03-0125.
- [8] G. D. Rey, M. Beege, S. Nebel, M. Wirzberger, T. H. Schmitt, and S. Schneider, "A meta-analysis of the segmenting effect," *Educational Psychology Review*, vol. 31, pp. 389–419, 2019, doi: 10.1007/s10648-018-9456-4.
- [9] Z. Shen, S. Tan, and M. J. Pritchard, "Effects of signalling mechanisms on cognitive engagement with educational videos in informal learning on social media," *Behaviour & Information Technology*, vol. 43, no. 12, pp. 2765–2784, 2024, doi: 10.1080/0144929X.2023.2259004.
- [10] J. C. Nunnally, *Psychometric Theory*, 2nd ed. New York, NY, USA: McGraw-Hill, 1978.
- [11] C. Ou, D. A. Joyner, and A. K. Goel, "Designing and developing video lessons for online learning: A seven-principle model," *Online Learning Journal*, vol. 23, no. 2, pp. 82–104, 2019, doi: 10.24059/olj.v23i2.1449.
- [12] C. Wekerle, M. Daumiller, S. Janke, O. Dickhäuser, M. Dresel, and I. Kollar, "Putting ICAP to the test: How technology-enhanced learning activities are related to cognitive and affective-motivational learning outcomes in higher education," *Scientific Reports*, vol. 14, 2024, doi: 10.1038/s41598-024-66069-y.
- [13] D. Ginting, R. Woods, Y. Barella, L. Limanta, A. Madkur, and E. H. Heng, "The effects of digital storytelling on the retention and transferability of student knowledge," *SAGE Open*, vol. 14, 2024, doi: 10.1177/21582440241271267.
- [14] R. V. Krejcie and D. W. Morgan, "Determining sample size for research activities," *Educational and Psychological Measurement*, vol. 30, no. 3, pp. 607–610, 1970, doi: 10.1177/001316447003000308.
- [15] R. F. DeVellis, *Scale Development: Theory and Applications*, 4th ed. Thousand Oaks, CA, USA: Sage Publications, 2017.

THE SYNERGY OF ARTIFICIAL INTELLIGENCE (AI) AND TRANSFORMATIONAL LEADERSHIP IN CREATING ERGONOMIC WORKPLACE ENVIRONMENTS

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ABSTRACT - To improve the working environment, ergonomics should be incorporated in transformational leadership, smoothed by artificial intelligence. Although the benefits can accrue, the incorporation of ergonomics can prove highly problematic, especially in environments or companies where organizational leaders fail to promote its effective implementation. As artificial intelligence continues to reshape the working environment, various benefits and facilities for employees can easily accrue. Nevertheless, for those who lack the requisite skills and knowledge, adapting and thriving in the AI environment can prove detrimental in terms of ergonomics. This paper will rely on its comprehensive examination of literature and will consider present research in assessing the implementation of ergonomics together with artificial intelligence in the working environment. Furthermore, its significance will be discussed in terms of its reliance on transformational leadership styles. The findings of the research culminate in a thematic analysis identifying five key elements that shape how businesses integrate ergonomics and AI under the guidance of transformational leadership. These include workplace design, basic knowledge of ergonomics, attitudes and behaviors of workers, roles and competencies of managers, organizational challenges, and their long-term consequences. Each theme has been further developed with a few subthemes arising from the analysis of spider charts. Given the focus of this study on the integration of ergonomics and AI under transformational leadership, it holds significant implications for businesses seeking to facilitate healthy and productive employees in line with Sustainable Development Goals 3 (Health and Well-Being) and 8 (Decent Work and Economic Growth). This summary, therefore, helps develop competent human capital that equips the workforce and businesses to overcome challenges and seize opportunities created by an increasingly automated and digital future.

Keywords: Ergonomic; Artificial Intelligence; Transformational Leadership; Sustainable Development Goals 3; Sustainable Development Goals 8

1. INTRODUCTION

The work productivity and efficiency within the organization are enhanced by ergonomics. The relevance of ergonomics is better understood when combined with artificial intelligence technology since this promotes the adaptive adjustment of workloads and processes, as pointed out in reference [1]. Staff within the organization can maximize their knowledge, skills, and abilities through the application of ergonomics aided by AI technology. Further, reference [2] found that ergonomics is helpful for workers since it assists them in achieving work-related balance regarding the psychological readiness required for optimal performance. Nevertheless, [3] stressed the need for appropriate consideration regarding organizational leadership for the promotion of ergonomics among workers. For instance, [4] emphasizes the following regarding the implications of transformational leadership in motivating employees to adopt these technologies through transformational leadership, employees are motivated and inspired. Similarly, effective training favourably influences a flexible and supportive workplace culture [5]. Thus, working together, ergonomics, AI, and transformational leadership promote not only employee satisfaction and well-being but also contribute significantly towards attaining corporate objectives. The attainment of such organizational objectives will facilitate the long-term sustainability of the mission and vision of any organization through assurance of a productive, healthy, and competitive staff. Accidents at work result in serious financial, psychological, and physical suffering [6]. Organizations may safely match workloads to worker skills by integrating AI analytics, ergonomics, and transformative leadership [7]. By reducing physical and emotional stress, this proactive strategy improves work-life balance, increases productivity, and ignites employee passion [8].

Basically, ergonomics relates to the examination of relationships between individuals, machine systems, tasks, and the workplace. This information can be utilized to adjust tasks to meet the requirements and abilities of individuals. The integration of AI in the process of ergonomics in modern, complex, high-tech organizations has significant implications. It facilitates efficient system design and data analysis for employees. According to some individuals, however, its approach transcends AI processes, receiving support primarily from management. In addition, it has also been revealed in research that transformational leadership has played an imperative role in integrating continuous improvement. Hence, AI ergonomics and transformational leadership interconnect to improve work quality and promote the welfare of employees. As such, the examination of interconnection among the three aspects is imperative in developing a secure working environment and addressing the pressing concerns of today, mainly caused by AI. Relying on adaptable leaders in organisations and stimulating effective direction can improve employee security.

1.1 Problem Statement

Despite this, there are challenges encountered in the adoption of ergonomics in the workplace, especially when the perspective of the user is not accorded prominence in work designs and within the work context. This is despite ergonomics aiming to incorporate comfortable work conditions for workers. Many companies, for instance, value productivity over employee physical and mental well-being while aiming for greater efficiency. To this end, AI can be used for workload analysis with system designs tailored towards personal preference, as claimed by [9]. Furthermore, [10] holds the conviction that transformational leadership is crucial for technology implementation within the context of organisational ergonomics. Motivating the workforce and ensuring a health and safety-oriented environment are two strategies that can ensure this is accomplished for performance of organisations. Organisations can ensure a safe environment is offered where health and safety considerations are at the forefront, using ergonomics, AI technology, and transformational leadership. Maintaining motivation, minimizing mental fatigue, and lowering employee stress all depend on flexible work arrangements [9]. Organizations can personalize jobs to lessen worker pressures by combining ergonomics, AI technology, and transformational leadership [11]. By preventing the mistakes and mishaps brought on by inflexible work settings, this integrated strategy fosters a friendly workplace that protects workers' mental health and increases output [12].

The health of employees is greatly affected by the types and conditions of employment, besides flexible work arrangements. This is because work-related issues that benefit employees can negatively affect their health. This implies that appropriate work processes and conditions are recognised as important elements within organisational ergonomics. It is recognised that employees are confronted with difficult work conditions arising from different work group backgrounds. Due to this diversity, it is necessary to have a flexible system that helps employees in continuous adjustment for better adaptation. Solutions based on AI technology can play a helpful role in better adaptation [13]. But organisational structure, market need, and technological development are some concerns that often affect the application of AI technology. Work environments should integrate AI dynamically to help enterprises analyse labour patterns. AI technology can identify obstacles and make proactive adjustments in tasks, as identified by [14]. However, top leadership is required to create successful ergonomic systems [15]. Transformational leaders must give the motivation, resources, and policies to propel these projects. Without strong leadership backing, initiatives to merge AI and ergonomics may fail, resulting in workplace unhappiness and people burdened with outdated technology [1].

Effective forms of work are one of the basic goals of ergonomics because it maximizes the performance levels of workers, as pointed out in [8]. Conversely, it

has been suggested in research by the author [13] that if gaps in motivation with regard to the working environment occur, they can prevent the attainment of maximum performance. On the other hand, it was pointed out in research by the author [12] that leadership styles affect the ergonomics of employees in the working environment and that less empathetic leaders usually apply excessive pressure to the employees. The objective is for leaders to lead their employees towards meeting new requirements in ergonomic needs, with the support of AI in managing their respective workloads. The role of transformational leadership in ensuring the adoption and optimal use of technology in ergonomic working practices. Employees can achieve balance within their organizations in their efforts towards overall productivity in accord with maximum working capability and good employee well-being as managed through transformational leaders and the creation of positive identity in their organizations [16].

1.2 Literature Review

The requirements of workers as well as work systems must be considered by transformational leadership for the successful implementation of ergonomics. Leaders using the transformational approach must possess an unwavering commitment, ability, and passion for influencing, motivating, and positively impacting employees, as stated by [16]. The significance of this contribution cannot be overemphasised since it involves providing support for continual improvement of the welfare of employees, as stated by [15]. Moreover, [14] stressed that leader support is a crucial ingredient for ensuring employee safety. The integration of safety and welfare ideals is significant since it provides employees with a feeling that they are valued by the leaders of their organization, thereby increasing employee commitment. Also, employees will be receptive to change, such as the application of AI technology for improved workflow processes. Transformational leaders are necessary to motivate, inspire, and positively influence staff members to pursue continuous improvement. This can lead to an improvement of AI interventions at the workplace. According to [7], successful adoption of AI requires the presence of appropriate skills and knowledge to avoid any mistakes that may interfere with employees' growth, safety, and well-being. Again in [17], the need for leaders to establish appropriate work processes that include organizational learning and training systems, aside from effective monitoring, is emphasized. In return, this ensures that workers apply AI technology under appropriate supervision. The leaders of this category help to encourage worker awareness and commitment to safe work practices in ergonomics [18]. AI's benefits must be considered theoretically as well as in practice, including their long-term benefits and shortcomings.

Employees can leverage the use of AI to enhance system design, change workloads, and assess risks [8]. However, to avoid increasing the risks associated with work environments, these measures should be subject to continuous monitoring. Employees are actively engaged in the identification of ergonomic risk factors and

their solutions through ideal influence, a sense of vision, and mental stimulation. Equal satisfaction of the needs of ergonomics is achieved through individual consideration. Organizations can develop a competitive, safe, and productive work environment through the integration of transformational leadership, artificial intelligence, and ergonomics. To implement scientific and technological concepts within a working environment, there is a need for the use of ergonomic pillars [19]. It allows organizations to understand between employee competencies and technological management and working environments. AI implementation can make it easy to analyze how workers relate to their environment and, therefore, implement a task alteration that can minimise injury risks. On this point, understanding and implementing ergonomic approaches that can embrace a high-performance working culture needs transformational management to confirm employees can relate to their surroundings both safely and properly if they understand key ergonomic concepts [18]. Productivity within organizations is boosted by a safe working environment, and implementing ergonomics and AI within transformational management gives organizations a conducive platform to reach maximum performance levels within a long-term approach.

Ergonomic standards have been considered essential in a wide range of studies undertaken in the past as the key to the growth of various key applied science fields. The ergonomic environment emphasizes the importance of creating a working environment where the well-being of the users comes first. From research carried out by [19], the working environment within the field of ergonomics takes into consideration the needs of the users of the working environment, emphasizing the point that the needs of the working environment should not be the paramount consideration. A scientific approach brings together people, technology, and the workplace to create environments that reduce physical and mental stress. Organizations may drastically reduce errors and accidents by leveraging AI technology to monitor worker data and intelligently alter tasks. Finally, transformational leadership is required to successfully integrate these technologies and maintain consistent ergonomic norms. The top management of every organization is required to demonstrate their commitment to following these vital practices [14]. Thus, every company needs to have a clear understanding of these key concepts in developing strategies for better work environment design practices and work systems that are more successful. Employee resilience can be promoted by integrating ergonomic principles with technology like artificial intelligence (AI) for intelligent load management or modification [20]. The combination of transformational leadership principles with artificial intelligence is vital in the development of the ergonomic work environment for maximum employee benefits. protection, too. [21] analysis of anthropometric data is greatly simplified by modern AI technologies. [21] AI allows for "intelligent adaptation to tasks, workplaces, and equipment, to employees' physical characteristics, thereby reducing the risk of injury and increasing volume performance. According to the author [6], human mobility optimization can lower the consumption of energy while enhancing

comfort and work efficiency. The role of leadership plays a significant part in this context. Transformational leadership behaviour can produce a supportive environment for product design and work design. Leaders are responsible for enhancing the working environment, ensuring a safe environment, and encouraging good physical and psychological health for their workers. As the author [8] relates, product design is particularly significant in the context of clothing, seating, work tools, and other essential items necessary for various tasks. According to the author [8], the work environment, including the height of tables, chairs, and machines in the working environment, should support workers' comfort in preventing tension and accidents.

1.3 Anthropometric Ergonomics

Anthropometrics is the study of the dimensions of human physical characteristics, such as height, weight, and skinfold thickness, among others. [22] As a science, it ensures that workplaces are tailored to meet the needs of employees. It is fundamental to ergonomic working spaces, most especially for engineers. Workspace comfort extends to movement and protection, too. [21] analysis of anthropometric data is greatly simplified by modern AI technologies. [21] AI allows for "intelligent adaptation to tasks, workplaces, and equipment, to employees' physical characteristics, thereby reducing the risk of injury and increasing volume performance. According to the author [6], human mobility optimization can lower the consumption of energy while enhancing comfort and work efficiency. The role of leadership plays a significant part in this context. Transformational leadership behaviour can produce a supportive environment for product design and work design. Leaders are responsible for enhancing the working environment, ensuring a safe environment, and encouraging good physical and psychological health for their workers. As the author [8] relates, product design is particularly significant in the context of clothing, seating, work tools, and other essential items necessary for various tasks. According to the author [8], the work environment, including the height of tables, chairs, and machines in the working environment, should support workers' comfort in preventing tension and accidents.

1.4 Ergonomics Biomechanics

Biomechanical ergonomics is interested in the study of human physical behaviour in terms of mechanics, particularly in machine and equipment design to facilitate effective and safe operations. In a workplace, the subject involves the application of mechanical principles for the analysis of the working environment and human body interface. The minimum biomechanical elements in work ergonomics include prevention of musculoskeletal disorders, ergonomic design of the workstation, and wearable devices. An organization can now apply sensors and machine learning algorithms that review workers' movements moment by moment for locating potential risks and thus optimising machine operations. AI-powered systems, for example, can dynamically modify the height of automated worktables and the

movement of robotic arms based on workers' physical capacities. Transformational leaders play an important role in building a safety-oriented work culture by motivating employees to continually prioritise occupational health and safety. Such leaders are expected to have a long-term view, as noted by [13], who observed that workplace injuries might result in large expenses, including compensation and other related obligations. As a result, leaders must actively motivate staff and ensure that work practices aim to minimise physical strain and discomfort during task completion

1.5 Ergonomics Physiology

Physiological ergonomics is the control of human physiological reactions and systemic systems that affect health and job performance [23]. As highlighted by previous studies [24], there ought to be physiological knowledge in assessing human performance while undertaking work tasks, and there is a great need to compare human capability and limitations to machines. Among the most significant factors of physiological ergonomic principles lies in muscular activity, given that humans need appropriate times to recover to replenish their wasted energy. From another perspective, [9] suggested that there is relevance to cardiovascular function in assessment and related to the role played by the heart in providing enough oxygen for effective attainment of work tasks. Lastly, and most importantly, there ought to be a precise assessment of the nervous system due to its significant role played in influencing movement to prevent physical stress, which may lead to neurological disorders such as numbness or nerve pains. Leaders' transformational leadership are more interested in the well-being of the employees. Also tend to adopt the use of artificial intelligence for improving the organizational working processes. Among the phenomena, such as in the case of the heavy industry, where the integration of artificial intelligence enables real-time monitoring of employee exhaustion using biomechanical sensors and wearable devices. AI systems may adjust workloads or call for rest periods when using cranes/heavy machinery, which will reduce the likelihood of damage occurring. This approach promotes a safe, efficient, and people-centric work environment. The synergy created by combining physiological ergonomics principles with AI technology and transformational leadership practices is that it will improve performance and efficiency, as well as enhance a safe work environment that safeguards workers' physiological welfare.

1.6 Ergonomics Psychology

Psychological ergonomics deals with the mental and cognitive processes of human beings, such as reasoning, thinking, memory, and perception, in relation to the design of the workplace system. As stated in [20], psychological ergonomics is also closely related to mental functions, and its major objective is to effectively relate mental stress to human cognition to reduce human errors and improve human productivity. Previous research has found significant correlations between employee

attitudes and actions and organisational performance standards [25]. Employees in blended work arrangements must manage a combination of on-site physical tasks and remote work activities, and performance may be limited by factors such as energy levels, physical strength, and individual characteristics such as age, skills, and posture [14]. Artificial intelligence (AI) can be used to monitor productivity, mental workload, and posture using smart applications and sensor-based technologies, as well as for automated job modifications and scheduled breaks. Transformational leadership enables people to adjust flexible work environments by fostering mental well-being, effective decision-making, and positive human-AI interaction in the workplace.

1.7 Intervention of Transformational Leadership Theory

According to [10], the five pillars of transformational leadership, an idealised influence, inspirational drive, intellectual stimulation, individualized consideration, and moral courage, can be effectively combined with AI and ergonomics to improve employee well-being. Through these characteristics, leaders serve as ethical role models for safe AI application, inspire a vision that reduces physical and cognitive workloads, encourage the creative use of AI to solve ergonomic challenges, use AI monitoring to prevent burnout by tailoring tasks to individual needs, and maintain high moral standards in a dynamic work environment. Finally, a commitment to systemic well-being ensures that integrating technologies into the workplace secures long-term comfort, safety, and productivity sustainably and aligns with global ergonomic standards [7], [14]. It is also essential for organizational ergonomics that there be transformational leadership. The study [3] presents that managers are responsible not only to guide the activities of individuals and groups but also to lead employees towards organizational performance and goals on strategy. In relation to the changing vocations and ergonomic requirements, it was found by [10] that the work systems are becoming increasingly dependent on digital technologies and hybrid work arrangements. Also, AI automatically measures employee productivity, posture, and workload, which helps managers to optimise operations and work environment [11]. This is in line with the findings of [18], which stress organizational leadership as a facilitator for good work systems of ergonomics. The transformational leaders are particularly successful in this process due to the potential for inspiration and motivation of the employees in the adoption and adaptation of AI-based ergonomics. The leaders play the dual role of initiators and role models in the enhancement of occupational health and safety. The combination of AI and transformational leadership results in the improvement of the welfare of the employees as it further reinforces the successful accomplishment of organizational tasks.

Moving towards the future, transformational leadership should incorporate strong communication skills for effective interaction between management and employees. Effective communication, as argued by [14], enhances proper communication for the exact transmission of commands, information, and feedback and enhances greater employee motivation and satisfaction with their work. Managers can better

identify employees who require further support by using AI to analyze conversation and deliver automatic feedback [9]. Furthermore, while AI systems may actively monitor industrial workers and detect ergonomic breaches, transformational leaders play an important role in supporting this technology by providing the tailored guidance and encouragement needed to assist people in adopting safer, better practices. Despite this, there exist many problems in enhancing effectiveness through effective synergy between AI technology and transformational leadership. According to research, effective management requires highly developed intellectual, communication, operational, and interpersonal skills for better coordination and successful monitoring of employees [15]. Such qualities are highly important for filling the gaps between ergonomic theory and practice. Transformational leaders are confronted with many difficulties, especially in terms of ergonomic theory and AI, since they are required to process data produced by AI in real time to adjust work environments to suit individuals [18]. To successfully integrate AI-driven ergonomic adjustments, staff resistance must be overcome, which is often based on age, attitudes, or self-doubt. As AI solutions such as workload tracking gain popularity, transformational leaders must improve their digital literacy and communication abilities to facilitate employee acceptance. By managing this transformation, executives may effectively balance safety and productivity while harnessing AI insights to promote employee health and meet long-term strategic goals.

2. MATERIALS AND METHODS

A Systematic Literature Review (SLR) methodology was used in this investigation. Finding, assessing, and summarising all pertinent prior research was conducted using a well-organised, planned approach. Because SLR follows a specific process, the results are more objective and thorough than those of normal literature reviews, which may be biased. The analysis based on SLR reveals five main themes such as workplace design, knowledge base, employee attitudes and behaviours, managerial skills and roles, and long-term difficulties and repercussions. This research also uses thematic analysis by previous studies for thematic and sub-thematic development. The thematic findings indicate the synergy between artificial intelligence (AI) and transformational leadership in developing an ergonomic workplace environment.

3. RESULTS AND DISCUSSION

Table 1 illustrates a theme analysis based on an in-depth review of previous investigations. The analysis reveals five main themes: workplace design, knowledge base, employee attitudes and behaviours, managerial skills and roles, and long-term difficulties and repercussions.

Table 1. Details of Ergonomic Analysis and Transformational Leadership Based on AI Synergy

Theme	Sub-Theme	Ergonomic Analysis and Transformational Leadership Based on AI Synergy
Ergonomic Workplace Design	Working Conditions, Acceptance of Working Forms	Motivating transformational leaders enables staff members to adopt ergonomic design and organizational transformation, lowering stress at work and increasing output for peak performance.
Basics of Ergonomics	Anthropometry, Biomechanics, Physiology	Transformational leaders may minimize injuries and increase safety and productivity by customizing activities to individual capacities through the integration of ergonomics and AI analytics.
Employee Attitude and Behaviour	Employee Psychology, Physical Capacity, Individual Factors, Work Environment	Transformational leaders acknowledge the variance in attitudes and abilities of employees and do so using AI analysis of work and personnel performance. Transformational leaders motivate people to adjust to their work requirements while ensuring their well-being and work quality through constant support and direction.
Manager Skills and Roles	Knowledge, Skills, Experience, And Communication	AI enables transformational leaders to provide clear ergonomic direction, encourage staff with data-driven feedback, reinforce discipline through automated monitoring, and develop a safer and more productive organisational culture.
Long-Term Challenges and Impacts	Leadership Challenges, Change Management, Work Culture Impacts	AI might assist transformational leaders in dealing with ergonomic implementation difficulties by monitoring employee performance, automatically ensuring compliance, improving safety and productivity, and boosting well-being, establishing a sustainable and human-centred company culture.

Table 1 provides an exhaustive explanation of each subject construct, which is incrementally elaborated through the systematic correlation of a multifaceted array of sub-themes. This systematic classification framework includes relevant dimensions like working condition requirements, level of integration within present-day workplace systems, and physical working dimensions, consisting of anthropometrics, biomechanics, and physiology. Moreover, this process of analysis extends to the fundamental aspects of human nature, incorporating expressions of employee psychology, physical capacity efficiency, and individual variations that perpetually interact with the work environment. Within the context of organisational development, the table consolidates functional metrics of human capital, consisting of basic knowledge skills, technical skills, and experiential learning. All these dimensions are systematically combined with an analytical assessment of communication channel effectiveness, modern leadership issues, flexibility in change management approaches, and integration within the work culture, thereby

creating a strong theoretical basis for exploring the sociotechnical relations of the organisation.

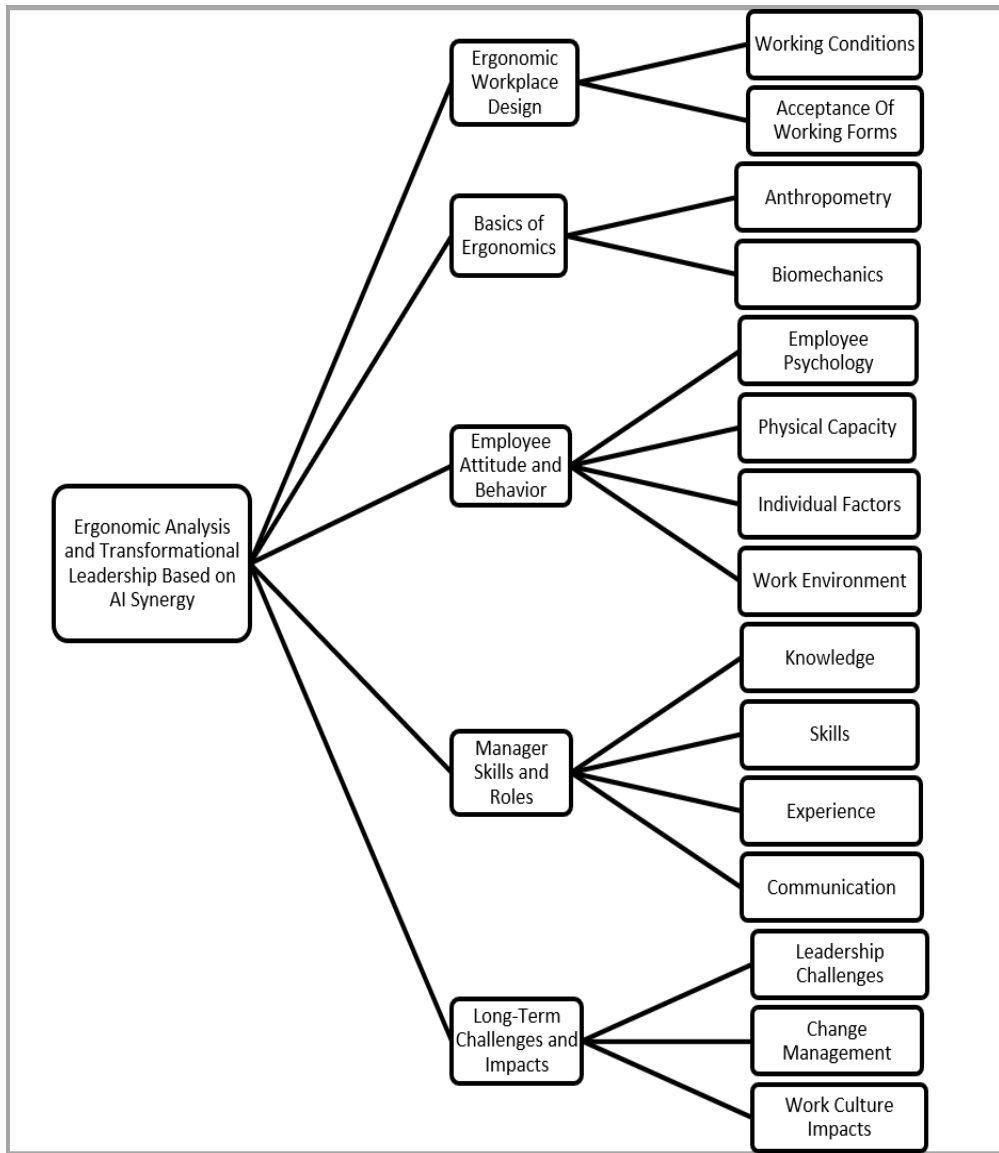


Figure 1. Diagram of the Thematic Distribution of Ergonomic Analysis and Transformational Leadership Based on AI Synergy

Thematic findings of the current study reveal a strategic synthesis or synergy that exists between the technologies of AI and the agility of transformational leadership in creating a sustainable ergonomic workplace ecosystem. The synergy between AI technology and transformational leadership has been illustrated in Figure 1 as an

example of the schematic representation of the complete thematic architecture carefully constructed using the methodology of Systematic Literature Review (SLR), where the extraction hierarchy of every main theme and sub-theme is described in detail to form a concept of this research. As a complementary methodological tool, Figure 2 represents the visual presentation of the multivariate distribution, known as "Spider Chart Distribution of Ergonomic Analysis and Transformational Leadership Based on AI Synergy". Such a representation is effective in estimating the degree of synergy and analysis of the weight ratio between different transformational leadership variables and ergonomic automation. Finally, the emergence of such an integrative synergy, which combines algorithmic intelligence and human leadership wisdom, not only initiates a new paradigm shift in modern management but also can be considered as the main contribution of this academic study.

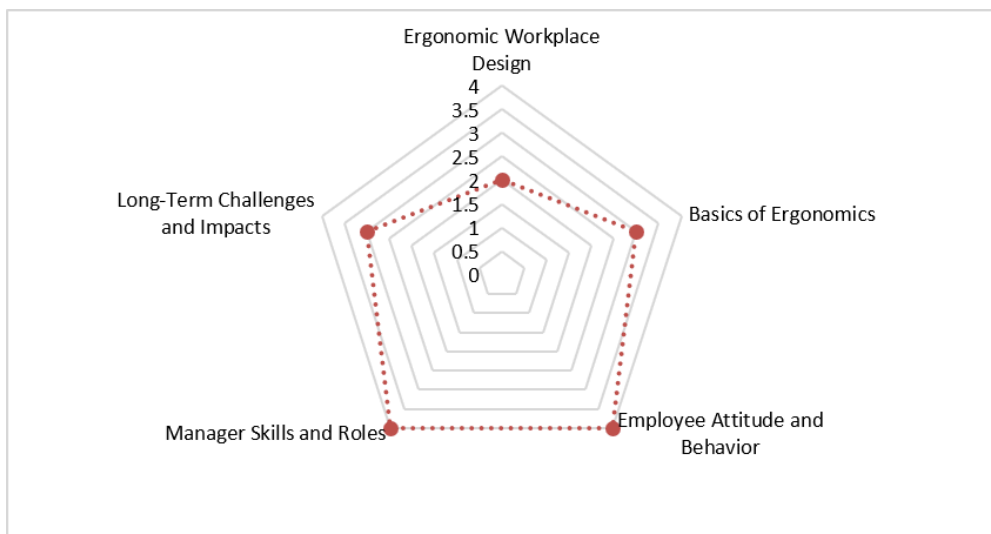


Figure 2. Spider Chart Distribution of Ergonomic Analysis and Transformational Leadership Based on AI Synergy

3.1 Research Discussion

Evidence from previous studies has shown that ergonomic workplace design is essential in reducing workplace accidents as well as improving workplace comfort and productivity. Flexible working conditions are very important in reducing workplace stress and emotional overload. This helps in motivating employees positively. In the topic of transformational leadership, leaders are very important in encouraging people to adapt to ergonomic workplace changes. The different assumptions in this topic have been proven in [25], where it was discovered that leaders who can create a positive workplace culture have a greater chance of convincing people to adapt to ergonomic methods. This will provide more successful completion of firm objectives while taking care of the employee's

well-being and reducing the likelihood of workplace accidents. Artificial Intelligence acts as a facilitation mechanism that provides more reinforcement to human labour rather than substituting it. Ergonomics is mainly concerned with using a few scientific disciplines, such as anthropometry, biomechanics, and physiology. These areas of study offer help based on empirical evidence in designing workspaces that can correlate well with human capability and limitations [10]. Transformational leadership is ideal for implementing ergonomic principles that improve workplace safety and productivity. By stressing effective communication, motivation, and individualized support, these leaders enable people to adjust to workplace needs and increase productivity [15]. Furthermore, integrating this leadership strategy with AI-driven ergonomic insights results in a powerful synergy that greatly decreases errors and accidents, there are still hurdles to completely deploying these systems. Perhaps one of the most difficult challenges to overcome is gaining employees' willingness to adopt different responsibilities and work environments. Employees are required to weigh their personal skills against business needs and learn to adjust work processes to suit their physical and mental characteristics. Transformational leadership could address these problems through effective change management and informed decision-making. Furthermore, [15] reiterates the importance of managers continually improving their knowledge, abilities, and experience to foster a safe, productive, and sustainable workplace culture. Eventually, effective transformational leadership improves employee well-being, motivation, and organisational goals [20].

4. CONCLUSION

The integration of ergonomics in the transformational leadership framework with the help of artificial intelligence (AI) is a crucial part of contemporary work environment design. Ergonomics plays a significant role in ensuring that workers can perform tasks within a safe and comfortable work environment. Ergonomics is, therefore, essential for the creation of a safe and productive work environment in organisations, and it is especially important in the future industrial environment in terms of transformational leadership principles. In such a scenario, there is a need for the implementation of long-term strategies to enhance the motivation levels, performance, as well as physical and mental well-being of the human resources within the organization. Transformational leaders acting as change agents are envisioned to develop innovative ways of work through ergonomics, develop discipline among the human resources, and develop a long-term work culture within the organization. This initiative is well aligned with Sustainable Development Goals of SDG 3: Health and Well-being & SDG 8: Decent Work and Economic Growth.

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REFERENCES

- [1] A. M. Lasota, "Manual palletizing simulation: Time and ergonomic study," *Int. J. Interact. Des. Manuf.*, 2025, doi: 10.1007/s12008-025-02474-5.
- [2] M. Gardezi, G. Sanekommu, and J. J. Lee, "Ergonomic challenges and considerations in endoscopic treatment of benign prostatic hyperplasia," *Curr. Urol. Rep.*, vol. 26, p. 37, 2025, doi: 10.1007/s11934-025-01266-4.
- [3] M. A. Quttainah, P. Sadhna, A. Aggarwal, *et al.*, "AI-savvy leadership for enhancing AI utilization and employee engagement among digital natives in the EdTech sector," *Sci. Rep.*, vol. 15, p. 45549, 2025, doi: 10.1038/s41598-025-29973-5.
- [4] Q. Li, P. Li, H. Hao, *et al.*, "The impact of leadership on AI deployment study outcomes in healthcare: An integrative analysis," *npj Digit. Med.*, vol. 8, p. 799, 2025, doi: 10.1038/s41746-025-02177-x.
- [5] S. Javed and B. G. Mujtaba, "Assessing the nexus between AI literacy, AI anxiety, and digital leadership in higher education: A configurational analysis for public sector institutions," *Public Organ. Rev.*, 2025, doi: 10.1007/s11115-025-00952-8.
- [6] F. Holzgreve, C. Rittinghausen, I. Hermanns, *et al.*, "Work-related musculoskeletal stress among residents of internal medicine on cardiological wards in their daily working practice—A kinematic and ergonomic analysis," *J. Occup. Med. Toxicol.*, vol. 20, p. 25, 2025, doi: 10.1186/s12995-025-00471-8.
- [7] P. Nickel and A. Lungfiel, "Evaluation of joystick built-in emergency stop function for mobile elevating work platform safety and human factors and ergonomics in accident prevention," *Z. Arb. Wiss.*, vol. 78, pp. 514–530, 2024, doi: 10.1007/s41449-024-00449-y.
- [8] G. Arbelaez Garces, B. Rose, T. Blandet, *et al.*, "A tool for ergonomic assessment of industrial workplaces: The Ergonom.io case," *Int. J. Interact. Des. Manuf.*, vol. 19, pp. 5687–5700, 2025, doi: 10.1007/s12008-024-02159-5.
- [9] M. D. Alam and I. A. Khan, "Relation between grip force, ergonomic interventions, and task performance: A review," *Int. J. Interact. Des. Manuf.*, vol. 19, pp. 4683–4713, 2025, doi: 10.1007/s12008-024-02145-x.
- [10] T. Yangailo, "The role of transformational leadership and process management in enhancing productivity," *SN Bus. Econ.*, vol. 5, p. 98, 2025, doi: 10.1007/s43546-025-00863-2.

- [11] X. Yuan, "A meta-analysis of the relationship between transformational leadership and employee burnout," *Curr. Psychol.*, vol. 44, pp. 13999–14015, 2025, doi: 10.1007/s12144-025-08099-x.
- [12] B. G. Agazu, C. A. Kero, and K. L. Debela, "Transformational leadership and firm performance: A systematic literature review," *J. Innov. Entrep.*, vol. 14, p. 29, 2025, doi: 10.1186/s13731-025-00476-x.
- [13] Y. Liu, F. Sheng, and R. Liu, "Generative AI adoption and employee outcomes: A conservation of resources perspective on job crafting, career commitment, and the moderating role of liking of AI," *Humanit. Soc. Sci. Commun.*, vol. 12, p. 1376, 2025, doi: 10.1057/s41599-025-05656-4.
- [14] A. Amayreh, M. A. Ta'Amnha, I. K. Magableh, *et al.*, "Exploring the impact of AI on employee self-competence performance key variables and outcomes," *Discov. Sustain.*, vol. 6, p. 582, 2025, doi: 10.1007/s43621-025-01438-9.
- [15] K. Ofosu-Ampompong and J. Adu-Ntim, "Transformational leadership, AI competitiveness, and project performance: A moderation analysis," *J. Glob. Bus. Compet.*, vol. 20, pp. 67–79, 2025, doi: 10.1007/s42943-025-00124-x.
- [16] G. He, X. Zheng, W. Li, *et al.*, "The mixed blessing of leaders' artificial intelligence (AI)-oriented change behavior: Implications for employee job performance and unethical behavior," *Appl. Res. Qual. Life*, vol. 19, pp. 469–497, 2024, doi: 10.1007/s11482-023-10250-4.
- [17] S. Kumari and M. Manshahia, "Advancements in smart textiles and ergonomic innovations for athletic footwear: Enhancing comfort, performance, and customization," *J. Inst. Eng. India Ser. E*, vol. 106, pp. 317–324, 2025, doi: 10.1007/s40034-025-00306-5.
- [18] C. Millhoff and J. Rowold, "Evaluation of change-oriented training in instrumental and transformational leadership behaviors," *Z. Arb. Wiss.*, vol. 79, pp. 105–118, 2025, doi: 10.1007/s41449-025-00458-5.
- [19] L. Dunai and I. S. Verdú, "The ergonomic design of the rollator handles," in *Advances on Mechanics, Design Engineering and Manufacturing V*, C. Machado del Val, R. Miralbes Buil, G. Peris Fajarnés, M. Moncho Santonja, C. Rizzi, and L. Roucoules, Eds., Lecture Notes in Mechanical Engineering. Cham, Switzerland: Springer, 2025, doi: 10.1007/978-3-031-72829-7_15.
- [20] K. Reinhold, "Building resilience: Pillars of workforce agility at organizational and individual levels in SMEs," in *Small and Medium-Sized Enterprise (SME) Resilience*, S. Durst and T. Henschel, Eds., Management for Professionals. Cham, Switzerland: Springer, 2024, doi: 10.1007/978-3-031-50836-3_11.
- [21] W. F. Mbasso, A. Harrison, I. Dagal, *et al.*, "Sensor-driven PCA–DEA framework for efficiency optimization in manual material handling: Application to industrial purification systems with ergonomic redesign validation," *Prod. Eng. Res. Devel.*, vol. 20, p. 8, 2026, doi: 10.1007/s11740-025-01400-8.

- [22] M. Mohammadian, S. Mollahoseini, and A. Naghibzadeh-Tahami, "Musculoskeletal disorders among office workers: Prevalence, ergonomic risk factors, and their interrelationships," *Sci. Rep.*, vol. 15, p. 45425, 2025, doi: 10.1038/s41598-025-30155-6.
- [23] J. Fan, D. Zhong, Y. Zhang, *et al.*, "A hybrid approach based on rough-AHP for evaluation in-flight service quality," *Multimed. Tools Appl.*, vol. 81, pp. 30797–30819, 2022, doi: 10.1007/s11042-022-12015-x.
- [24] L. Bernaers, T. M. Willems, G. H. Lam, *et al.*, "Experiences and perceptions of employees and healthcare professionals on a multidisciplinary program for the secondary prevention of low back pain," *Sci. Rep.*, vol. 15, p. 13091, 2025, doi: 10.1038/s41598-025-97683-z.
- [25] W. Zhang, X. Lou, X. Hu, *et al.*, "Optimizing virtual reality interfaces: Ergonomic guidelines for hand interaction based on user age, gender, and handedness," *Virtual Reality*, vol. 29, p. 142, 2025, doi: 10.1007/s10055-025-01230-0.

REIMAGINING LIFELONG LEARNING FOR SOCIETY 5.0: A CONCEPTUAL FRAMEWORK FOR DIGITAL TRANSFORMATION IN CONTINUING EDUCATION

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ABSTRACT - The rise of the Fourth Industrial Revolution (IR 4.0) and Society 5.0 has increased the need for higher education institutions to rethink lifelong learning and continuing education through digital transformation. Although new technologies like artificial intelligence (AI), learning analytics, and mobile learning have become more available, many continuing education institutions still struggle with rigid teaching methods, administrative problems, and imbalanced use of technology. Most existing studies focus on these technologies separately and do not explore integrated frameworks that link tech innovation with changes in teaching and institutional practices in continuing education settings. To fill this gap, this concept paper suggests a strategic framework for positioning technology and innovation as essential drivers of digital transformation at the School of Professional and Continuing Education (SPACE) at Universiti Teknologi Malaysia (UTM). Based on the Technology Acceptance Model (TAM) and Disruptive Innovation Theory, the framework shows how adopting new technologies can support flexible teaching and efficient administration, helping to shape future-ready lifelong learners. The paper also proposes a validation strategy that includes needs analysis, benchmarking studies, pilot projects, and data-driven evaluation to aid future research and institutional implementation. By bringing together technological innovation, learner-centered teaching, and organizational change into one framework, this paper adds to the discussion on digital transformation in higher education. It also offers a strategic base for future research, planning, and policy development aimed at improving accessibility, responsiveness, and sustainability in continuing education.

Keywords: Technology and Innovation; Lifelong Learning; Digital Transformation; Continuing Education

1. INTRODUCTION

1.1 Society 5.0, Digital Transformation, and Continuing Education

The digital transformation driven by the rapid advancement of digital technologies associated with IR 4.0 and society 5.0 revolutionizes higher education [1]. Society 5.0 advocates a human-centered approach towards the application of digital technologies so as to resolve various societal problems, improve quality of life, and enhance productivity of society. Consequently, higher education institutions are challenged to go beyond traditional teaching mode to flexible and easily accessible and tech-enabled learning that support the lifelong learning or reskilling and upskilling throughout the lives of individuals.

The importance of lifelong learning is coherent to the goals of the United Nations Sustainable Development Goals (SDGs) namely SDG 4 (Quality education), SDG 8 (Decent work and economic growth), SDG 9 (Industry, Innovation and Infrastructure). These goals emphasize inclusive and equitable access to quality education and learning that contributes to work force preparedness and innovative and sustainable development through digital transformation [2]. As such, continuing education institutions are becoming crucial instruments for the development of the workforce to remain competitive in ever changing and dynamic labour market.

As one of the pioneers to provide lifelong learning and continuing education in Malaysia, School of Professional and Continuing Education (SPACE UTM) has helped many working adults, industry practitioners, and non-traditional students to access to higher education. However, with the post-pandemic, higher education is facing more rigorous expectations for a comprehensive digital learning ecosystem beyond typical online learning environments and Open Educational Resources (OERs) [3]. Institutions are expected to implement novel technologies to the whole process of teaching, learning, learner support, and administrative aspects for remain resilient, competitive and sustainable [4].

While there is significant progress in technology adoption, there are limitations on the impact of digital transformation on continuing education. Firstly, existing programs are predominantly centered on traditional teaching method and are lack in pedagogy; they failed to support flexibility, autonomy and personalization required by the adult learners [5]. Secondly, administrative processes are predominantly manual, which causes lower productivity and delay in service provision. Thirdly, the implementation of advanced technologies such as artificial intelligence (AI), learning analytics, and mobile learning platforms is often not integral as part of the institution-wide strategy, but rather in isolated components [6], resulting a disparity between the technology available and actual transformation in education [7].

Although literature on digital transformation in higher education is increasing significantly, research have tended to focus on certain technology or certain aspect of digital learning [4], [8], namely AI in education, learning analytics, mobile

learning, and digital credentials. Comprehensive frameworks explaining the integration of these technologies to foster pedagogical innovation, administrative transformation, and learner development in the context of continuing education have limited research attention. Limited effort has also been put in relating technological adoption to institutional transformation to create a successful lifelong learning ecosystem, highlighting a critical gap in literature.

In filling this gap, this concept paper proposes an institution-focused strategic framework to drive digital transformation in SPACE UTM through technology and innovation. Based on the Technology Acceptance Model (TAM) and Disruptive Innovation Theory, this framework demonstrates the role of innovative technologies in fostering agile pedagogy and smart administration, as well as developing a future-ready workforce. This framework also contributes to the existing body of literature by providing a holistic conceptual model on technology adoption, pedagogical innovation and institutional transformation for continuing education.

Significance of this study extend beyond planning for individual institutions. It offers guidelines for educators to adopt the human-centered, tech-enabled teaching pedagogy and flexible, personalised learning [9], provide partnership opportunities between industries and education institutions to support industry professional with flexible learning and credentials on the demands of the labour market [10], support for the national agenda on digital transformation and human capital development in Malaysia [11], and reaffirm SPACE UTM's position as an agent of change in lifelong learning.

1.2 Research Objectives

- a) To examine how AI-supported learning management systems can facilitate adaptive and personalised learning experiences for diverse learner populations [9].
- b) To investigate how mobile-first and accessible learning technologies can enhance participation among learners from diverse geographical and socio-economic backgrounds [12].
- c) To conceptualise the role of learning analytics and data-driven decision-making in improving administrative efficiency, learner support, and institutional responsiveness [2], [4].

Through these objectives, the paper seeks to establish a strategic foundation for future research and implementation initiatives that position technology and innovation as key enablers of lifelong learning transformation within SPACE UTM and similar continuing education institutions.

1.3 Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) developed by Davis (1989) proposes that two beliefs about technology (perceived usefulness and perceived ease of use) will most significantly influence technology adoption. A user is likely to adopt and use a technology if it is believed that the technology would be beneficial to performing a job and is easy to use. Studies have recently validated TAM's relevance for technology adoption in higher education, especially in contexts of online learning, AI systems, and digital learning environments [13].

For the case of SPACE UTM, TAM serves as the theoretical explanation for how faculty, students and administrative staff may adopt new technologies such as AI-supported learning systems, mobile learning applications and learning analytics. Acceptance of these technologies would be based not only on the availability of these technologies, but also on users' perception that they would increase effectiveness for teaching, learning and administration. TAM thus explains the mechanisms at the user level driving technology adoption and facilitating the emergence of agile pedagogy and smart administration.

1.4 Disruptive Innovation Theory

While TAM explains technology adoption at the individual level, Disruptive Innovation Theory attempts to illustrate technological adoption from an institutional point of view, and organisational transformation [4], [8]. The theory suggests that disruptive innovations offer new alternatives and challenge established systems in the marketplace by providing more affordable, easier-to-access, and more convenient technologies. The effect of disruptive innovations in higher education could include the reshaping of conventional educational practices through online learning, micro-credentials, personalised learning and online service delivery.

In the context of continuing education institutions such as SPACE UTM, digital transformation entails more than mere implementation of technologies; it refers to a change in how educational services are designed, delivered and managed. By leveraging new technologies, institutions are better enabled to meet the demands of the learner, workplace and industry. Therefore, Disruptive Innovation Theory describes how technology acts as a driver for the transformation of institutions. It implies enabling flexible learning opportunities, efficient administration and innovative pedagogy.

1.5 Integration of TAM and Disruptive Innovation Theory

The integration of TAM and Disruptive Innovation Theory provides an overall framework to describe the digital transformation of continuing education. While TAM describes how the stakeholders may adopt and utilise new technologies, Disruptive Innovation Theory addresses how they contribute to organisational change. Together, the two theories support the argument that successful technology

adoption leads to the development of agile pedagogy and smart administration and, in turn, results in future-ready learners.

While TAM is used to describe the adoption of emerging technologies by faculty, students and administrative staff, Disruptive Innovation Theory is adopted to describe how institutions integrate these new technologies into pedagogy and administration systems. The interaction between the two theories is the theoretical basis of the proposed conceptual framework.

1.6 Literature Review

1.6.1 Digital Transformation in Continuing Education

Digital transformation has become a key strategic priority for higher education institutions seeking to stay relevant in the present, rapidly changing and technologically-advanced learning environments [8]. However, the literature suggests that numerous institutions still approach the process as a purely technological one rather than as organisational change. As a result, investment in digital technologies fails to bring about effective improvements to learner engagement, institutional productivity and learning outcomes.

Digital transformation faces many challenges for continuing education institutions, since it deals with the diverse demands of adult learners, professional practitioners and non-traditional students. Unlike traditional undergraduate students, continuing education necessitates more flexibility and easy access to knowledge and is responsive to demands from the changing business world [5]. Therefore, Digital Transformation is expected to exceed simply using learning management systems, and it must also lead to transformation in pedagogy, learner support and administrative functions.

1.6.2 Lifelong Learning and Adult Learning

Lifelong learning has become essential to professional development in the knowledge-based economy. Continuous skill updating and reskilling have become necessities throughout one's career with the fast pace of technological innovation and its impacts on employment dynamics [1]. However, adult learners are fundamentally different from students; they often need a more flexible approach to learning that focuses on applied, hands-on experiences and allows for personal and professional circumstances [5].

Unfortunately, traditional methods still dominate many continuing education courses and may not enable flexibility and learners' self-direction. This pedagogical rigidity hinders the achievement of lifelong learning goals and the successful implementation of Digital Transformation strategies [3], [4].

1.6.3 Artificial Intelligence, Learning Analytics and Micro-Credentials

Emerging technologies are changing how continuing education is delivered. AI has the potential for supporting personalised learning environments, adaptive instruction, immediate automated feedback and intelligent learner support systems [9]. Learning analytics could improve institutional performance through identifying learning trends, anticipating learning difficulties and providing targeted intervention [2].

Despite these technologies' potential individual benefits, literature suggests they have often been examined in isolation, leaving gaps in studies seeking a consolidated framework to improve pedagogy, administration, and learning outcomes of continuing education institutions.

2. MATERIALS AND METHODS

2.1 Proposed Conceptual Framework

Emerging Technologies serve as the driver of institutional transformation and are presented as the central element of the conceptual framework proposed here. Emerging technologies refer to various digital technologies like artificial intelligence, learning analytics, mobile learning technologies and others that can facilitate lifelong learning and continuing education.

This framework argues that the adoption and successful implementation of these technologies result in two interconnected aspects of institutional change: Agile Pedagogy and Smart Administration.

Agile Pedagogy includes technology-enhanced learning strategies that promote flexibility, learner-centeredness, personalisation, real-time feedback, collaboration and learners' autonomy. Smart Administration encompasses the use of digital technologies to boost the efficiency and effectiveness of operations, decision making, service delivery and learner support services.

The interaction between Agile Pedagogy and Smart Administration constitutes an integrated educational environment which will further enhance the development of Future-Ready Learners, characterised by digital literacy, flexibility, lifelong learning competency, problem-solving skills, and readiness for evolving workplace demands.

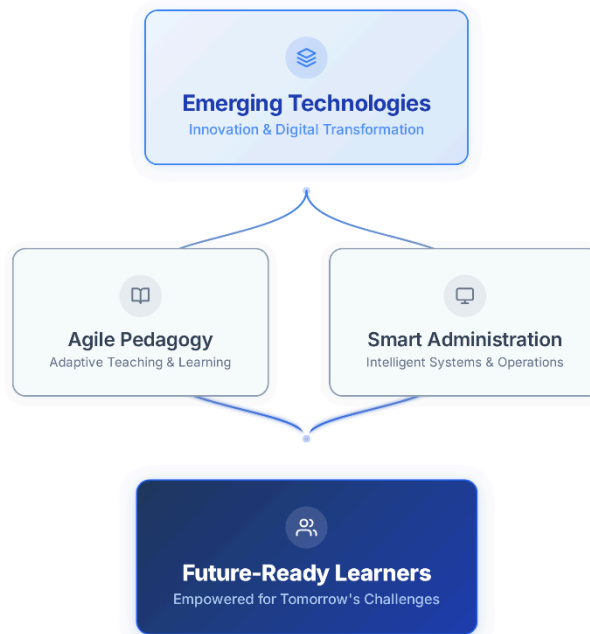


Figure 1. The Proposed Conceptual Framework

2.2 Conceptual Propositions

Drawing upon the conceptual framework suggested by Figure 1 and the combined principles of the Technology Acceptance Model (TAM), Disruptive Innovation theory, and the literature review discussed, the following set of conceptual propositions is formed to describe the proposed interrelationships between constructs: These propositions are a guide for further empirical study of this framework within the context of continuing education.

- P1: Emerging technologies positively influence the development of agile pedagogy.
- P2: Emerging technologies positively influence the implementation of smart administration.
- P3: Agile pedagogy positively influences learner engagement, autonomy, and personalised learning experiences.
- P4: Smart administration positively influences institutional efficiency, service quality, and learner satisfaction.
- P5: The combined influence of agile pedagogy and smart administration contributes to the development of future-ready lifelong learners.

2.3 Proposed Validation Strategy And Future Research Agenda

As this paper is a framework, not an empirical study, a phased validation strategy is proposed to determine the feasibility, effectiveness, and scalability of the framework for future research and implementation activities. A mixed methods approach seems appropriate as it will allow for thorough examination of stakeholders' requirements while at the same time permitting evidence-based examination of institutional performance.

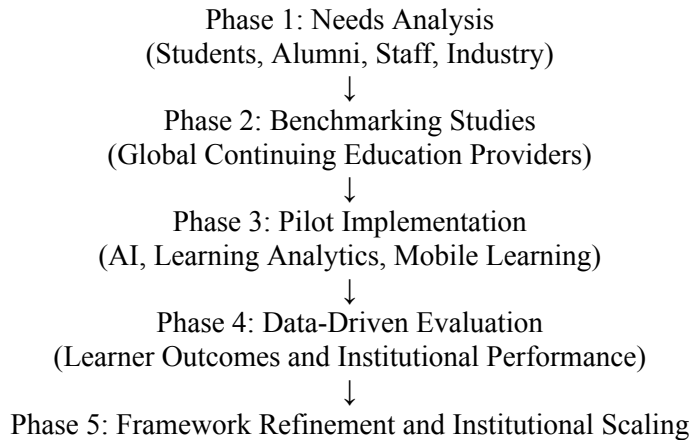
Phase 1 would consist of a needs analysis comprising surveys, interviews and focus groups with relevant stakeholders (e.g., current students, alumni, academic and administrative staff, industry). It will aim to establish existing technological needs, provision requirements for lifelong learning, and areas requiring significant attention for continuing education settings. Meeting the needs of all stakeholders is crucial for effective adoption of any subsequent technological interventions [5].

Phase 2 involves a benchmarking exercise based on studies of internationally recognized professional and continuing education providers (e.g. Open University United Kingdom, MIT Continuing Education Units (CEUs), Open University Malaysia, Open University Malaysia (OUM), Universiti Sains Malaysia (USM) through its Centre for Development of Academic Excellence (CDAE) and lifelong learning initiatives, Universiti Teknologi MARA (UiTM) through iCEPS (Institute of Continuing Education and Professional Studies) and other institutions recognized for their initiatives of digital transformation in areas related to technology enhanced learning, learner support services, micro-credentials implementation and digital administration. From the results of the benchmarking, applicable practice(s) to be adapted to the environment of SPACE UTM can be identified.

Phase 3 would pilot specific digital innovations to investigate their viability, usability and effectiveness before institutional adoption. The potential technological innovations are, e.g. an AI-powered learning assistant, a learning analytics dashboard, or a mobile learning application. Previous research showed that pilot studies of emergent educational technologies are critical for avoiding implementation risk and maximising user acceptance [9], [14].

Phase 4 would involve empirical evaluation through the examination of learning analytics and institutional performance metrics. These may be compared across different user groups or institutions to derive evidence-based comparisons. Quantitative measures such as learners' engagement, academic success, retention and quality of service could be analysed in combination with qualitative evidence. This approach will enable to fine-tuning the proposed framework and make evidence-based decisions about scaling the framework institution-wide. Together, these phases provide a concrete roadmap to validate the framework and obtain empirical evidence to support further research in areas of digital transformation, lifelong learning, and continuing education in the higher education sector.

2.4 Validation Strategy Framework



3. RESULTS AND DISCUSSION

3.1 Expected Outcomes and Institutional Implications

The envisioned implementation of the technology and innovation approach in SPACE UTM can be instrumental to achieving positive effects in the education of learners and industry partners and in the institution itself. Nevertheless, this effect should be regarded as a potential outcome of the institutional application and should be examined through future empirical research and evaluation.

In an educational aspect, the learning framework is anticipated to enable learners to have more personalised, flexible, and learner-centred educational experiences via the application of technology and agile pedagogies. It can be argued that the technologies of artificial intelligence, learning analytics and mobile learning environments will help in establishing adaptive learning experiences, immediate feedback to learners and greater learner engagement on adult and non-traditional learners [9].

At the institutional level, the implementation of smart administrative systems may support an efficient operation, effective decision-making and timely response to learner demands. Automation of parts of the administration tasks, coupled with the data analytical capabilities, may assist in reducing process time, enhancing service quality, and facilitating management in the information era [2], [4].

It can potentially bolster the capacity of SPACE UTM to deliver continuing education by fostering more accessible and flexible learning opportunities. Digital learning environment can provide wider access to education beyond the physical limitation, thereby facilitating higher participation in workforces, remote locations

and from overseas, and so forth [8]. However, the overall contribution to the enrolment growth, learner retention and institutional scalability is context-specific and needs to be identified by future research.

Likewise, a close relationship between technology-enhanced learning and industry partners may be established. With better usage of market intelligence, learning analytics, and close collaborations with business sectors, continuing education programmes may be made more adaptive to current skills demands [4].

Ultimately, the learning framework has a promise of developing future-ready students. Future learners, or the people learning continuously, will be more resilient as they are equipped with the essential skills such as digital literacy, adaptivity and lifelong learning capability. These are required skills in the new and evolving information economy, where innovation and rapid technological changes occur all the time.

4. CONCLUSION

With the coming of IR 4.0 and Society 5.0, continuing education institutions face an immediate and imperative need to adapt an agile, learner-centred, technology-enabled approach towards lifelong learning. The issue at hand, it is argued here, is not the non-availability of technologies but the lack of a cohesive framework linking technological innovation to pedagogy, administration, and the development of learner competencies. A conceptual framework based on TAM and Disruptive Innovation Theory is presented here to account for how emergent technologies are enabling agile pedagogy and smart administration in developing future-ready learners.

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REFERENCES

- [1] N. W. Gleason, Ed., *Higher Education in the Era of the Fourth Industrial Revolution*. Singapore: Palgrave Macmillan, 2018, doi: 10.1007/978-981-13-0194-0.
- [2] UNESCO, *AI and Education: Guidance for Policy-Makers*. Paris, France: United Nations Educational, Scientific and Cultural Organization, 2021. [Online]. Available: <https://unesdoc.unesco.org/ark:/48223/pf0000376709>
- [3] C. Rapanta, L. Botturi, P. Goodyear, L. Guàrdia, and M. Koole, "Online university teaching during and after the COVID-19 crisis: Refocusing teacher

- presence and learning activity,” *Postdigital Sci. Educ.*, vol. 2, pp. 923–945, 2020, doi: 10.1007/s42438-020-00155-y.
- [4] A. Haleem, M. Javaid, M. A. Qadri, and R. Suman, “Understanding the role of digital technologies in education: A review,” *Sustainable Operations and Computers*, vol. 3, pp. 275–285, 2022, doi: 10.1016/j.susoc.2022.05.004.
- [5] A. W. Bates, *Teaching in a Digital Age: Guidelines for Designing Teaching and Learning*, 2nd ed. Vancouver, BC, Canada: Tony Bates Associates Ltd., 2019. [Online]. Available: <https://pressbooks.bccampus.ca/teachinginadigitalagev2/>
- [6] G. Chen, B. Xu, M. Lu, and N. S. Chen, “Exploring blockchain technology and its potential applications for education,” *Smart Learning Environments*, vol. 5, no. 1, pp. 1–10, 2018, doi: 10.1186/s40561-017-0050-x.
- [7] T. Jagušt, I. Botički, and H. J. So, “Examining competitive, collaborative and adaptive gamification in young learners’ math learning,” *Comput. Educ.*, vol. 125, pp. 444–457, 2018.
- [8] E. Abad-Segura, M. D. González-Zamar, J. C. Infante-Moro, and G. Ruipérez García, “Sustainable management of digital transformation in higher education: Global research trends,” *Sustainability*, vol. 12, no. 5, p. 2107, 2020, doi: 10.3390/su12052107.
- [9] G. J. Hwang, H. Xie, B. W. Wah, and D. Gašević, “Vision, challenges, roles and research issues of artificial intelligence in education,” *Comput. Educ.: Artif. Intell.*, vol. 1, p. 100001, 2020, doi: 10.1016/j.caeai.2020.100001.
- [10] W. T. Aun, O. T. Chin, T. S. Fern, and K. J. Yao, “A case study of private higher education institutions in conforming to the Malaysian Education Blueprint 2015–2025 (Higher Education),” *Malaysian Journal of Qualitative Research*, vol. 6, no. 1, 2020.
- [11] Universiti Teknologi Malaysia, *Envisioning UTM 2025: Strategic Plan*. Johor Bahru, Malaysia: UTM Press, 2020. [Online]. Available: <https://envision2025.utm.my/>
- [12] H. Crompton and D. Burke, “The use of mobile learning in higher education: A systematic review,” *Comput. Educ.*, vol. 123, pp. 53–64, 2018, doi: 10.1016/j.compedu.2018.04.007.
- [13] K. Lee, M. Fanguy, B. Bligh, and X. S. Lu, “Adoption of online teaching during the COVID-19 pandemic: A systematic analysis of changes in university teaching activity,” *Educational Review*, vol. 74, no. 3, pp. 460–483, 2022.
- [14] O. Zawacki-Richter, V. I. Marín, M. Bond, and F. Gouverneur, “Systematic review of research on artificial intelligence applications in higher education—Where are the educators?,” *Int. J. Educ. Technol. Higher Educ.*, vol. 16, no. 1, p. 39, 2019, doi: 10.1186/s41239-019-0171-0.

KEY QUALITY DIMENSIONS IN E-LEARNING: A SYNTHESIS OF ASSESSMENT MODELS IN HIGHER EDUCATION

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ABSTRACT - E-learning has become a key form of teaching and learning in higher education worldwide, however, there is a lack of an integrated view of the dimensions of quality and models for assessing e-learning. Using systematic narrative synthesis approach, empirical studies published between 2000 and 2024 were systematically searched in Scopus, Web of Science, and Google Scholar. After thorough two-stage screening and interrater reliability (Cohen's kappa: 0.85 to 0.88), 30 peer-reviewed studies from 16 countries were analysed. The majority of the designs were quantitative (60%) and the most common method of analysis was structural equation modeling. Four main quality dimensions were identified: content quality (87% of studies), interaction quality (70%), platform usability (60%) and instructor effectiveness (53%). SERVQUAL (40%) and the Technology Acceptance Model (37%) were the most popular models, but both have significant weaknesses in representing digital-native concepts like personalization, adaptive learning, and real-time feedback. The number of publications increased significantly during the COVID-19 period (2020-2024), with a 63% increase. There are still significant gaps in geographic representation (Asia: 17%, Africa: 0%), examination of emerging technologies (13%), faculty experience studies (7%) and long-term learning outcomes (0%). The results suggest that there is an urgent need for integrated, digital-native assessment frameworks that are validated across diverse cultural contexts to move towards equitable and effective e-learning in higher education.

Keywords: E-learning Quality; Service Quality; SERVQUAL; Technology Acceptance Model (TAM); Higher Education.

1. INTRODUCTION

E-learning, defined as the use of technology to deliver instruction that enables students to access learning materials remotely at any time [1], has transformed

teaching and learning across higher education systems globally. The COVID-19 pandemic accelerated this shift, driving an unprecedented global transition from face to face to fully online instruction [2] and exposing significant disparities in institutional readiness, digital infrastructure, and pedagogical practice [3]. As digital learning environments continue to expand, the quality of e-learning has become a central concern for universities, administrators, and accreditation bodies [3]. E-learning quality is inherently multidimensional, encompassing content quality, system usability, interaction quality, instructor effectiveness, technical infrastructure, and learner support services, each of which shapes student satisfaction and learning outcomes [4],[5]. SERVQUAL and its derivatives have been widely applied to conceptualize and measure perceived quality in online learning contexts [6], while the Technology Acceptance Model (TAM) [7] and the Unified Theory of Acceptance and Use of Technology (UTAUT2) [8] emphasize perceived usefulness and ease of use as key drivers of technology adoption in education. The Community of Inquiry (CoI) framework [9] further identifies cognitive, social, and teaching presence as essential conditions for effective online learning, with student instructor interaction consistently identified as the most significant predictor of learning satisfaction [10]. Despite this theoretical richness, empirical research remains fragmented across disciplines, methodologies, and geographic contexts, often focusing narrowly on teacher presence or platform usability without theoretical synthesis [4],[10]. [11] note that the literature remains disproportionately concentrated in North America and Europe, with limited empirical evidence from Asia, Africa, and Latin America, an imbalance that constrains the generalizability of existing findings [2],[11].

Addressing this gap, [11] call for a comprehensive synthesis that identifies key dimensions of e-learning quality, maps commonly used assessment models, and highlights persistent limitations in the field. This study responds to that call by systematically reviewing 30 empirical studies on e-learning quality in higher education published between 2000 and 2024, drawing on established frameworks from service quality [5],[6], technology acceptance [7],[12], information systems [4], and online learning [9],[10] to construct an integrated overview of how e-learning quality has been conceptualized and measured across diverse geographic and institutional contexts. This synthesis addresses three research questions (RQ):

- RQ1: What are the key dimensions of e-learning quality examined in higher education?
- RQ2: Which assessment models and frameworks are most commonly used to evaluate e-learning quality, and what are their main strengths and limitations?
- RQ3: What major gaps remain in the current evidence base, and what future research directions are needed?

2. MATERIALS AND METHODS

The study used a systematic narrative synthesis method to fully explore e-learning quality dimensions and assessment frameworks in higher education. To ensure methodological rigour and transparency, a structured search protocol, clearly defined inclusion and exclusion criteria, and a two-stage independent screening process were used. The following procedures were performed following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.

2.1 Search Strategy

Empirical studies on the quality of e-learning in higher education were retrieved from three major databases: Scopus, Web of Science and Google Scholar. Articles were searched from January 2000 to December 2024, encompassing both pre- and post-COVID-19 pandemic times, which saw an unprecedented surge in online learning. The following terms were used in combination to search all databases: e-learning, online learning, distance education, or blended learning; quality or service quality; higher education, university, or undergraduate; and student satisfaction, learning outcome, or user experience. Several Boolean operators were used to systematically identify relevant studies as shown in Table 1.

Table 1. Boolean Search Strings Used Across Databases

Search	Quality-Related Construct	Search Terms (Boolean Operators)
1	Quality	"e-learning" OR "online learning" OR "distance education" OR "blended learning" AND "quality" AND "student satisfaction" AND "higher education" OR "university" OR "undergraduate"
2	Service quality; platform usability; content quality; instructor quality; interaction quality; assessment model/quality dimensions	Same base string as Search 1, with "quality" replaced by each construct listed (and "student satisfaction" replaced by "learning outcome" for content quality)

Only peer-reviewed journal articles in English were included in the search. Also, reference lists of included studies and relevant review articles were manually scanned to identify eligible studies that were not identified by the primary database searches.

2.2 Inclusion and Exclusion Criteria

Articles from peer-reviewed journals in English indexed in Scopus or Web of Science from January 2000 to December 2024 were systematically searched. Only articles that met the following inclusion criteria were considered for analysis: (1) addressed higher education contexts (undergraduate or postgraduate learners); (2) empirically examined e-learning quality dimensions, service quality, platform usability, or factors related to student satisfaction or learning outcomes in technology-mediated courses; and (3) were published in English.

If studies: (1) only studied K-12, corporate training or informal learning contexts; (2) only studied technical aspects of the platform and not quality dimensions or student outcomes; (3) did not contain primary empirical data such as conceptual papers, editorials, or purely theoretical studies; or (4) were systematic reviews, scoping reviews, books, or conference abstracts, they were excluded. These criteria guaranteed that the synthesis was targeted towards primary empirical evidence specifically pertaining to e-learning quality in higher education.

This review was performed following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The systematic search resulted in 412 records as shown in Figure 1. A total of 318 unique records were screened by title and abstract, and 218 were excluded because they did not meet the eligibility criteria. A hundred full-text articles were then evaluated, and 70 of these were excluded because they lacked empirical data or focused only on the technical aspects of the system or were not set in a higher education context. The remaining 30 studies met all inclusion criteria and were included in the final synthesis.

All abstracts and full texts were screened independently by two trained reviewers. Each article was independently reviewed by the reviewers and data were extracted from each article such as author, year, country, study design, sample size, statistical analysis used, theoretical framework used, quality dimensions examined, and key findings. At the title and abstract screening stage, the interrater agreement was substantial (Cohen's kappa coefficient = 0.85). Cohen's kappa for full-text assessment was 0.88, indicating almost perfect agreement. Any discrepancies at both stages were addressed through discussion until consensus was reached.

2.3 Statistical Analysis

Data from the 30 included studies were analysed using a descriptive statistical and narrative synthesis approach, consistent with PRISMA guidelines for the search and screening stages [13]. Frequencies (*n*) and percentages (%) described study characteristics across the final sample, including research design, geographic representation, publication year trends, sample size ranges, and the prevalence of each e-learning quality dimension (content quality, interaction quality, platform

usability, and instructor effectiveness), as well as the relative prevalence of each identified assessment framework: SERVQUAL, TAM, UTAUT2, the Community of Inquiry (CoI) framework, and hybrid models.

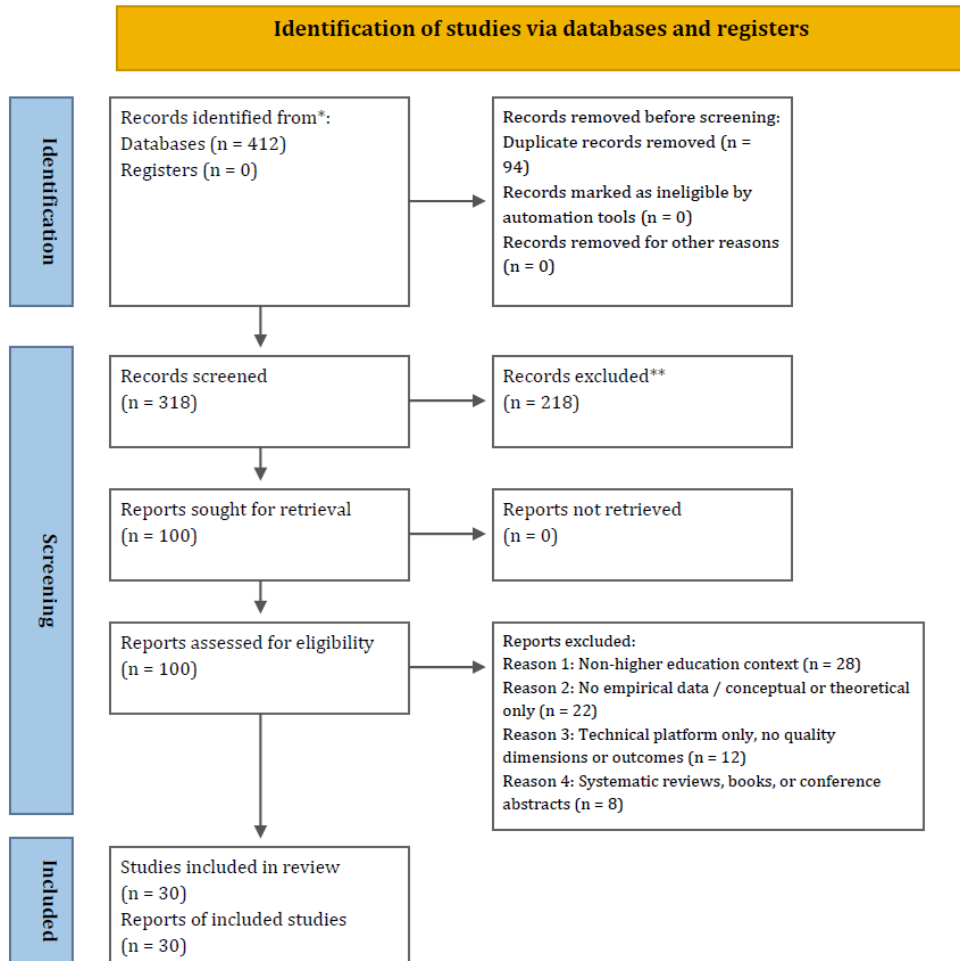


Figure 1. PRISMA Flow Diagram

Most studies (60%, $n = 18$) used quantitative designs, consistent with the broader trend favouring survey based and structural equation modelling research [4], [5]; 27% ($n = 8$) were qualitative and 13% ($n = 4$) mixed methods. Geographically, the sample skewed heavily toward North America (40%, $n = 12$) and Europe (33%, $n = 10$), with limited representation from Asia (17%, $n = 5$), South America (7%, $n = 2$), and Oceania (3%, $n = 1$); no African studies met inclusion criteria (0%), a critical gap in the evidence base. Publications rose sharply during the COVID-19 period, 2020 to 2024 (63%, $n = 19$), compared with the preceding two decades, 2000 to 2019 (37%, $n = 11$).

Content quality was the most frequently studied dimension (87%, $n = 26$) and was consistently linked to student satisfaction and learning outcomes [4], [5]. Interaction quality followed (70%, $n = 21$), with [10] reporting the strongest effect in this synthesis ($r = 0.51$), identifying it as the most powerful predictor of online learning satisfaction. Platform usability was examined in 60% ($n = 18$) of studies, with [4] identifying system quality as the most important predictor of e-learning success ($\beta = 0.48$, $p < .001$). Instructor effectiveness was the least studied dimension (53%, $n = 16$) yet showed the largest direct effect on satisfaction among recent studies ($\beta = 0.52$, $p < .001$; [5]). Standardised effect sizes, including correlation coefficients (r) and structural equation modelling path coefficients (β), were extracted and tabulated to indicate the typical magnitude and direction of relationships across studies, without statistical pooling.

Table 2 summarises the prevalence and critical appraisal of the five assessment frameworks identified. SERVQUAL was the most widely used (40%, $n = 12$), valued for its structured gap analysis of expectations versus perceptions of service quality [6], though it underestimates instructor mediated quality and omits digital native constructs such as personalisation and adaptive learning [5]. TAM and UTAUT2, used in 37% ($n = 11$) of studies, showed strong predictive validity for technology acceptance across cultural contexts [7], [12], though both address individual acceptance rather than pedagogical effectiveness [4]. The CoI framework (27%, $n = 8$) aligned most closely with educational objectives through its three presence model but lacked platform specific constructs [9]. DeLone and McLean's IS Success Model, used in 17% ($n = 5$) of studies, offered a broader information systems perspective but limited pedagogical applicability [4].

Hybrid models combining two or more frameworks appeared in 30% ($n = 9$) of studies, reflecting growing recognition of e-learning quality's multidimensionality [11]. Given substantial methodological heterogeneity across the included studies, a formal meta-analysis was not performed; instead, a narrative synthesis approach was adopted, consistent with the Synthesis Without Meta-Analysis (SWiM) reporting guideline and established guidance on narrative synthesis in systematic reviews [14].

Table 2. Assessment Frameworks Identified: Prevalence, Strengths, and Limitations ($n = 30$)

Framework	n	Prevalence (%)	Key Strengths	Key Limitations
SERVQUAL	12	40%	Structured five-dimension gap analysis; widely validated	Underestimates instructor quality; omits personalisation and adaptive learning constructs

Framework	<i>n</i>	Prevalence (%)	Key Strengths	Key Limitations
TAM / UTAUT2	11	37%	High predictive validity for technology adoption; cross-culturally validated	Focuses on individual acceptance, not pedagogical quality or learning outcomes
Community of Inquiry (CoI)	8	27%	Pedagogically grounded; captures cognitive, social, and teaching presence	Lacks platform-specific and service-quality constructs
DeLone & McLean IS Model	5	17%	Comprehensive IS success dimensions; include system, information, and service quality	Primarily designed for information systems; limited pedagogical applicability
Hybrid Models	9	30%	Combines service quality, technology acceptance, and pedagogical constructs	Inconsistent construct definitions across studies; limited cross-context validation

Note. Percentages are over 100% when multiple studies used more than one framework. Prevalence is expressed as a percentage of the 30 studies included.

The interrater reliability between two independent reviewers was evaluated at the title and abstract screening stage ($\kappa = 0.85$) and the full-text assessment stage ($\kappa = 0.88$), which shows substantial to near perfect agreement, respectively [15]. Any disagreement at both stages was solved by discussion until reaching consensus. Standard spreadsheet software (Microsoft Excel) was used to carry out all frequency counts and percentage calculations.

3. RESULTS AND DISCUSSION

As outlined in Section 2.3, descriptive statistics (frequencies and percentages) were computed across the 30 included studies to characterize study design, geographic distribution, publication year, and coverage of quality dimensions and assessment frameworks. Sample sizes ranged from 45 to 23,611 participants (median = 263), spanning 16 countries: the United States, Canada, the United Kingdom, Brazil, Greece, Spain, Vietnam, Malaysia, China, Iran, Turkey, Poland, India, Bangladesh, Finland, and New Zealand. Most studies (63%, $n = 19$) were published between 2020 and 2024, reflecting heightened research interest during the COVID-19 pandemic [2]. Structural equation modelling (SEM) was the dominant analytical method among quantitative studies (61%, $n = 11$ of 18), consistent with prior service-quality and technology-acceptance research [4], [5]. Results are organized

according to the three research questions guiding this synthesis: study characteristics, key quality dimensions, and assessment frameworks.

3.1 Study Characteristics

Of the 30 studies, 60% ($n = 18$) were quantitative, 27% ($n = 8$) qualitative, and 13% ($n = 4$) mixed methods. Undergraduate populations comprised 73% of samples, drawn predominantly from North America (40%, $n = 12$) and Europe (33%, $n = 10$), with Asia (17%, $n = 5$), South America (7%, $n = 2$), and Oceania (3%, $n = 1$) markedly underrepresented; no African based studies met inclusion criteria, a structural limitation revisited in Sections 3.4 and 3.6. Publications rose sharply from 2020 to 2024 (63%, $n = 19$) relative to the preceding two decades (37%, $n = 11$), underscoring the pandemic's role as a catalyst for e-learning quality research [3]. Early qualitative work established foundational constructs such as cognitive, social, and teaching presence, while studies from 2011 to 2021 shifted toward quantitative, TAM based designs. Large scale studies consistently identified student to instructor interaction as a primary satisfaction predictor, with recent research trending toward hybrid frameworks to capture the construct's multidimensionality [2], [10].

3.2 RQ1: What are The Key Dimensions of E-Learning Quality in Higher Education?

Four dimensions recurred across the corpus: content quality (87%, $n = 26$), interaction quality (70%, $n = 21$), platform usability (60%, $n = 18$), and instructor effectiveness (53%, $n = 16$), as shown in Tables 2 and B, forming the basis of the integrated framework in Section 3.5 (Figure 2). Since no formal meta-analysis was performed, associations are reported narratively rather than as pooled effect sizes. Content quality showed the highest prevalence and was linked to satisfaction and outcomes across contexts [4], [5], including during pandemic era remote learning [2], suggesting it is a necessary but insufficient condition for positive outcomes. Interaction quality was confirmed in 90% of studies examining it (19 of 21); [10] reported that student to instructor interaction was the strongest satisfaction predictor overall ($r = 0.51$), though [5] found no significant relationship, suggesting moderation by culture or class size. Platform usability, assessed mainly through TAM [7], was linked to e-learning success by [4] (system quality $\beta = 0.48$, $p < 0.001$) and to continued use under UTAUT2 by [12]; cross cultural validity was reinforced by [6] in the Vietnamese higher education context. Instructor effectiveness, though the least studied dimension (53%), showed the largest standardized effect on satisfaction ($\beta = 0.52$, $p < 0.001$; [5]), consistent with the CoI framework's emphasis on teaching presence [9], and reinforced by [3]'s finding that pandemic driven gaps in faculty digital competency undermined satisfaction, indicating this dimension is under researched but high leverage for faculty development investment.

3.3 RQ2: What are The Most Popular Assessment Models and Framework for Assessing the Quality of E-Learning and What are Their Key Strengths and Weaknesses?

Five frameworks emerged in Table 2: SERVQUAL (40%, $n = 12$), TAM/UTAUT2 (37%, $n = 11$), Community of Inquiry (27%, $n = 8$), IS Success Model (17%, $n = 5$), and hybrid models (30%, $n = 9$). SERVQUAL, adapted for e-learning by replacing tangibles with system or platform quality [6], offers structured gap analysis but overlooks digital native features such as personalization and learning analytics, and tends to underweight instructor mediated quality [5]. TAM/UTAUT2 [7], [12] show strong cross cultural predictive validity for adoption intention but focus narrowly on technology acceptance rather than pedagogical effectiveness [4]; [10] found that integrating TAM with IS success constructs improved explanatory power, supporting complementary model use. CoI [9], the most pedagogically grounded framework identified, aligns closely with educational objectives but lacks platform quality constructs, prompting hybrid pairings with TAM or SERVQUAL [5]. The IS Success Model [6] offers a systems perspective encompassing system, information, and service quality, but has limited direct pedagogical relevance given its origins outside education [4]. The growing use of hybrid models (30%, $n = 9$) reflects a consensus that no single framework captures the multidimensionality of e-learning quality [11], motivating the integrated framework proposed in Section 3.5.

Geographic imbalance remains the most significant structural gap: North America and Europe together account for 73% of the evidence base, while Asia, South America, Oceania, and Africa remain severely underrepresented, despite these regions experiencing the most rapid and least documented growth in e-learning adoption and the lowest generalizability of existing frameworks [2], [11]. Only 13% ($n = 4$) of studies addressed emerging technologies such as artificial intelligence, learning analytics, and adaptive learning, indicating that current frameworks lag behind digital native developments [4], [5] and pointing to a need for next generation assessment instruments. Faculty digital competency, despite its demonstrated impact on quality outcomes [3], was examined in only 7% ($n = 2$) of studies, a striking mismatch given the outsized effect size of instructor effectiveness reported under RQ1, warranting further research linking faculty development to student outcomes. Finally, none of the 30 studies assessed long term learning outcomes beyond immediate satisfaction (0%), a critical gap since satisfaction is, at best, a proxy for durable learning gains [11]; longitudinal designs measuring academic achievement, student retention, and post graduation employability are needed to confirm lasting impact.

3.4 Proposed Integrated Framework

To fill this gap between RQ2 and RQ3, this synthesis suggests an integrated e-learning quality framework (Figure 2) where the four empirically supported quality dimensions (content quality, interaction quality, platform usability, and instructor effectiveness) are direct antecedents of overall e-learning quality

(H1–H4), which in turn predicts student satisfaction (H5), and emerging technologies (H6) are proposed as an additional antecedent reflecting the technological gap identified in Section 3.3. Geographic context, institutional readiness and technology level are theorised to moderate the full model. This framework is an integration of service-quality, technology-acceptance, and pedagogical-presence constructs within a single architecture, which is an extension of existing frameworks and can be tested and empirically validated in various higher-education environments.

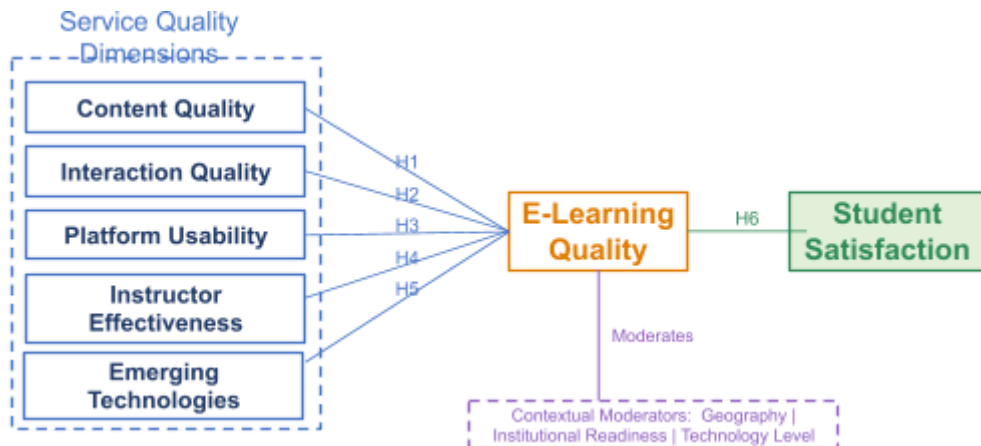


Figure 2. Proposed Conceptual Framework

3.5 Limitations

There are four important limitations to this synthesis. First, there is geographic bias: 73% of the included studies come from North America and Europe, which have significantly different digital infrastructure, institutional capacity, and cultural norms regarding e-learning than Asia, Africa, Latin America, and Oceania, thus limiting the cross-contextual generalisability of the results reported under RQ1 and RQ2. Second, the lack of grey literature, conference proceedings, and non-English publications may have led to publication bias, which could have overrepresented results from well-resourced academic environments. Third, the narrative synthesis approach was used due to the high methodological heterogeneity of the included studies, and the effect sizes presented in Section 3 should be viewed as illustrative rather than meta-analytically validated parameters. Fourth, pre-2020 validated frameworks may not fully capture the nature of AI-enhanced e-learning environments, due to the rapid rate of technological developments since then. As such, the integrated framework presented in Section 3.4 is not a validated causal model, but rather a conceptual synthesis to be tested empirically in the future.

4. CONCLUSION

This systematic narrative synthesis of 30 empirical studies from 16 countries traces four main aspects of e-learning quality in higher education from 2000 to 2024. Positive outcomes are dependent on the quality of the content, and instructor effectiveness has the highest direct effect on student satisfaction ($\beta = 0.52$, $p < 0.001$; [5] There is no digital-native component in existing assessment frameworks, including personalisation, adaptive learning and real-time feedback, which encourages an integrated and context-sensitive e-learning quality framework. There are still some areas that need further investigation, such as limited geographical coverage, lack of research on AI-enabled and adaptive systems, and limited evidence of faculty digital competency and longitudinal evidence of achievement, retention, and employability outcomes.

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REFERENCES

- [1] T. Anderson and J. Dron, "Three generations of distance education pedagogy," *Int. Rev. Res. Open Distance Learn.*, vol. 12, no. 3, pp. 80–97, 2011, doi: 10.19173/irrodl.v12i3.890.
- [2] A. Bozkurt and R. C. Sharma, "Emergency remote teaching and learning in a time of global crisis," *Asian J. Distance Educ.*, vol. 15, no. 1, pp. i–iv, 2020.
- [3] V. J. García-Morales, A. Garrido-Moreno, and R. Martín-Rojas, "The transformation of higher education after the COVID disruption: Emerging challenges in an online learning scenario," *Front. Psychol.*, vol. 12, p. 616059, 2021, doi: 10.3389/fpsyg.2021.616059.
- [4] T. R. Shah and P. Chhaniwal, "Modelling e-learning quality, self-efficacy and students' behaviour," *Int. J. Learn. Technol.*, vol. 19, no. 1, pp. 58–84, 2024, doi: 10.1504/IJLT.2024.137896.
- [5] N. Bouranta, E. L. Psomas, and D. Kafetzopoulos, "Integrating online learning into service quality assessment in higher education: Its influence on student satisfaction," *TQM J.*, vol. 37, no. 5, pp. 1418–1445, 2025, doi: 10.1108/TQM-06-2023-0180.
- [6] E. P. Mines, A. Q. Taray, and Q. A. Cunanan, "A SERVQUAL-based gap analysis in higher education: Basis for online learning improvement," *Int. J. Educ. Manag. Dev. Stud.*, vol. 6, no. 2, pp. 25–54, 2025, doi: 10.53378/ijemds.353194.

- [7] F. D. Davis, "Perceived usefulness, perceived ease of use, and user acceptance of information technology," *MIS Q.*, vol. 13, no. 3, pp. 319–340, 1989, doi: 10.2307/249008.
- [8] V. Venkatesh, M. G. Morris, G. B. Davis, and F. D. Davis, "User acceptance of information technology: Toward a unified view," *MIS Q.*, vol. 27, no. 3, pp. 425–478, 2003, doi: 10.2307/30036540.
- [9] M. Mielikäinen and E. Viippola, "ICT engineering students' perceptions on project-based online learning in Community of Inquiry (CoI)," *SAGE Open*, vol. 13, no. 3, 2023, doi: 10.1177/21582440231180602.
- [10] S. Bali, M.-C. Liu, and H. Sari, "Examining key determinants of social presence and satisfaction in online learning: An exploration with undergraduate students," *Int. J. Educ. Math. Sci. Technol.*, vol. 12, no. 4, pp. 1071–1089, 2024.
- [11] Y. B. Limbu and L. Pham, "Impact of e-learning service quality on student satisfaction during the COVID-19 pandemic: A systematic review," *Knowl. Manag. E-Learn.*, vol. 15, no. 4, pp. 523–538, 2023, doi: 10.34105/j.kmel.2023.15.030.
- [12] V. Venkatesh, J. Y. L. Thong, and X. Xu, "Consumer acceptance and use of information technology: Extending the unified theory of acceptance and use of technology," *MIS Q.*, vol. 36, no. 1, pp. 157–178, 2012, doi: 10.2307/41410412.
- [13] M. J. Page *et al.*, "The PRISMA 2020 statement: An updated guideline for reporting systematic reviews," *BMJ*, vol. 372, p. n71, 2021, doi: 10.1136/bmj.n71.
- [14] P. M. Podsakoff, S. B. MacKenzie, J. Y. Lee, and N. P. Podsakoff, "Common method biases in behavioral research: A critical review of the literature and recommended remedies," *J. Appl. Psychol.*, vol. 88, no. 5, pp. 879–903, 2003, doi: 10.1037/0021-9010.88.5.879.
- [15] M. L. McHugh, "Interrater reliability: The kappa statistic," *Biochem. Medica.*, vol. 22, no. 3, pp. 276–282, 2012.

EVALUATING MUSEUM-BASED EXPERIENTIAL LEARNING IN BUILT ENVIRONMENT EDUCATION: IMPACTS ON COGNITIVE DEVELOPMENT AND LIFELONG LEARNING

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ABSTRACT - The study examined the effects of museum-based experiential learning on spatial experience, cognitive outcomes and lifelong learning of students in built environment programmes. A structured educational visit was carried out at the Museum and Art Gallery Bank Negara Malaysia involving 40 diploma students from the Architecture and Quantity Surveying programmes. Data were collected using pre-visit and post-visit questionnaires, and 34 valid responses were analysed using Partial Least Squares Structural Equation Modelling (PLS-SEM). The results show that experiential learning has a significant positive effect on spatial experience ($\beta = 0.636, p < 0.001$), and spatial experience has a significant effect on cognitive outcomes ($\beta = 0.793, p < 0.001$). Furthermore, cognitive outcomes had a robust positive impact on lifelong learning ($\beta = 0.850, p < 0.001$). However, the direct relationship between experiential learning and cognitive outcomes was not significant ($\beta = -0.032, p = 0.842$), indicating that cognitive development mainly occurs through students' spatial experiences in the museum environment. The model explained 40.5% of the variance of the spatial experience, 59.7% of the variance of the cognitive outcomes, and 72.3% of the variance of lifelong learning. The findings emphasise the significance of authentic learning environments in built environment education, and illustrate the role of spatial experience as a key mechanism connecting experiential learning and cognitive development. Therefore, experiential learning in museums could be an effective pedagogical approach to improving students' spatial knowledge and cultivating lifelong learning attitude.

Keywords: Experiential Learning; Lifelong Learning; Built Environment Education; Quantity Surveying; Architectural Education.

1. INTRODUCTION

Built environment education requires the integration of theoretical knowledge with practical understanding of space, materials, and environmental contexts. Disciplines such as Architecture and Quantity Surveying rely heavily on students' ability to interpret and apply knowledge within real-world settings. However, traditional lecture-based teaching approaches often limit students' exposure to authentic

environments, resulting in a gap between theoretical learning and professional practice. Effective higher education therefore requires active learning strategies that encourage students to engage directly with real situations and experiences [1].

To solve this problem, experiential learning has been developed as an important pedagogical approach. Dewey [2] pointed out that learning is rooted in experience and then Kolb [3] developed learning as a process where knowledge is created through the transformation of experience. Experiential learning in built environment education provides students the opportunity to observe, interpret and reflect on spatial relationships, architectural elements and environmental conditions that cannot be fully appreciated through classroom instructions alone. This view is further reinforced by the concept of reflective practice, where learning is achieved through ongoing interaction between action and reflection [4].

Museums provide a valuable setting for experiential learning because they function as authentic built environments that combine spatial design, circulation systems, material expression, heritage interpretation, and architectural narratives. Unlike conventional classroom settings, museums allow students to engage directly with real spaces and observe how built environment concepts are applied in practice. Museums are also recognised as “free-choice learning environments” where learners actively construct knowledge through exploration and discovery [5].

Although experiential learning has been widely discussed in higher education, empirical evidence examining its effectiveness within built environment education remains limited. Previous studies have primarily focused on studio-based learning, site visits, and fieldwork activities as mechanisms for linking theoretical knowledge with professional practice [6], [7]. Comparatively little attention has been given to museum-based experiential learning, particularly in understanding how students’ spatial experiences contribute to educational outcomes. Furthermore, limited studies have simultaneously examined the relationships among experiential learning, spatial experience, cognitive outcomes, and lifelong learning using a structural modelling approach.

The importance of lifelong learning has become increasingly significant within built environment professions due to continuous developments in technology, materials, regulations, and industry practices [8]. Experiential learning has been shown to encourage reflection, curiosity, and self-directed learning, all of which contribute to the development of lifelong learning attitudes [9]. These aspirations are consistent with the Malaysian higher education agenda, which emphasises graduate employability, continuous learning, and professional development [10].

Therefore, this study addresses these gaps by investigating museum-based experiential learning as a pedagogical approach within built environment education. Specifically, the study examines the role of spatial experience in influencing

cognitive outcomes and lifelong learning among students. Drawing upon Experiential Learning Theory [3], the study proposes that experiential learning contributes to cognitive development both directly and indirectly through spatial experience, which subsequently supports lifelong learning. The proposed relationships are examined using Partial Least Squares Structural Equation Modelling (PLS-SEM).

The aim of this study is to investigate the effects of museum-based experiential learning on cognitive outcomes and lifelong learning among built environment students. In particular, the study examines the mediating role of spatial experience in explaining how experiential learning contributes to students' cognitive development.

This study addresses the following research questions:

- (i) What is the impact of experiential learning on cognitive outcomes among built environment students?
- (ii) How does experiential learning contribute to lifelong learning?
- (iii) What role does spatial experience play in the relationship between experiential learning and cognitive outcomes?

1.1 Literature Review And Hypothesis Development

1.1.1 Experiential Learning and Cognitive Learning Outcomes

According to Kolb [3] in his Experiential Learning Theory, knowledge is formed through the transformation of experience [3]. Learning happens when people actively engage with their environments, reflect on their experiences, conceptualise their observations and apply their new knowledge [3].

More recent work still supports the value of experiential learning in higher education. Morris (2020) [11] states that experiential learning fosters critical thinking, integration of information, and reflective practice, while authentic learning environments provide a context for students to relate theoretical concepts to real-world applications. Experiential learning activities such as site visits and museum visits in built environment education allow students to acquire a greater understanding of architectural features, materials and spatial relationships [6], [7].

Hence, it is the goal of experiential learning to boost students' cognitive outputs.

H1: Experiential Learning positively influences Cognitive Outcomes.

1.1.2 Experiential Learning and Spatial Experience

Spatial experience is the perception, interpretation and comprehension of physical space by an individual. Spatial experience is an important dimension in the

development of students' capacity to identify spatial organisation, circulation patterns, architectural forms and environmental interactions across built environment disciplines [6].

Museum environments are rich spatial experiences in which visitors move through and engage with architectural surroundings [5]. The museum-based experience provides students with opportunities to experience scale, proportion, materiality and spatial sequencing firsthand in a way that traditional classroom instruction cannot [5]. Studies indicate that active engagement with physical environments enhances spatial awareness and supports meaningful learning [5], [6].

Therefore, it is believed that experiential learning activities in museum contexts will increase students' spatial experience.

H2: Experiential Learning positively influences Spatial Experience.

1.1.3 Spatial Experience and Cognitive Outcomes

The spatial experience of learners plays a vital role in the way knowledge is acquired, organised and interpreted in built environment disciplines [6]. Direct interaction with actual surroundings enables students to develop a deeper understanding of spatial relationships, architectural design principles, circulation systems and functional planning [6].

Previous studies have shown that exposure to real built environments improves students' ability to evaluate architectural elements and strengthens their cognitive understanding of design and construction concepts [6]. Museums provide students with opportunities to observe and interpret spatial arrangements, which may enhance understanding and knowledge retention [5]. Spatial experience is therefore expected to be a key pathway through which experiential learning contributes to cognitive development.

H3: Spatial Experience positively influences Cognitive Outcomes.

1.1.4 Cognitive Outcomes and Lifelong Learning

Lifelong learning is the voluntary and self-motivated pursuit of knowledge for personal or professional development [8]. Lifelong learning becomes all the more critical in the built environment professions where technological development, regulations, materials and industry practices continue to develop [8].

Students with stronger cognitive outcomes are more likely to develop confidence, curiosity and motivation to continue learning beyond formal education [9]. Educational research suggests that meaningful learning experiences promote

self-directed learning behaviours and sustained engagement with professional knowledge [9]. Therefore, improvements in cognitive outcomes through experiential learning are expected to contribute positively to lifelong learning attitudes among students.

H4: Cognitive Outcomes positively influence Lifelong Learning.

1.1.5 Conceptual Framework

A conceptual framework was constructed to test the links between experiential learning, spatial experience, cognitive results and lifelong learning based on the literature review and the hypotheses provided. The paradigm predicts that experiential learning directly impacts cognitive outcomes and spatial experience. Moreover, spatial experience is expected to influence cognitive outcomes, and cognitive outcomes are expected to contribute to lifelong learning. The proposed study framework is presented in Figure 1.

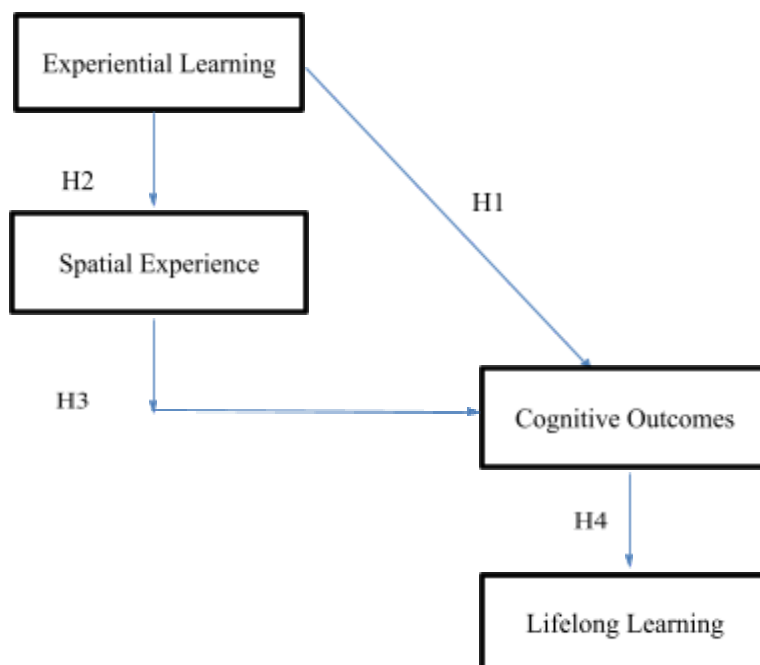


Figure 1. Proposed conceptual framework depicting the hypothesised relationships between experiential learning, spatial experience, cognitive outcomes, and lifelong learning.

2. MATERIALS AND METHODS

2.1 Research Design

A quantitative research design was used to examine the effect of museum-based experiential learning on cognitive outcomes and lifelong learning of built environment students. The experiential learning activity was carried out through an organised educational visit to the Museum and Art Gallery of Bank Negara Malaysia (MAG) which exhibits Malaysian monetary history, architecture, heritage and cultural artefacts.

The choice of the museum environment was based on its potential to provide students with the chance to interact with architectural spaces, circulation paths, exhibition layouts and heritage elements in a real learning situation. Pre-visit and post-visit questionnaires were used to collect data and the data were analysed using Partial Least Square Structural Equation Modelling (PLS-SEM).

2.2 Study Setting

The investigation was done at the Museum and Art Gallery Bank Negara Malaysia (MAG), Kuala Lumpur. The museum was selected as an experiential learning site because of its architectural significance, exhibition design, heritage material and educational value. The tour encouraged students to consider spatial organisation, circulation patterns, architectural aspects, exhibition layouts and heritage items in relation to their study of the built environment.

The tour was a part of a structured experiential learning program, which aimed at complementing classroom teaching, and giving students the opportunity to be directly exposed to authentic built environment situations.

2.3 Participants

This study was conducted on 40 diploma students from Universiti Teknologi Malaysia in built environment programmes; 25 students from Architecture and 15 students from Quantity Surveying. A structured museum visit, designed as a museum-based experiential learning activity, was undertaken by all participants.

Data were collected via pre-visit and post-visit questionnaires. Prior to analysis, responses were screened and cleaned to remove duplicate submissions and incomplete records. The pre-visit questionnaire was used to collect students' baseline information on their learning expectations and perceptions prior to the museum visit.

After the experiential learning activity, a post-visit questionnaire was administered to evaluate experiential learning, spatial experience, cognitive outcomes and lifelong learning. We collected 34 complete and valid post-visit responses to be used for the Structural Equation Modelling (SEM) analysis.

The final sample consisted of 34 valid responses. Even though the sample size is relatively small, it is acceptable for the purpose of exploratory studies using Partial Least Squares Structural Equation Modelling (PLS-SEM). PLS-SEM is a popular prediction-oriented analysis technique which is appropriate for studies with relatively small sample sizes and complex research models [12]. As argued by Hair et al. [12], PLS-SEM has sufficient statistical power for medium to large path coefficients and is therefore suitable for the purposes of the present study.

Respondent Profile:

Table 1. Demographic Profile of Respondents

Variable	Frequency	Percentage
Programme		
Architecture	21	61.8%
Quantity Surveying	13	38.2%
Year of Study		
Year 1	19	55.9%
Year 2	8	23.5%
Year 3	7	20.6%
Total	34	100.0%

Of the 34 valid responses used for analysis, 21 respondents (61.8%) were from the Architecture programme and 13 respondents (38.2%) were from the Quantity Surveying programme. In terms of year of study, the majority of respondents were Year 1 students (55.9%), followed by Year 2 students (23.5%) and Year 3 students (20.6%).

2.4 Development of Instruments

The students' learning experiences during the museum visit were assessed through structured pre-visit and post-visit questionnaires. The items in the questionnaire were adapted from the existing literature on experiential learning, museum learning, spatial learning and lifelong learning, and later modified to fit the context of built environment education. Prior to administration, the instrument was reviewed by academic staff involved in built environment programmes to ensure relevance and clarity of content.

Four latent constructs (Experiential Learning, Spatial Experience, Cognitive Outcomes and Lifelong Learning) were measured using eleven items from the post-visit questionnaire. All items were rated on a 5-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree).

Together with the closed-ended questions, two open-ended questions were included to give students the opportunity to reflect on the key lessons learned during the visit, as well as to identify the architectural elements that most impacted their learning experience. These qualitative responses were used to triangulate the interpretation of quantitative findings.

2.5 Measurement Constructs

Table 2. Measurement Constructs and Indicators

Construct	Code	Indicators
Experiential Learning	EL	Overall visit satisfaction; Activities relevance
Spatial Experience	SE	Spatial design; Circulation flow; Architectural elements
Cognitive Outcomes	CO	Understanding of museum; Heritage understanding; Relation to course learning
Lifelong Learning	LL	Interest in heritage; Future Museum visits; Lifelong learning awareness

The measurement model comprises four reflective constructs. Cognitive Outcomes are the perceived learning gains students have made as a result of the museum visit. Spatial Experience refers to the students' perceptions of spatial design, circulation patterns, and architectural elements in the museum environment. Experiential Learning is the overall appraisal of the learning activity given by students, while Lifelong Learning is characterised by students' motivation to engage in continuous learning and future activities related to heritage and museum.

3. RESULTS AND DISCUSSION

3.1 Measurement Model Assessment

For the measurement model, internal consistency reliability, convergent validity and discriminant validity were tested. Cronbach's alpha, composite reliability (CR) and average variance extracted (AVE) were used to examine the reliability and validity of the constructs. Results of reliability and validity are presented in Table 3.

Table 3. Reliability and Validity Assessment

Construct	Cronbach's Alpha	CR	AVE
CO	0.833	0.900	0.751
EL	0.692	0.864	0.762
LL	0.663	0.818	0.605
SE	0.719	0.843	0.644

The findings reveal that the composite reliability values for all constructs are satisfactory with a range of 0.818 to 0.900, which are greater than 0.70, the

recommended threshold. The Cronbach's alpha for Experiential Learning (0.692) and Lifelong Learning (0.663) was slightly lower than the recommended value of 0.70, but still acceptable for exploratory research.

All AVE values were also above 0.50, indicating adequate convergent validity. Thus, the measurement model showed satisfactory reliability and convergent validity.

3.2 Discriminant Validity Assessment

Discriminant validity was assessed using the Heterotrait-Monotrait Ratio (HTMT).

Table 4. HTMT Results

Constructs	HTMT
CO – EL	0.598
LL – EL	0.846
SE – EL	0.884
CO – SE	0.984
LL – CO	1.137
LL – SE	1.015

Most of the HTMT values were below the recommended cut-off of 0.90. However, the values between the Cognitive Outcomes, Spatial Experience and Lifelong Learning were above the threshold suggesting a possible overlap among these constructs. This finding may be explained by the exploratory nature of the study and the relatively small sample size. Larger sample sizes are recommended for further studies to examine discriminant validity.

3.3 Structural Model Assessment

Bootstrapping (5,000 resamples) was applied to test the significance of the hypothesised relationships for the structural model.

Table 5. Structural Model Results

Relationship	β	<i>t</i> -value	<i>p</i> -value	Decision
EL → SE	0.636	5.418	0.000	Supported
SE → CO	0.793	5.435	0.000	Supported
CO → LL	0.850	17.108	0.000	Supported
EL → CO	-0.032	0.200	0.842	Not Supported

The results show that experiential learning had a significant positive effect on spatial experience ($\beta = 0.636$, $p < 0.001$). Spatial experience also contributed to cognitive outcomes positively significantly ($\beta = 0.793$, $p < .001$). Also, cognitive outcomes strongly affected lifelong learning ($\beta = 0.850$, $p < 0.001$).

Experiential learning had no significant direct effect on cognitive outcomes ($\beta = -0.032$, $p = 0.842$). Thus, the proposed direct relationship between experiential learning and cognitive outcomes was not supported.

3.4 Mediation Analysis

Table 6. Indirect Effect Results for Mediation Analysis

Relationship	β	t	p
EL $\rightarrow$ SE $\rightarrow$ CO	0.500	3.634	<0.001

In PLS-SEM, the bootstrapping procedure was used to test the mediating role of Spatial Experience between Experiential Learning and Cognitive Outcomes. The results showed that the indirect effect of Experiential Learning on Cognitive Outcomes via Spatial Experience was significant ($\beta = 0.500$, $t = 3.634$, $p < 0.001$).

However, the direct effect of Experiential Learning on Cognitive Outcomes was not significant ($\beta = -0.032$, $p = 0.842$). The results show that Spatial Experience is a complete mediator of the relationship between Experiential Learning and Cognitive Outcomes.

This would suggest that experiential learning in the museum does not directly lead to enhanced students' cognitive outcomes. Instead, it is through students' interaction with and understanding of the spatial features of the museum environment that learning gains are achieved. The results further emphasise the significance of authentic spatial experiences as a key medium for experiential learning to foster cognitive development in students of built environment education.

3.5 Coefficient of Determination (R^2)

Table 7. R^2 Values

Construct	R^2
SE	0.405
CO	0.597
LL	0.723

The model explained 40.5% of the variance in Spatial Experience, 59.7% of the variance in Cognitive Outcomes, and 72.3% of the variance in Lifelong Learning. These results suggest that the proposed model has moderate to large explanatory power.

3.6 Discussion

The results indicate that experiential learning in a museum setting is an important factor in students' spatial experience. This outcome is consistent with the

proposition that students can enhance their understanding of the built environment concepts through hands-on engagement with architectural spaces, circulation patterns and exhibition environments.

The relationship between spatial experience and cognitive outcomes is substantial, showing that students learn better in authentic spatial environments where they can engage with them. The museum environment provided the students with the opportunity to observe the architectural features, exhibition designs and circulation systems. This allowed the students to relate theoretical knowledge to practical experience. This finding is consistent with Salama [6], who emphasised that direct engagement with built environments enhances students' spatial understanding and supports deeper learning processes.

Interestingly, there were no direct effects of experiential learning on cognitive outcomes. This result indicates that the development of learning is not only produced by engagement in museum activities, but also by the quality of the spatial experiences lived during the visit. In other words, spatial experience is a crucial mechanism that connects experiential learning and cognitive outcomes.

The findings also offer an important insight into the role of spatial experience in experiential learning in museums. While experiential learning did not directly affect cognitive outcomes, it greatly improved students' spatial experience, which led to cognitive development. This points to spatial experience being a key learning mechanism, enabling students to convert real-world interactions into meaningful knowledge. This finding supports the proposition of the Experiential Learning Theory that learning occurs through involvement in authentic environments and reflective interpretation of experiences.

The strongest association was between cognitive outcomes and lifelong learning. This suggests that students who learned more on the museum visit were more likely to generate an interest in future heritage-related learning and museum engagement. This finding indicates the potential of museum-based experiential learning in developing a lifelong learning attitude in the students of the built environment.

The mediation analysis also revealed that Spatial Experience fully mediates the relationship between Experiential Learning and Cognitive Outcomes. The direct effect of Experiential Learning on Cognitive Outcomes was not significant, but the indirect effect through Spatial Experience was significant ($\beta = 0.500$, $p < 0.001$). This finding suggests that students do not get cognitive gains just by participating in museum-based activities. Instead, learning takes place through students' active engagement with, and interpretation of, the spatial characteristics of the museum environment. The result supports Experiential Learning Theory which emphasises that meaningful learning is developed through direct engagement with authentic environments and reflective interpretation of experience

4. CONCLUSION

Through a planned visit to the Museum and Art Gallery Bank Negara Malaysia (MAG), this study investigates the impact of museum-based experiential learning on spatial experience, cognitive results, and lifelong learning among students studying the built environment.

The results suggested that experiential learning significantly improved students' spatial experience and spatial experience significantly improved cognitive outcomes. Cognitive outcomes also demonstrated a strong positive influence on lifelong learning. However, the direct association between experiential learning and cognitive outcomes was not significant, indicating that the learning gains were primarily through students' interaction with the spatial environment of the museum and not through the experiential activity alone.

The findings stress the importance of incorporating real-life learning environments into the education of the built environment. Museum visits expose students to architectural elements, spatial organization, circulation patterns and exhibition design of real-world settings, thus enhancing learning outcomes and fostering lifelong learning attitudes.

By demonstrating that spatial experience is a key mediator between experiential learning and cognitive outcomes in built environment education, this study adds to the body of literature on experiential learning.

The study generally confirms that experiential learning within a museum setting can be an effective educational approach in enhancing spatial understanding and in supporting lifelong learning among built environment students.

4.1 Limitations and Future Research

There are several restrictions on the study. First, the results may not be as broadly applicable as they may be due to the small sample size and restriction to diploma students from a single university. Second, certain HTMT values were over the suggested cutoff, suggesting that some constructs might overlap. Third, the study may not accurately reflect different experiential learning environments because it was carried out in a specific museum.

Larger samples from various academic disciplines and institutions should be used in future studies to increase the findings' generalisability. The suggested approach could be further validated by examining additional museums and historical places. Future studies could evaluate various experiential learning activities in built environment education and look into the mediating role of spatial experience.

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REFERENCES

- [1] J. Biggs and C. Tang, *Teaching for Quality Learning at University*, 4th ed. McGraw-Hill Education, 2011.
- [2] J. Dewey, *Experience and Education*. Macmillan, 1938.
- [3] D. A. Kolb, *Experiential Learning: Experience as the Source of Learning and Development*. Prentice Hall, 1984.
- [4] D. A. Schön, *The Reflective Practitioner: How Professionals Think in Action*. Basic Books, 1983.
- [5] J. H. Falk and L. D. Dierking, *The Museum Experience Revisited*. Routledge, 2013.
- [6] A. M. Salama, *Spatial Design Education: New Directions for Pedagogy in Architecture and Beyond*. Ashgate, 2015.
- [7] M. Healey and A. Jenkins, *Developing Undergraduate Research and Inquiry*. Higher Education Academy, 2009.
- [8] UNESCO, *Learning to Be: A Holistic and Integrated Approach to Values Education for Human Development*. UNESCO, 2016.
- [9] P. Jarvis, *Towards a Comprehensive Theory of Human Learning*. Routledge, 2006.
- [10] Ministry of Higher Education Malaysia, *Malaysia Education Blueprint 2015–2025 (Higher Education)*. Ministry of Higher Education Malaysia, 2021.
- [11] T. H. Morris, “Experiential learning—A systematic review and revision of Kolb’s model,” *Interactive Learning Environments*, vol. 28, no. 8, pp. 1064–1077, 2020.
- [12] J. F. Hair, G. T. M. Hult, C. M. Ringle, and M. Sarstedt, *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)*, 2nd ed. Sage Publications, 2019.

IMPLEMENTATION AND EVALUATION OF IOT-BASED ACTIVE LEARNING USING THE 6E INSTRUCTIONAL MODEL: EVIDENCE FROM STUDENT ENGAGEMENT, STUDENT PERCEPTIONS, AND LEARNING OUTCOMES

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ABSTRACT - The Internet of Things (IoT) has become an important component of technology education; however, its concepts can be challenging for foundation-level students due to their abstract and interdisciplinary nature. Despite the growing adoption of IoT in education, limited empirical evidence is available on the effectiveness of structured IoT-based active learning approaches for foundation-level learners. This study therefore evaluated the effectiveness of an IoT-based active learning approach implemented using the 6E instructional model in enhancing student engagement, student perception, and learning outcomes. A quasi-experimental pre-post research design was conducted among 30 foundation-level students enrolled in a Computer Literacy course at a higher education institution. The intervention incorporated structured hands-on activities using sensors, microcontrollers, and mobile applications organised according to the six phases of the 6E instructional model. Student learning outcomes were measured using pre- and post-quiz assessments, while student engagement and student perception were evaluated using a post-intervention questionnaire. The intervention resulted in a statistically significant improvement in students' learning outcomes, with the mean score increasing from 62.4 ($SD = 8.1$) in the pre-test to 78.9 ($SD = 7.5$) in the post-test ($t = 9.21, p < 0.001$), representing a 26.4% improvement. Students also reported positive perceptions of the learning activities, with mean scores ranging from 4.09 to 4.27, indicating favourable responses towards the usefulness and overall learning experience of the proposed approach. Overall, the findings suggest that integrating IoT-based active learning with the 6E instructional model provides a practical pedagogical framework for enhancing experiential learning and supporting foundation students' understanding of IoT concepts.

Keywords: Internet of Things (IoT); Active Learning; 6E Instructional Model; Student Perception; Learning Outcomes

1. INTRODUCTION

The rapid advancement of Internet of Things (IoT) technology has increasingly influenced modern educational practices, particularly within science, technology, engineering, and computing disciplines. IoT systems support real-time data collection, automation, and remote monitoring, offering new opportunities to create interactive and experiential learning environments. In higher education, incorporating IoT-based learning activities enables students to engage with authentic, real-world applications, enhancing conceptual understanding and strengthening problem-solving abilities.

Active learning has been widely recognised as an effective pedagogical approach for improving student engagement and knowledge retention. Compared with traditional lecture-based instruction, which often limits opportunities for interaction and practical application, active learning emphasises participation, collaboration, and hands-on experience. To ensure that active learning is implemented effectively in technology-oriented courses, the use of structured instructional frameworks is essential. One such framework is the 6E instructional model, which comprises six sequential learning phases: Engage, Explore, Explain, Elaborate, Evaluate, and Extend. This model provides a systematic pathway for guiding students through progressive learning experiences while supporting deeper comprehension of technological concepts.

Despite the growing interest in integrating IoT technologies into educational settings, empirical evidence evaluating the effectiveness of IoT-based instructional approaches remains relatively limited, particularly at the foundation level where students are still developing fundamental technical competencies. Understanding how structured active learning models influence student engagement, student perceptions, and learning outcomes is therefore important for improving instructional practices in introductory technology courses. In practice, the use of IoT in teaching and learning is frequently confined to demonstrations or theoretical explanations rather than sustained hands-on engagement. This limitation is especially evident among foundation-level students, who may lack the confidence and foundational skills required to fully understand abstract IoT concepts. Consequently, students may experience reduced motivation and engagement when learning activities are delivered primarily through conventional instructional methods.

Furthermore, while educators are encouraged to adopt active learning strategies, their successful implementation requires clear instructional design and appropriate evaluation mechanisms. Without a structured framework, hands-on activities may not be effectively aligned with learning objectives, making it challenging to determine whether the instructional approach meaningfully supports student learning. In many cases, IoT-based activities are introduced without systematic

guidance on how to design, implement, and assess learning experiences in a consistent and measurable manner.

Existing studies on IoT-based learning frequently focus on advanced learners or specialised technical applications, leaving a gap in understanding how introductory-level students respond to structured IoT learning environments. There is therefore a need for empirical evidence that demonstrates how structured instructional models, such as the 6E instructional model, can support student engagement, student perception, and improvement in learning outcomes at the foundation level. Accordingly, this study aims to evaluate the effectiveness of an IoT-based active learning approach implemented using the 6E instructional model. The evaluation focuses on three key dimensions, (1) Student engagement; (2) Student perception, and (3) Learning outcomes, measured through pre-post performance assessments.

1.1 Literature Review

The literature review provides the theoretical and empirical foundation for understanding the role of active learning, student perception, instructional effectiveness, and structured pedagogical models in technology-enhanced education. Previous studies have highlighted the importance of integrating emerging technologies into teaching and learning environments to improve student engagement, motivation, and learning performance. In the context of Internet of Things (IoT) education, the use of structured instructional models and systematic evaluation methods has become increasingly relevant for supporting meaningful learning experiences.

1.1.1 Active Learning for IoT

Active learning involves instructional methods that engage students in meaningful learning activities requiring them to think, analyze, and apply knowledge. In IoT education, active learning typically involves hands-on experimentation using sensors, microcontrollers, and mobile applications. Studies have shown that experiential learning environments improve student motivation, engagement, and conceptual understanding [1].

IoT-based learning environments provide authentic problem-solving experiences, allowing students to interact with physical devices and observe real-time data. Such environments align with constructivist learning theory, where students build knowledge through direct experience. The integration of IoT technology into active learning has been shown to enhance student engagement and support experiential learning in technology-based education [2], [3].

1.1.2 Student Perception in Technology-Enhanced Learning

Student perception plays an important role in determining the effectiveness of technology-enhanced learning, as learners' experiences and attitudes influence their engagement, satisfaction, and willingness to participate in technology-supported activities. Positive perceptions are often associated with learning environments that are perceived as useful, easy to use, interactive, and relevant to students' learning needs, ultimately contributing to improved learning experiences and academic outcomes [4]. In the context of IoT-based education, hands-on activities that enable students to interact with real-world devices and receive immediate feedback have been shown to promote favourable perceptions towards the learning process while increasing motivation and active participation [2], [5]. Consequently, evaluating students' perceptions provides valuable insights into the usability and educational value of technology-enhanced instructional approaches, complementing objective measures of learning outcomes and supporting the continuous improvement of innovative teaching practices.

1.1.3 Learning Outcome Evaluation (Pre–Post)

Pre–post assessment is a widely used method to evaluate the effectiveness of instructional interventions by measuring student performance before and after learning activities. This approach enables researchers to determine learning gains and assess the impact of innovative teaching strategies in educational settings [6]. In technology-enhanced learning environments, pre–post evaluation provides empirical evidence of instructional effectiveness and supports data-driven decision-making in curriculum design. Previous research has demonstrated that structured learning interventions, particularly those involving active and inquiry-based learning strategies, can significantly improve student learning outcomes [2], [7].

1.1.4 6E Instructional Model

The 6E instructional model is an extension of the 5E learning cycle that emphasizes inquiry-based and experiential learning. The model consists of six phases: Engage, Explore, Explain, Elaborate, Evaluate, and Extend. This structured instructional approach supports student-centered learning and promotes deeper conceptual understanding through active participation [8]. Research has shown that learning models based on inquiry and experiential learning cycles can improve student engagement, motivation, and conceptual understanding in science and technology education [7]. The effectiveness of the 6E instructional model in technology-enhanced learning environments has also been demonstrated in recent studies involving IoT-based active learning implementations [9].

2. MATERIALS AND METHODS

2.1 Research Design

This study adopted a quasi-experimental pre–post research design to examine the effectiveness of IoT-based active learning implemented using the 6E instructional model. The design allowed the comparison of students' performance and perceptions before and after the learning intervention. The integration of Internet of Things (IoT) technology into structured learning activities provided an opportunity to evaluate changes in student engagement, student perception, and learning outcomes within an authentic learning environment. The use of a pre–post design was considered appropriate as it enables the measurement of learning gains and supports evidence-based evaluation of instructional effectiveness.

2.2 Participants

A total of 30 foundation-level students enrolled in a Computer Literacy course participated in this study. The participants were selected using convenience sampling, as they were registered in the course where the IoT-based active learning intervention was implemented. All participants completed both the pre-test and post-test assessments, as well as the post-intervention questionnaire. Participation was voluntary, and students were informed about the purpose of the study prior to data collection.

2.3 Learning Environment and IoT Implementation

The learning activities were conducted in a technology-enabled classroom equipped with IoT devices that allowed students to interact directly with physical components and real-time data. The IoT learning system was designed to support hands-on experimentation and collaborative problem-solving. Students worked in small groups to configure sensors, collect data, and interpret system responses. This environment supported experiential learning and encouraged students to apply theoretical knowledge to practical tasks, which is consistent with the principles of active learning.

Table 1. IoT components

Component	Description
Microcontroller	Arduino or ESP32 board used to control system operations
Sensors	Devices used to collect environmental data such as temperature or motion

Connectivity Module	Wireless communication component enabling data transmission
Monitoring Application	Mobile or web-based interface for observing system data
Visualization Interface	Display platform showing real-time sensor readings

2.4 Implementation of the 6E Instructional Model

The instructional activities were structured based on the 6E instructional model, which emphasizes inquiry-based and student-centered learning. Each phase of the model guided the progression of learning activities, ensuring that students were actively involved in exploring concepts, applying knowledge, and reflecting on their learning experiences. The structured implementation of the model supported meaningful engagement throughout the learning process.

Table 2. 6E instructional phases

Phase	Description of Learning Activities
Engage	Students were introduced to IoT concepts through demonstrations and real-world scenarios
Explore	Students conducted hands-on activities using sensors and microcontrollers
Explain	Students discussed observations and explained system behavior based on collected data
Elaborate	Students applied knowledge to solve more complex tasks or modify system configurations
Evaluate	Students completed quizzes to assess understanding of IoT concepts
Extend	Students reflected on learning and explored additional real-world applications

2.5 Data Collection Instruments

Data for this study were collected using structured instruments designed to measure student learning outcomes, engagement, and student perception. The primary instrument was a pre-post quiz used to evaluate students' knowledge before and after the intervention. In addition, questionnaires were administered to evaluate students' perceptions of the IoT-based active learning activities, including their perceived usefulness, ease of learning, and overall learning experience. All

questionnaire items were measured using a five-point Likert scale ranging from strongly disagree to strongly agree.

2.6 Data Analysis

The collected data were analyzed using both descriptive and inferential statistical techniques. Descriptive statistics, including mean and standard deviation, were used to summarize students' responses and performance levels. To determine whether there was a statistically significant difference between pre-test and post-test scores, a paired sample *t*-test was conducted at a significance level of 0.05. This analysis enabled the evaluation of the effectiveness of the IoT-based active learning intervention in improving student learning outcomes.

3. RESULTS AND DISCUSSION

This section presents the findings obtained from the implementation of IoT-based active learning using the 6E instructional model. The analysis focuses on changes in student performance before and after the intervention. Descriptive statistics were first used to summarize students' performance levels, followed by inferential analysis using a paired sample *t*-test to determine whether the observed improvement was statistically significant.

3.1 Descriptive Statistics for Pre-Test and Post-Test

Descriptive statistics were calculated to provide an overview of students' performance before and after the implementation of IoT-based active learning. The results indicate a noticeable increase in the mean score following the intervention, suggesting that students demonstrated improved understanding of the learning content after participating in the hands-on IoT activities. Table 3 summarizes the descriptive statistics for both assessments.

Table 3. Descriptive statistics for Pre-Test and Post-Test

Assessment	<i>N</i>	Mean	Standard Deviation
Pre-Test	30	62.4	8.1
Post-Test	30	78.9	7.5

3.2 Paired Sample *t*-Test Analysis

A paired sample *t*-test was conducted to examine whether the difference between pre-test and post-test scores was statistically significant. The results demonstrate a significant improvement in student performance after the implementation of

IoT-based active learning. The obtained p -value was below the significance level of 0.05, indicating that the improvement in scores was unlikely to have occurred by chance. These findings suggest that the integration of IoT technology within the 6E instructional framework contributed positively to student learning outcomes.

Table 4. Paired Sample t -Test Analysis

Variable	Mean Difference	t -value	df	p -value
Post-Test – Pre-Test	16.5	9.21	29	< 0.001

3.3 Comparison of Mean Scores

Figure 1 illustrates the comparison between the mean scores obtained from the pre-test and post-test assessments. The increase in the post-test mean score reflects a positive shift in students' performance after exposure to the IoT-based active learning activities. The visual representation further supports the quantitative findings presented in Table 3 and highlights the effectiveness of the instructional intervention.

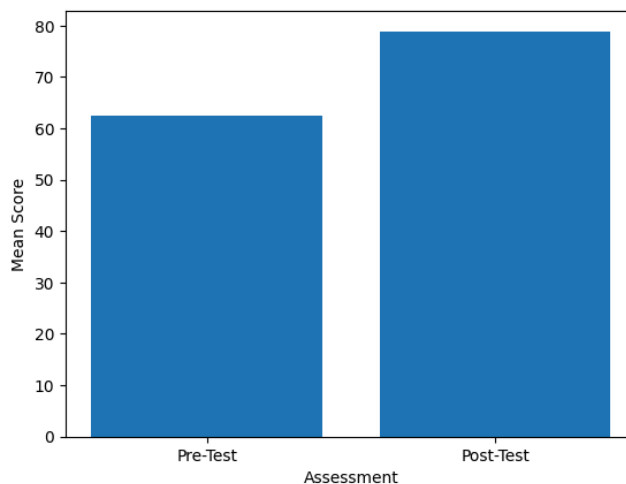


Figure 1. Mean comparison between Pre-Test and Post-Test

3.4 Learning Improvement Analysis

To further evaluate the magnitude of improvement, the percentage increase in student performance was calculated. The analysis revealed an overall improvement of approximately 26.4% following the intervention. This finding indicates that the use of IoT-based active learning within the 6E instructional model not only enhanced student engagement but also contributed to measurable gains in learning achievement.

4. CONCLUSION

This study evaluated the effectiveness of integrating IoT-based active learning with the 6E instructional model in a foundation-level technology course. The findings demonstrate that the proposed instructional approach successfully supported students' understanding of IoT concepts through structured, hands-on learning experiences. The combination of real-time interaction with IoT devices and the sequential learning phases of the 6E instructional model encouraged active participation, strengthened student perception, and created a more engaging learning environment. Collectively, these findings provide empirical evidence that integrating IoT technology within a structured pedagogical framework can enhance the effectiveness of technology-enhanced learning in higher education.

Beyond its contribution to classroom practice, this study highlights the value of combining emerging technologies with learner-centred instructional strategies to bridge the gap between theoretical knowledge and practical application. Such an approach is particularly relevant for introductory technology courses, where experiential learning can improve students' confidence and readiness to apply newly acquired knowledge in authentic contexts. Nevertheless, the findings should be interpreted in light of several limitations. The intervention was conducted with a relatively small sample of 30 foundation-level students from a single higher education institution and within a single course context. Consequently, the findings may not be fully generalizable to different educational settings, student populations, or disciplines.

Future research should validate the proposed approach using larger and more diverse samples across multiple institutions and examine its effectiveness over longer implementation periods. Further studies may also investigate the integration of complementary technologies, such as artificial intelligence, learning analytics, or adaptive learning systems, within the 6E instructional framework to support more personalized and data-driven learning experiences. Comparative studies involving alternative pedagogical models would also provide valuable insights into the relative effectiveness of different technology-enhanced instructional approaches. Overall, this study contributes to the growing body of evidence supporting IoT-based active learning and demonstrates that the 6E instructional model provides a practical and scalable framework for fostering meaningful learning experiences in technology education.

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REFERENCES

- [1] M. Prince, "Does active learning work? A review of the research," *Journal of Engineering Education*, vol. 93, no. 3, pp. 223–231, 2004, doi: 10.1002/j.2168-9830.2004.tb00809.x.
- [2] M. Al-Emran, S. I. Malik, and M. N. Al-Kabi, "A survey of Internet of Things (IoT) in education: Opportunities and challenges," *Education and Information Technologies*, vol. 25, pp. 127–158, 2020, doi: 10.1007/s10639-019-09905-4.
- [3] M. M. Rahman and M. Ahmad, "Enhancing student engagement through IoT-based learning environments," *Computers & Education*, vol. 168, Art. no. 104211, 2021, doi: 10.1016/j.compedu.2021.104211.
- [4] F. D. Davis, "Perceived usefulness, perceived ease of use, and user acceptance of information technology," *MIS Quarterly*, vol. 13, no. 3, pp. 319–340, 1989, doi: 10.2307/249008.
- [5] M. Bond, S. Bedenlier, V. I. Marín, and M. Händel, "Student engagement in technology-enhanced learning: A systematic literature review," *International Journal of Educational Technology in Higher Education*, vol. 17, Art. no. 23, 2020, doi: 10.1186/s41239-019-0176-8.
- [6] P. Schober, C. Boer, and L. A. Schwarte, "Correlation coefficients: Appropriate use and interpretation in educational research," *Anesthesia & Analgesia*, vol. 132, no. 1, pp. 44–51, 2021, doi: 10.1213/ANE.0000000000004837.
- [7] M. Bond, S. Bedenlier, V. I. Marín, and M. Händel, "Student engagement in technology-enhanced learning environments," *Educational Technology Research and Development*, vol. 68, pp. 3137–3160, 2020, doi: 10.1007/s11423-020-09823-5.
- [8] K. Kwon and J. Kim, "Effectiveness of inquiry-based learning using digital technologies in STEM education," *International Journal of STEM Education*, vol. 10, Art. no. 45, 2023, doi: 10.1186/s40594-023-00419-8.
- [9] V. Venkatesh, M. G. Morris, G. B. Davis, and F. D. Davis, "User acceptance of information technology: Toward a unified view," *MIS Quarterly*, vol. 27, no. 3, pp. 425–478, 2003, doi: 10.2307/30036540.
- [10] H. Crompton, D. Burke, and K. H. Gregory, "The use of mobile learning in higher education: A systematic review," *Computers & Education*, vol. 123, pp. 53–64, 2022.

RESEARCH - VS. TEACHING-LEADERSHIP: A MALAYSIAN PERSPECTIVE

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ABSTRACT – Academic leaders in Malaysian higher education face increasing pressure to balance the competing demands of teaching excellence and research productivity. However, expectations differ considerably between public and private universities, owing to their distinct institutional missions and governance frameworks. This study compares the leadership standards and competencies required for teaching-focused and research-focused roles across both types of institutions. Employing thematic analysis of semi-structured interview data, the study examines how institutional contexts shape definitions of leadership effectiveness. The findings reveal that while private universities prioritise teaching quality, student engagement, and industry alignment, public universities place greater emphasis on research output and publication metrics. These divergent expectations significantly influence daily responsibilities, institutional performance, and academic professional identity. By identifying context-specific leadership competencies for research and teaching functions, this study contributes to the growing discourse on leadership development in Malaysian higher education. Implications for institutional strategy, leadership development programmes, and policy formulation are also discussed.

Keywords: Lifelong Learning; Academic-Leadership; Malaysia

1. INTRODUCTION

Higher education institutions across the globe are confronted with mounting expectations to achieve distinction in both research and pedagogical practice. Nevertheless, the demands imposed on academic administrators differ substantially, contingent upon institutional governance models, financial frameworks, and strategic objectives. In the Malaysian context, public universities tend to be research-oriented, with a pronounced emphasis on global rankings and scholarly publication metrics. In contrast, private institutions place greater priority on instructional quality, student involvement, and industry relevance, as a means of sustaining competitiveness within a market-driven educational landscape [1].

The expansion of Malaysia's higher education sector, particularly following the Private Higher Educational Institutions Act of 1996, has raised concerns over the

availability of sufficient academic leaders and their capability to support institutional development [2]. Academics who previously focused on research and teaching are increasingly assigned administrative positions with limited training or orientation, creating a critical gap in leadership preparation [2]. The Malaysia Education Development Plan (Higher Education) 2015-2025 explicitly emphasises the importance of quality and excellence among educators, researchers, institutional leaders, and support staff, underscoring the need for effective academic leadership across all institutional types [3].

Academic leaders are anticipated to reconcile these frequently competing expectations; nevertheless, empirical inquiry into the variability of leadership expectations across institutional categories remains scant. The extant literature delineates four principal modalities of academic leadership within the Malaysian higher education landscape: instructional leadership, research leadership, public engagement leadership, and administrative leadership [4]. Notwithstanding this typology, the precise competencies germane to each domain, as well as their differential prioritisation across institutional sectors, have yet to be comprehensively examined. The present study seeks to explore and compare the leadership expectations and competency frameworks requisite for research-intensive as opposed to teaching-intensive roles within both public and private universities in Malaysia.

This study was designed to pursue two principal objectives. The first objective was to compare leadership expectations pertaining to research and teaching responsibilities between public and private universities in Malaysia. The second objective was to delineate the core leadership competencies necessary for the effective administration of both research and teaching functions across these two institutional categories.

In addressing these aims, this research contributes to the expanding body of literature on leadership development and institutional capacity enhancement within the Malaysian higher education landscape. The resultant findings provide valuable perspectives on institutional support frameworks, preparatory mechanisms, and the professional identity construction of academic leaders who concurrently manage dual-functional responsibilities.

1.1 Literature Review

1.1.1 Academic Leadership in Malaysian Higher Education

Academic leadership in Malaysian higher education encompasses diverse institutions, including public and private universities, requiring leaders who can navigate different educational models and systems [3]. The contemporary higher education landscape demands swift institutional responses to ensure management is perceived as efficient and effective within a changing global environment [3]. Academic leaders play a critical role in fostering a culture of inquiry, securing

funding, setting research priorities, ensuring regulatory compliance, and adopting student-centred approaches responsive to learners' needs and aspirations [3].

The pressure created by global ranking systems has compelled higher education institutions to implement targeted efforts to raise academic leadership standards [4]. In the Malaysian context, academic leadership empowerment encompasses capacity development, emotional intelligence, authentic leadership, communication, and systemic thinking skills [4]. Recent studies have examined the key capacities of effective leaders in Malaysian focused universities, identifying essential leadership capabilities and managerial competencies as key performance drivers [5].

1.1.2 Sectoral Divergence in Leadership Priorities

Research demonstrates that public and private universities in Malaysia exhibit fundamentally different leadership priorities shaped by institutional missions. Public universities, particularly the five research universities (Universiti Malaya, Universiti Kebangsaan Malaysia, Universiti Sains Malaysia, Universiti Putra Malaysia, and Universiti Teknologi Malaysia), face mounting pressure to achieve global recognition [6]. The Ministry of Higher Education aims to place one Malaysian public research university in Asia's Top 25 and two in the Global Top 100 by 2025, intensifying research expectations on academic staff [6].

Conversely, private universities in Malaysia operate in a market-driven environment where teaching quality, student engagement, and graduate employability are paramount [7]. Semi-elite private institutions are typically teaching universities with practical teaching capabilities, sometimes conducting pedagogical-related research [7]. Deans in private universities face the challenge of balancing competing managerial and academic values, requiring sustainable leadership approaches that align central administration, deans, and academics [7].

1.1.3 Leadership Competencies and Professional Identity

Research leadership competencies include grant acquisition, team mentoring, publication strategy, and securing research funding [4], [8]. Teaching leadership requires instructional design, student engagement, curriculum innovation, and responsiveness to industry needs [3]. However, both sectors systematically underdevelop their non-priority leadership function, leaving academics to self-learn critical competencies [4].

Professional identity is shaped by institutional mission and expectations [9]. Studies on early career academics in Malaysian private higher education reveal that identity development is imbued with challenges and complexities as academics navigate multiple institutional demands [10]. Identity-role conflict frequently emerges when cognitive commitments misalign with behavioural expectations, manifesting as tension between professional identity and role requirements [11]. This conflict is

particularly pronounced in academic settings where staff must simultaneously fulfil research and teaching expectations while managing administrative responsibilities [11].

1.1.4 Workload Pressure and Well-Being

Academic staff in Malaysian universities face significant workload pressure, which has been linked to diminished psychological well-being and burnout [6], [12]. Research on Malaysian academic leaders at research universities has identified cognitive, emotional, and physical demands as significant contributors to burnout, which subsequently affects both in-role and extra-role performance [13]. The multiple job scopes and evolving priorities that academic staff face have contributed to a rise in mental health concerns, with excessive workloads acting as significant stressors [6].

Studies have examined the relationship between organisational stressors including role ambiguity, role conflict, and workload and job performance among Malaysian academics [14]. Supervisory support and welfare have been found to impact role conflict, which subsequently affects affective states and attitudes in the Malaysian academic environment [15]. Academic leaders utilize a range of coping mechanisms to manage occupational stress, among which problem-focused engagement strategies including cognitive restructuring and systematic problem-solving are reported to be the most frequently employed [16].

1.1.5 Research Gap and Theoretical Framework

Despite growing attention to academic leadership, limited empirical research has systematically compared leadership expectations and competencies across Malaysian public and private universities. Existing studies have examined leadership capacities [5], talent management [17], and stress coping strategies [16], but few have investigated how institutional mission shapes the development of research versus teaching leadership competencies. This study addresses this gap by comparing leadership expectations and identifying context-specific competencies required for effectively managing both functions across institutional types. The findings contribute to understanding institutional support systems, preparation mechanisms, and the professional identity of academic leaders navigating dual roles in Malaysian higher education.

2. MATERIALS AND METHODS

2.1 Research Design

The present study adopted a qualitative research design to examine the multifaceted nature of academic leadership. This methodological choice facilitated a nuanced exploration of participants' lived experiences, perceptual frameworks, and the

contextual variables shaping institutional dynamics. Within this approach, semi-structured interviews were employed as the primary data collection technique, enabling academic leaders to articulate both the challenges and opportunities inherent in balancing research and teaching obligations.

2.2 Participants and Sampling Strategy

A purposive sampling strategy was utilized to select academic leaders from Malaysian public and private higher education institutions. To ensure a comprehensive range of perspectives aligned with the study's objectives, participants were recruited across varied academic positions, disciplinary backgrounds, and institutional affiliations, encompassing multiple academic ranks including professors, senior lecturers, and lecturers. A total of twelve participants were enlisted, comprising professors, directors, senior lecturers, and lecturers from both public and private university settings. This sample size was considered adequate for qualitative inquiry within the domain of higher education leadership, consistent with the recommendations of Guest et al. (2020), who propose that 6–12 interviews are sufficient to achieve thematic saturation in relatively homogeneous populations. To safeguard participant confidentiality during data reporting, pseudonyms were assigned to all individuals representing both public and private universities.

2.3 Data Collection Instrument

The present study employed semi-structured interviews, guided by a purposefully developed protocol designed to investigate the following thematic domains: institutional support for leadership development; preparation for research-oriented versus teaching-oriented roles; perceived competencies requisite for each function; workload equilibrium and professional identity formation; and institutional incentive structures alongside recognition systems.

Data collection was undertaken between January and March 2026. Each interview session ranged from approximately 45 to 60 minutes in duration and was administered either in person or through secure online conferencing platforms. All interviews were audio-recorded following the obtainment of informed consent from participants, and subsequently transcribed verbatim for analytical purposes.

The semi-structured interview guide was developed from a literature review on academic leadership and explored the five domains outlined above. Two senior academics reviewed the initial version, leading to refinements in wording and the addition of probing prompts. The guide was then pilot-tested with two academic leaders (one from a public university and one from a private university) who were not included in the main sample. Minor revisions were made based on pilot feedback, including the rephrasing of ambiguous questions and the reordering of

topics for improved conversational flow. The final guide was used consistently across all twelve interviews.

2.4 Data Analysis

Thematic analysis was performed following the six-phase framework established by Braun and Clarke (2021): (1) familiarisation with the data, (2) generating initial codes, (3) searching for themes, (4) reviewing themes, (5) defining and naming themes, and (6) producing the report. Codes were generated using a hybrid approach: deductive codes were derived from the research objectives, while inductive codes emerged from repeated reading of the transcripts. Line-by-line coding of all transcripts was conducted, with 20% independently coded by a second researcher to enhance reliability; discrepancies were resolved through discussion. NVivo 14 software was used to organise, code, and retrieve data, facilitating the grouping of related codes into candidate themes. Initial themes were then reviewed, refined, and collapsed or split through iterative team discussions, with constant cross-checking against raw data to ensure accurate representation of participant experiences.

2.5 Ethical Considerations

Ethical clearance for this study was secured from the appropriate institutional review boards. Written informed consent was obtained from all participants prior to their involvement. Strict confidentiality was assured, and all potentially identifying data were anonymized or systematically removed. Furthermore, participants were explicitly informed of their entitlement to withdraw from the study at any juncture, without penalty or adverse repercussion.

3. RESULTS AND DISCUSSION

3.1 The Findings

The findings reveal a clear sectoral divergence in leadership priorities, expectations, and competency development between Malaysian public and private universities. This divergence is not merely a matter of institutional preference but reflects deeper structural forces that systematically shape leadership identity and practice. It presents a synthesis of the thematic findings derived from the qualitative analysis. Five overarching themes were identified, each elucidating distinct dimensions of academic leadership in the Malaysian higher education context.

3.1.1 Role Asymmetry and Professional Identity

Public university leaders identify with research leadership due to global ranking pressures (QS, THE) that prioritise publication output. Private university leaders

derive identity from teaching excellence, driven by market competition where student enrolment and employability are paramount.

First, a pronounced role asymmetry was observed: academic leaders in public universities exhibited a stronger professional identification with research leadership, whereas their counterparts in private institutions derived their professional identity primarily from teaching excellence.

3.1.2 Competency Divergence and Institutional Neglect

Public universities invest in research infrastructure (FRGS, LRGS grants) while neglecting teaching development. Private universities prioritise teaching workshops (MQA accreditation) but offer minimal research support. Leaders develop expertise only in the domain that attracts institutional resources.

Second, a clear competency divergence emerged, wherein research leadership necessitated proficiencies in grant acquisition, team mentorship, and publication strategy, while teaching leadership demanded expertise in instructional design, student engagement, and curricular innovation.

3.1.3 Workload Imbalance and Burnout

Public university promotion emphasises publications and grants; private university promotion prioritises teaching evaluations and student feedback. This polarised reward system drives role overload and burnout across both sectors.

Third, institutional neglect was evident across both sectors, as systematic development of the non-priority leadership function remained conspicuously absent, compelling academics to acquire critical competencies through self-directed learning.

3.1.4 Institutional Culture and Leadership Priorities

Public universities valorise scholarly output and international recognition, while private universities foster service-oriented cultures focused on student satisfaction and industry relevance. These embedded norms shape what constitutes successful leadership in each sector.

Fourth, a pervasive workload imbalance was reported: public university leaders faced excessive research-related pressures, while private university leaders contended with disproportionately heavy teaching loads, with both conditions contributing to elevated burnout risk.

3.1.5 Hybrid Roles as an Emerging Alternative

Hybrid leadership models in transnational universities remain rare but suggest a pathway toward balanced leadership. Their scarcity highlights the need for policy reforms, including balanced promotion criteria and resource allocation across both functions.

Finally, an incipient trend toward hybrid leadership roles was noted, particularly within transnational and dual-sector institutions, although such integrated models remain exceptional and limited in scope.

3.2 Main Thematic Analysis: Sectoral Divergence in Academic Leadership Development Priorities

The thematic analysis revealed a significant divergence between Malaysian public and private universities in their approaches to academic leadership development. This overarching theme demonstrates that institutional mission, funding structures, and strategic priorities substantially influence the types of leadership competencies that academics are encouraged and supported to develop. The findings indicate that each sector prioritises different dimensions of academic leadership, resulting in contrasting developmental experiences for academic staff.

3.2.1 Public University Context

Participants from public universities consistently reported that institutional support is primarily directed towards research leadership. Leadership development opportunities were closely associated with research productivity through structured initiatives such as grant-writing workshops, mentoring by experienced researchers with externally funded projects (e.g., Fundamental Research Grant Scheme [FRGS]), and access to research infrastructure and equipment funding. Several participants described receiving substantial institutional investment, including financial support for research equipment, which facilitated the development of research-related leadership competencies.

In contrast, participants perceived considerably less institutional emphasis on teaching leadership. Pedagogical leadership development was commonly viewed as an individual responsibility rather than an organisational priority. One participant noted that leadership was generally perceived as an inherent quality rather than a competency that could be systematically cultivated, highlighting the limited institutional support available for academics seeking to enhance their leadership capabilities in teaching and learning.

3.2.2 Private University Context

A contrasting pattern emerged from the experiences of participants in private universities. Institutional development initiatives predominantly focused on

teaching excellence and industry engagement. Participants reported access to professional development programmes, including teaching excellence workshops and training activities designed to strengthen industry collaboration and enhance graduate employability, reflecting the strategic priorities of private higher education institutions.

Conversely, research leadership development was described as receiving minimal institutional support. Participants frequently reported limited opportunities for research capacity building, citing the absence of research funding, protected research time, seed grants, publication assistance, and structured mentorship. Several participants indicated that they had received little or no guidance in developing grant-writing competencies and were expected to navigate research activities independently, often through trial-and-error experiences.

3.2.3 Interpretive Summary

The findings reveal a clear sectoral distinction in academic leadership development priorities, whereby neither public nor private universities provide a comprehensive and balanced approach to developing leadership across both teaching and research domains. Public universities predominantly invest in strengthening research leadership through funding, infrastructure, and mentorship, while placing comparatively less emphasis on teaching leadership. In contrast, private universities prioritise teaching quality and industry engagement but provide limited institutional support for research leadership development.

These findings suggest that institutional missions and funding models extend beyond determining the allocation of resources; they shape the leadership competencies that academics are expected to develop throughout their careers. Consequently, academics in the two sectors experience distinct leadership development trajectories, reflecting the strategic objectives and performance expectations of their respective institutions.

This study contributes to the growing body of literature on academic leadership by providing empirical evidence of how sectoral differences influence leadership development within Malaysian higher education. The findings underscore the importance of adopting a more integrated approach that supports leadership development across both teaching and research domains. Given the exploratory nature of this study and its relatively limited sample, future research should include larger and more diverse participant groups to further examine leadership development across hybrid institutional settings, including transnational universities and institutions operating within dual-sector higher education systems.

3.3 Discussion

The thematic analysis conducted in this study identified sectoral divergence in leadership development priorities as the overarching theme. This finding highlights a clear distinction between Malaysian public and private universities in their approaches to academic leadership development. Each institutional sector predominantly invests in leadership capabilities that align with its core organisational mission while providing comparatively limited support for the complementary function. Consequently, institutional mission emerges as a key determinant of leadership development strategies, resource allocation, and the formation of academic professional identity. Public universities predominantly strengthen research leadership while placing comparatively less emphasis on teaching leadership. In contrast, private universities prioritise teaching excellence but provide limited opportunities for research leadership development. The analysis generated four principal findings.

First, institutional support is characterised by a significant imbalance between research and teaching leadership development. Both public and private universities allocate considerable resources to activities that advance their primary institutional objectives while systematically underinvesting in the secondary domain. Participants from public universities described substantial institutional investments in research infrastructure and funding, including research grants and laboratory resources, but reported limited institutional support for pedagogical development. Conversely, participants from private universities consistently indicated that institutional support for research was minimal, with limited access to protected research time, seed funding, publication assistance, or structured research development programmes. These findings suggest that institutional investment patterns are strongly influenced by organisational priorities rather than by a balanced approach to academic leadership development.

Second, leadership preparation is polarised across institutional sectors. Public university participants indicated that they received comprehensive preparation for research leadership through grant-writing workshops, research mentoring, and publication support, yet reported that teaching leadership development largely depended on personal initiative and self-directed learning. In contrast, participants from private universities acknowledged receiving regular professional development in teaching and learning but expressed limited confidence in research leadership, particularly in areas such as securing research funding and managing research projects. As a result, academic leaders in both sectors become highly competent in the domain prioritised by their institutions while experiencing substantial developmental gaps in the complementary area. This imbalance contributes to role strain and limits leaders' ability to fulfil the increasingly integrated expectations of contemporary higher education.

Third, professional identity is shaped by institutional mission and organisational expectations. Participants from public universities predominantly identified

themselves as researchers, with teaching often viewed as a secondary professional responsibility. In contrast, participants from private universities primarily perceived themselves as educators and facilitators of industry-relevant learning, while research leadership was regarded as beyond the scope of their institutional roles. Consequently, balanced professional identities that integrate both teaching and research leadership competencies were rarely observed. This finding demonstrates that institutional culture not only influences leadership development opportunities but also shapes how academic leaders conceptualise their professional roles and career trajectories.

Finally, the findings indicate the need for systemic change in academic leadership development. The current sector-specific emphasis on either research or teaching leadership is unlikely to meet the evolving demands of higher education, which increasingly require academic leaders to demonstrate competence across both domains. Institutions should therefore adopt integrated leadership development frameworks that recognise teaching and research as complementary rather than competing responsibilities. Such frameworks should include equitable allocation of protected time for teaching and research activities, dedicated funding to support cross-domain initiatives, performance and promotion systems that recognise excellence in both areas, and structured professional development programmes designed to cultivate leadership capabilities in teaching and research simultaneously. Implementing a more balanced approach would enable institutions to develop versatile academic leaders capable of responding effectively to the multifaceted challenges of contemporary higher education.

4. CONCLUSION

This study highlights the need for a balanced approach to academic leadership development that gives equal emphasis to teaching and research. Without such balance, disparities between institutional sectors are likely to persist, limiting the overall effectiveness of higher education systems. In an increasingly competitive global higher education landscape, institutions require academic leaders who possess strong capabilities in both teaching and research leadership. Achieving this balance requires comprehensive policy reforms, strategic allocation of resources, and sustained cultural change across all sectors of higher education.

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REFERENCES

- [1] G. Guest, E. Namey, and M. Chen, "A Simple Method to Assess and Report Thematic Saturation in Qualitative Research," *PLoS ONE*, vol. 15, no. 5, e0232076, May 2020. [Online]. Available: <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0232076>
- [2] V. Arkorful and N. Abaidoo, "The Role of E-Learning, Advantages and Disadvantages of Its Adoption in Higher Education," *Int. J. Instr. Technol. Distance Learn.*, vol. 12, pp. 29–42, 2015.
- [3] "Academic Leadership," Institute of Management and Leadership Development, Universiti Tunku Abdul Rahman. [Online]. Available: <https://imld.utar.edu.my/Academic-Leadership.php>.
- [4] "Academic Leadership in Higher Education," Universiti Teknologi Malaysia, Oct. 2023. [Online]. Available: https://people.utm.my/radhiahtulraehan/2023/10/06/___trashed/.
- [5] "Pemeriksaan Kepimpinan Akademik dalam Kalangan Staf Akademik di UTeM: Satu Tinjauan," CORE, 2023.
- [6] M. Ghasemy, S. Hussin, A. Z. B. A. Razak, M. J. Maah, and S. Ghavifekr, "Determining the Key Capacities of Effective Leaders in Malaysian Public and Private Focused Universities," *SAGE Open*, vol. 8, 2018.
- [7] M. S. Chan and H. A. Halim, "Predictors of Psychological Well-Being among Academic Staff in Malaysian Higher Education," *Cogent Psychol.*, 2025.
- [8] "Balancing Managerial and Academic Values," *Sci. Direct*, 2016.
- [9] N. Ismail, "Leadership Indicators for Lifelong Learning Readiness," unpublished, 2025.
- [10] I. F. bt Adi Badiozaman, "Experiences of Early Career Academics in a Private Malaysian Higher Education Institution," *Asia Pac. J. Educ.*, 2021.
- [11] "What Kind of Teacher Should We Become: Identity-Role Consistency and Authenticity," *Front. Educ.*, vol. 10, 2025.
- [12] M. Yousefi and A. G. K. Abdullah, "Influence of Organisational Stressors on Job Performance among Academic Staff," *Int. J. Instr.*, vol. 12, 2019.
- [13] M. Graizi, K. S. L. Cheah, and K. E. Hoque, "Effects of Physical, Emotional, and Cognitive Demands on Academic Leaders' Performance in Malaysian Research Universities," *Int. J. Learn. Teach. Educ. Res.*, vol. 20, no. 3, pp. 282–303, 2021.
- [14] M. Ghasemy, S. R. Alvani, B. L. Abel, I. F. Cepeda-Carrion, and G. Cepeda-Carrion, "Job Satisfaction and Job Performance of Academics in Malaysian Universities," *High. Educ. Policy*, 2021.
- [15] M. Ghasemy, A. Derahvasht, and J. Castillo Apraiz, "Work Environment Features, Work Events, Affective States and Attitudes in the Malaysian Academic Environment," *J. Appl. Res. High. Educ.*, 2022.
- [16] G. K. Sidhu and N. S. Aziz, "Stress Management Coping Strategies of Academic Leaders in an Institution of Higher Learning in Malaysia," *Asian J. Univ. Educ.*, [no volume/issue provided].

- [17] "Talent Management and Succession Planning in Higher Education Institutions," IIUM Leadership Centre, Sep. 2024.
- [18] V. M. Sivakumaran, M. R. M. Amin, M. S. M. Yusof, W. C. Hoo, L. K. Yew, and A. Raman, "Analyzing the Effect of Leader Traits on Organizational Performance in Malaysian Private Higher Education," *J. Appl. Res. High. Educ.*, 2025.

STUDENTS' PERCEPTIONS OF TECHNOLOGY-INTEGRATED ENTREPRENEURIAL EDUCATION: EVIDENCE FROM SPACE UTM

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ABSTRACT - The rise of digital technologies is transforming how entrepreneurial education is delivered, enabling more interactive, practical, and engaging learning experiences. However, limited empirical evidence exists on how students perceive technology-integrated entrepreneurship courses, particularly within continuing education contexts. This study examines students' perceptions of technology integration in entrepreneurship courses at the School of Professional and Continuing Education (SPACE UTM), Malaysia, and investigates its association with student engagement, collaborative learning, and entrepreneurial competency development. A cross-sectional descriptive correlational design was employed, involving 226 full-time students from diverse academic backgrounds. Data were collected from a structured questionnaire and analysed using descriptive statistics, Pearson correlation, and multiple regression analysis. The results indicate that students reported positive perceptions of technology integration ($M = 4.12$, $SD = 0.56$). Perceived usefulness demonstrated a strong association with student engagement ($r = 0.64$, $p < 0.01$) and significantly predicted entrepreneurial competency development ($\beta = 0.46$, $p < 0.01$). Ease of use also significantly predicted collaborative learning ($\beta = 0.39$, $p < 0.01$), with the regression model explaining 42% of the variance in perceived competencies. Descriptive findings further reveal that while more than half of the students rated the quality of entrepreneurial education as good or excellent, approximately 40% reported neutral perceptions, indicating variability in student experience. Additionally, 22.1% of respondents reported limited access to technology, highlighting gaps in digital readiness. The study provides empirical evidence on student perceptions and associated factors influencing technology-enhanced entrepreneurial education within a specific institutional context. While positive associations are observed, the findings are based on cross-sectional and self-reported data and therefore do not imply causality. The results offer practical implications for improving digital access, enhancing student engagement, and strengthening pedagogical design in technology-supported entrepreneurship education.

Keywords: Entrepreneurial Education; Technology Integration; Student Perceptions; Student Engagement; Collaborative Learning

1. INTRODUCTION

In today's digital era, rapid technological advancements are transforming higher education from traditional lecture-based approaches into interactive, technology-rich learning environments [1]. Within this transformation, entrepreneurial education has become an essential component of modern academic systems, equipping students with critical competencies such as creativity, problem-solving, opportunity recognition, and innovation-driven thinking required to succeed in dynamic and competitive markets [2], [3]. The integration of digital technologies, including artificial intelligence (AI), augmented and virtual reality (AR/VR), gamification, and collaborative platforms, further enhances this transformation by enabling more experiential, flexible, and student-centered learning approaches [4], [5].

These technological developments are particularly relevant in entrepreneurship education, where experiential learning and real-world application are central to effective knowledge acquisition [6]. Digital tools provide opportunities for simulation-based learning, collaborative problem-solving, and interactive engagement, allowing students to develop entrepreneurial competencies in a controlled and low-risk environment. As a result, technology integration is increasingly recognised as a key enabler of meaningful and practice-oriented entrepreneurial learning [3]. Despite these advancements, the implementation of technology in entrepreneurship education remains uneven across institutions. Many programmes continue to rely on traditional teaching methods, which may limit opportunities for active engagement and applied competency development [7], [8]. Furthermore, existing research on technology-enhanced entrepreneurial education is largely concentrated in conventional undergraduate or Western higher education contexts, with limited empirical evidence from continuing education environments. This creates a gap in understanding how students in such contexts perceive technology integration and how these perceptions relate to key learning outcomes.

This gap is particularly pronounced at the School of Professional and Continuing Education (SPACE UTM), where students come from diverse academic backgrounds and exhibit varying levels of digital readiness and prior exposure to technology. While digital tools are increasingly available, their integration into entrepreneurship courses may not be fully optimised, and disparities in access persist. These conditions may affect students' engagement, collaborative learning experiences, and the development of entrepreneurial competencies. To address this gap, this study examines students' perceptions of technology integration in entrepreneurship courses at SPACE UTM and investigates its relationship with student engagement, collaborative learning, and entrepreneurial competency development. Specifically, the study aims to: (1) assess students' perceptions of technology use, (2) examine the relationships between technology-related factors and learning outcomes, and (3) identify challenges affecting the implementation of

technology-enhanced learning. The study is grounded in the Technology Acceptance Model, experiential learning theory, and constructivist perspectives, which emphasise the roles of perceived usefulness, ease of use, and active engagement in shaping learning outcomes [6], [9], [10]. By focusing on a continuing education context within Malaysia, this research provides context-specific empirical insights into the opportunities and challenges of technology integration in entrepreneurial education. The findings contribute to both theory and practice by extending existing frameworks to a less-explored educational setting and offering practical implications for improving digital access, enhancing student engagement, and designing more effective technology-supported learning environments.

1.1 Literature Review

1.1.1 Technology Integration in Entrepreneurial Education

Entrepreneurial education has evolved from traditional, theory-based instruction toward more experiential and practice-oriented approaches aimed at developing innovation, creativity, and problem-solving skills [2]. The integration of digital technologies has played a critical role in this transformation by enabling interactive, flexible, and student-centered learning environments. Technologies such as artificial intelligence (AI), augmented and virtual reality (AR/VR), gamification, and collaborative digital platforms allow students to engage in simulation-based learning, real-time decision-making, and collaborative problem-solving [4], [5].

These tools are particularly relevant in entrepreneurship education, where experiential learning is essential for bridging the gap between theoretical knowledge and real-world application [6]. Digital platforms can replicate entrepreneurial scenarios in low-risk environments, allowing students to experiment, fail, and learn iteratively. As a result, technology integration is increasingly viewed as a key enabler of effective entrepreneurial learning [3]. However, the extent to which these technologies are effectively adopted and perceived by students remains context-dependent, particularly in non-traditional and continuing education settings.

1.1.2 Technology Acceptance and Student Perceptions

The Technology Acceptance Model (TAM) provides a widely used framework for understanding how individuals adopt and use technology [9]. According to TAM, two key factors, perceived usefulness and perceived ease of use influence users' attitudes and behavioural intentions toward technology adoption. In educational contexts, perceived usefulness refers to the extent to which students believe that technology enhances their learning performance, while ease of use reflects the degree to which technology is perceived as user-friendly and accessible.

Empirical studies have shown that both perceived usefulness and ease of use significantly influence students' engagement with digital learning tools and their overall learning experience [4]. When students perceive technology as beneficial and easy to use, they are more likely to actively participate in learning activities, interact with peers, and engage in collaborative tasks. In contrast, low perceived usefulness or usability barriers may hinder effective adoption and reduce learning outcomes. Therefore, understanding student perceptions is critical for evaluating the effectiveness of technology integration in entrepreneurial education.

1.1.3 Student Engagement and Collaborative Learning

Student engagement is a central construct in higher education, reflecting the level of cognitive, emotional, and behavioural involvement in learning activities [11]. Technology-enhanced learning environments have been shown to improve engagement by providing interactive, personalized, and immersive experiences [1]. Tools such as gamification and simulations can increase motivation and participation, while collaborative platforms facilitate communication, teamwork, and knowledge sharing.

Collaborative learning is essential in entrepreneurship education, as entrepreneurial processes often involve teamwork, negotiation, and collective decision-making [12]. Digital tools such as shared workspaces, discussion platforms, and virtual collaboration environments enable students to work together effectively, regardless of time and location constraints. Previous studies suggest that technology-supported collaboration enhances problem-solving skills, critical thinking, and interpersonal competencies [4]. However, the effectiveness of such tools depends on students' willingness to adopt and engage with them, which is influenced by their perceptions of technology.

1.1.4 Entrepreneurial Competency Development

Entrepreneurial competencies refer to a set of skills and abilities that enable individuals to identify opportunities, manage risks, innovate, and create value [3]. These competencies include cognitive skills (e.g., problem-solving and decision-making), behavioural skills (e.g., initiative and adaptability), and social skills (e.g., leadership and collaboration). Technology-enhanced learning environments can support the development of these competencies by providing experiential and practice-based learning opportunities.

Simulation-based learning, for instance, allows students to engage in realistic entrepreneurial scenarios, enhancing decision-making and risk assessment skills. Similarly, collaborative platforms support teamwork and leadership development, while gamification can stimulate creativity and innovation [5]. Despite these potential benefits, the extent to which technology contributes to entrepreneurial

competency development is often influenced by students' perceptions and level of engagement. Therefore, examining the relationships between technology-related factors and competency outcomes is essential for understanding the effectiveness of technology integration in entrepreneurship education.

1.1.5 Research Hypotheses

Based on the literature, prior studies have largely overlooked continuing education contexts and variations in digital readiness, highlighting the need for context-specific empirical investigation. Therefore, this study proposes that students' perceptions of technology particularly perceived usefulness and ease of use are associated with key learning outcomes, including engagement, collaborative learning, and entrepreneurial competency development. Accordingly, the following hypotheses are proposed:

- H1: Perceived usefulness of technology is positively associated with student engagement in entrepreneurship courses.
- H2: Perceived usefulness of technology is positively associated with entrepreneurial competency development.
- H3: Perceived ease of use of technology is positively associated with collaborative learning.
- H4: Student engagement is positively associated with entrepreneurial competency development.
- H5: Collaborative learning is positively associated with entrepreneurial competency development.

2. MATERIALS AND METHODS

This study adopts a cross-sectional descriptive correlational design to examine relationships between technology-related factors and learning outcomes in entrepreneurial education. Data were collected through a structured questionnaire administered to students enrolled in entrepreneurship modules at the School of Professional and Continuing Education (SPACE UTM), Universiti Teknologi Malaysia. A stratified sampling approach was used to ensure representation across academic levels, resulting in 226 valid responses from foundation, diploma, and bachelor's students. The majority were foundation-level students (73%), with a higher proportion of female respondents (63.7%).

The questionnaire measured perceived usefulness, perceived ease of use, student engagement, collaborative learning, entrepreneurial competency development, and challenges in technology integration using a five-point Likert scale. Content validity was established through expert review, and reliability analysis confirmed acceptable internal consistency (Cronbach's $\alpha > 0.70$). Data were analysed using descriptive statistics, Pearson correlation, and multiple regression analysis. Statistical significance was set at $p < 0.05$, and model explanatory power was evaluated using R^2 . The Severity Index (SI) was applied to rank challenges in

technology integration. Given the sample size ($N = 226$), parametric tests were deemed appropriate given sample size and distribution assumptions.

3. RESULTS AND DISCUSSION

3.1 Digital Readiness

As shown in Table 1, the majority of respondents reported moderate access to technology (61.5%), while 22.1% indicated limited access and only 16.4% reported advanced access. This distribution suggests that although digital tools are generally available, access is not uniform across students. Such disparities may influence students' ability to engage effectively with technology-enhanced learning environments. This finding is consistent with previous studies highlighting infrastructural and accessibility constraints as key barriers to effective educational innovation [13].

Table 1. Digital Readiness

Characteristics	Description	Frequency	Percentage (%)
Technology Accessibility	Advanced	37	16.4
	Limited	50	22.1
	Moderate	139	61.5
Assessment of the overall quality of entrepreneurial education at SPACE UTM	Excellent	28	12.4
	Good	96	42.5
	Neutral	94	41.6
	Poor	8	3.5
Level of satisfaction with the existing entrepreneurial curriculum	Dissatisfied	2	.9
	Extremely Dissatisfied	2	.9
	Extremely Satisfied	24	10.6
	Neutral	92	40.7
	Satisfied	106	46.9

3.2 Technology Integration

The descriptive results indicate that students generally hold positive perceptions of technology integration in entrepreneurship education. As presented in Table 2, most constructs fall within the high category, particularly benefits of technology-driven education ($M = 4.07$), teaching and learning approaches ($M = 3.96$), and impact on entrepreneurial skills ($M = 3.96$). This suggests that students recognise the value of

digital tools in supporting interactive and applied learning experiences. Furthermore, Figure 1 and Figure 2 illustrate that the majority of respondents expressed agreement or strong agreement with statements related to technology use and its benefits. These findings reinforce the positive role of digital technologies in enhancing engagement and experiential learning, as highlighted in previous research [3], [5]. However, challenges to incorporating technology were rated at a moderate level ($M = 3.47$). Additionally, approximately 40% of respondents reported neutral perceptions, indicating variability in student experiences. This suggests that while technology integration is beneficial, its effectiveness is not consistent across all learners, which aligns with prior studies identifying institutional and pedagogical limitations [7], [8].

Table 2. Composite Mean Score Classification

Variable	Composite Mean	Classification
Awareness and Use of Technology in Education	3.74	High
Benefits of Technology-Driven Education	4.07	High
Effectiveness of Existing Entrepreneurship Courses	3.84	High
Challenges to Incorporating Technology	3.47	Moderate
Teaching and Learning Approaches	3.96	High
Impact of Technology and Innovative Teaching Methods on Entrepreneurial Skills	3.96	High
Strategic Recommendations for Technology Use	4.01	High
Future Research and Opportunities	3.93	High

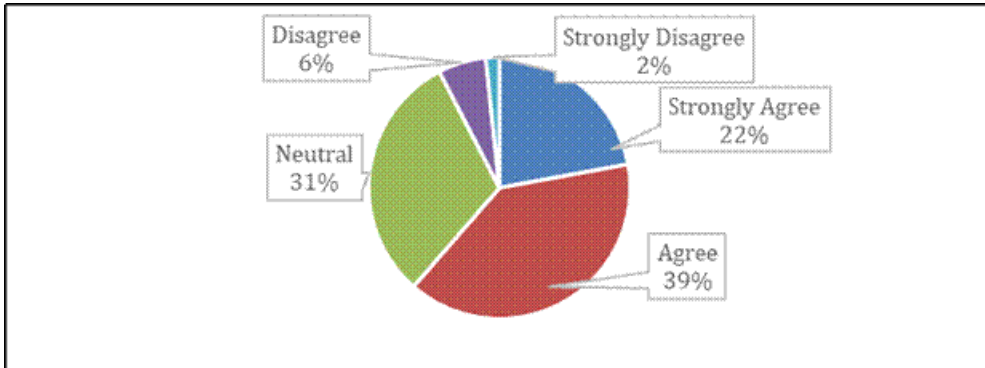


Figure 1. Awareness and Use of Technology in Education

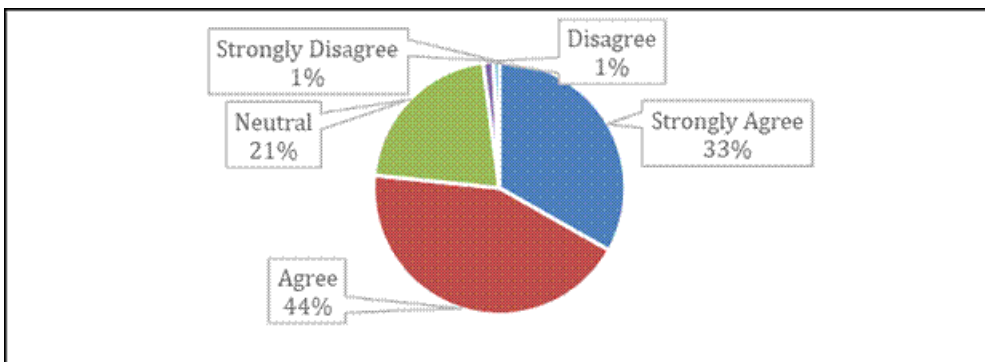


Figure 2. Benefits of Technology-Driven Education

3.3 Correlation and Regression Analysis

The correlation analysis reveals statistically significant relationships between key constructs. Perceived usefulness of technology demonstrates a strong positive association with student engagement ($r = 0.64, p < 0.01$), supporting H1, and is also positively associated with entrepreneurial competency development, supporting H2. These findings indicate that students who perceive technology as beneficial are more likely to actively engage in learning activities and report stronger competency development. This is consistent with prior research emphasising the role of technology-enhanced learning environments in facilitating engagement and skill development [4], [3]. The regression results further support the proposed relationships. As presented in Table 3, perceived usefulness significantly predicts entrepreneurial competency development ($\beta = 0.46, p < 0.01$), while perceived ease of use significantly predicts collaborative learning ($\beta = 0.39, p < 0.01$), supporting H3. The model explains 42% of the variance ($R^2 = 0.42$) in entrepreneurial competency development, indicating moderate explanatory power. These findings reinforce the importance of perceived usefulness and ease of use as key determinants of effective technology adoption, consistent with the Technology

Acceptance Model [9]. The validity of the regression model was further assessed through classical assumption testing. As shown in Table 4, no significant issues related to multicollinearity or heteroscedasticity were identified, with tolerance and variance inflation factor (VIF) values within acceptable thresholds. Although minor deviations from normality were observed, the analysis is considered robust given the sample size ($N = 226$), in line with the central limit theorem.

Table 3. Multiple Regression Results

Predictor Variable	Dependent Variable	Standardised Coefficient (β)	Significance (p -value)
Perceived Usefulness	Entrepreneurial Competency Development	0.46	< 0.01
Perceived Ease of Use	Collaborative Learning	0.39	< 0.01

Table 4. Classical Assumption Test

Test	Normality Test		Multicollinearity Test		Heteroscedasticity Test	
	Kolmogorov-Smirnov	Asymp. Sig	Variable	Tolerance	VIF	Sig. Value
Dependent Variable (DV)	0.091	0.000	IV1_Effectiveness	0.545	1.836	> 0.05
			IV2_Challenges	0.829	1.206	> 0.05
			IV3_Teaching	0.282	3.546	> 0.05
			IV4_Impact	0.291	3.442	> 0.05
			IV5_Strategic	0.256	3.900	> 0.05
			IV6_Futureresearch	0.286	3.495	> 0.05
Significance Limit		0.05				0.05

3.4 Engagement, Collaboration and Competency Development

The results indicate that students generally report positive perceptions of the role of technology in supporting entrepreneurial competency development. As illustrated in Figure 3, high mean scores are observed across key skill dimensions, particularly in collaboration, decision-making, and creativity. This suggests that technology-enhanced learning environments contribute significantly to the development of entrepreneurial competencies. In particular, collaborative tools are perceived to enhance teamwork and leadership, while simulation-based and

technology-supported approaches facilitate decision-making and the application of theoretical knowledge in practical contexts. These findings highlight the role of technology in supporting both individual and collaborative learning processes. The relationships between student engagement, collaborative learning, and entrepreneurial competency development are further supported by the correlation and regression results presented in Table 3. These findings indicate that higher levels of engagement and collaboration are associated with improved competency development. This aligns with prior research emphasising the importance of experiential and collaborative learning in entrepreneurship education [12].

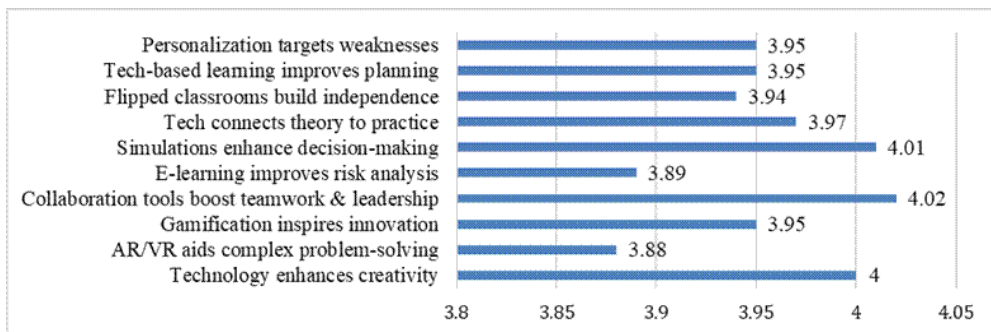


Figure 3. Impact of Technology on Entrepreneurial Skills Development

3.5 Challenges in Technology Integration

The severity of technological challenges is presented in Figure 4. The Severity Index (SI) was used to rank these challenges, providing a systematic assessment of their relative importance based on Likert-scale responses. As shown in Figure 4, the most critical challenges include poor internet connectivity, lack of modern technological tools, and the high cost of advanced technologies such as AR/VR. These findings indicate that, despite generally positive perceptions of technology integration, significant infrastructural and financial barriers persist.

Such constraints may limit the effective implementation of technology-enhanced learning, particularly in environments characterised by uneven access to digital resources. This is consistent with previous studies highlighting that institutional readiness, infrastructure, and funding limitations remain key obstacles to innovation in education [8], [13].

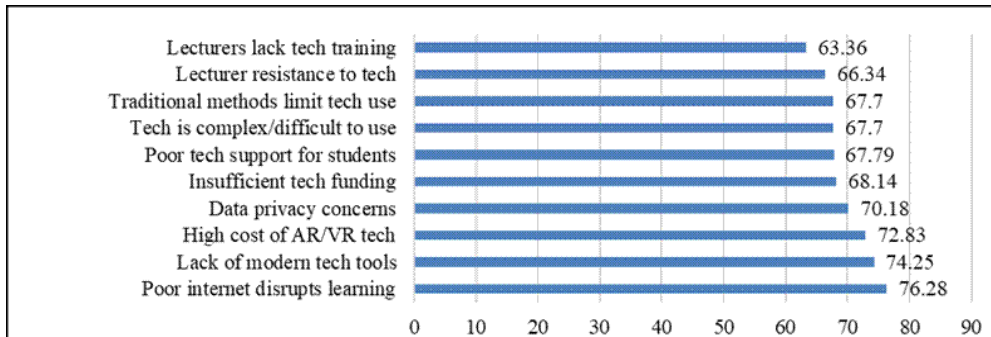


Figure 4. Severity of Challenges in Technology Integration Based on Severity Index (SI)

3.6 Discussion and Implications

The findings confirm that perceived usefulness and ease of use significantly influence engagement, collaboration, and entrepreneurial competency development, supporting the Technology Acceptance Model [9]. Students who perceive technology as beneficial are more likely to engage actively and develop key entrepreneurial skills. These results suggest that when students perceive digital tools as beneficial and accessible, they are more likely to actively participate in learning activities and develop key entrepreneurial skills. The positive association between engagement, collaboration, and competency development further reinforces the importance of interactive and experiential learning approaches in entrepreneurship education [6], [12]. Technology-enhanced environments facilitate these processes by enabling communication, teamwork, and real-world problem-solving experiences.

However, the findings also highlight persistent challenges related to digital access and resource availability. Variability in technology accessibility and the presence of infrastructural constraints indicate that the benefits of technology integration are not equally experienced by all students. This suggests the need for institutions to adopt more inclusive strategies that ensure equitable access to digital tools and resources. From a theoretical perspective, this study extends the application of the Technology Acceptance Model within the context of continuing education, demonstrating its relevance in explaining student engagement and learning outcomes in entrepreneurship education. From a practical standpoint, the findings emphasise the importance of investing in digital infrastructure, enhancing instructional design, and promoting interactive learning approaches to maximise the effectiveness of technology integration.

4. CONCLUSION

This study examined students' perceptions of technology integration in entrepreneurship education at SPACE UTM and its relationship with engagement,

collaborative learning, and entrepreneurial competency development. The findings indicate that students generally perceive technology-enhanced learning positively, with perceived usefulness and ease of use playing key roles in shaping engagement, collaboration, and competency outcomes. Despite these positive perceptions, the study identified several persistent challenges, including disparities in digital access, infrastructural constraints, and the cost of advanced technologies. These findings highlight that effective technology integration requires more than the availability of digital tools; it necessitates appropriate pedagogical implementation and institutional support.

This study contributes to the literature by providing empirical evidence from a continuing education context, which remains relatively underexplored compared to traditional higher education settings. The findings offer practical implications for higher education institutions seeking to enhance student engagement and entrepreneurial competency development through technology. However, this study is limited by its cross-sectional design, self-reported data, and single-institution context. The sample is also skewed toward foundation-level students. Future research should incorporate longitudinal designs and objective performance measures to enhance generalisability and causal interpretation.

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REFERENCES

- [1] C. R. Graham, W. Woodfield, and J. B. Harrison, "A framework for institutional adoption and implementation of blended learning," *The Internet and Higher Education*, vol. 38, pp. 4–14, 2019.
- [2] H. M. Neck and P. G. Greene, "Entrepreneurship education: Known worlds and new frontiers," *Journal of Small Business Management*, vol. 49, no. 1, pp. 55–70, 2011, doi: 10.1111/j.1540-627X.2010.00314.x.
- [3] G. Nabi, F. Liñán, A. Fayolle, N. Krueger, and A. Walmsley, "The impact of entrepreneurship education in higher education: A systematic review and research agenda," *Academy of Management Learning & Education*, vol. 16, no. 2, pp. 277–299, 2017, doi: 10.5465/amle.2015.0026.
- [4] L. Chen, D. Ifenthaler, and J. Y.-K. Yau, "Online and blended entrepreneurship education: A systematic review of applied educational technologies," *Entrepreneurship Education*, vol. 4, no. 2, pp. 191–232, 2021, doi: 10.1007/s41959-021-00047-7.

- [5] X. Sun, "Innovation and practice of higher education entrepreneurship education models in the context of web technology," in *Proc. 3rd Int. Conf. New Media Development and Modernized Education (NMDME 2023)*, 2024, doi: 10.4108/eai.13-10-2023.2341159.
- [6] D. A. Kolb, *Experiential Learning: Experience as the Source of Learning and Development*. Englewood Cliffs, NJ, USA: Prentice-Hall, 1984.
- [7] A. O'Connor, "A conceptual framework for entrepreneurship education policy: Meeting government and economic purposes," *Journal of Business Venturing*, vol. 28, no. 4, pp. 546–563, 2013, doi: 10.1016/j.jbusvent.2012.07.003.
- [8] M. M. Rahman, M. A. Hossain, and M. M. Uddin, "The role of entrepreneurship education in developing entrepreneurial intentions: Evidence from Bangladesh," *Cogent Business & Management*, vol. 11, no. 1, Art. no. 2371178, 2024, doi: 10.1080/23311975.2024.237117.
- [9] F. D. Davis, "Perceived usefulness, perceived ease of use, and user acceptance of information technology," *MIS Quarterly*, vol. 13, no. 3, pp. 319–340, 1989.
- [10] L. S. Vygotsky, *Mind in Society: The Development of Higher Psychological Processes*. Cambridge, MA, USA: Harvard University Press, 1978.
- [11] J. A. Fredricks, P. C. Blumenfeld, and A. H. Paris, "School engagement: Potential of the concept, state of the evidence," *Review of Educational Research*, vol. 74, no. 1, pp. 59–109, 2004.
- [12] R. Bridgstock, D. Jackson, K. Lloyd, and M. Tofa, "Social connectedness and graduate employability: Exploring the professional networks of graduates from business and creative industries," *Higher Education Research & Development*, vol. 38, no. 2, pp. 260–273, 2019, doi: 10.1080/07294360.2018.1517733.
- [13] E. A. Rasmussen and R. Sørheim, "Action-based entrepreneurship education," *Technovation*, vol. 26, no. 2, pp. 185–194, 2006, doi: 10.1016/j.technovation.2005.06.012.

GENERATION Z AND HOFSTEDE'S POWER DISTANCE CULTURAL DIMENSION IN MALAYSIA

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ABSTRACT - A successful user interface (UI) design begins with a clear comprehension of the system's users. This study focuses on Generation Z UTM full-time diploma students in Kuala Lumpur centre as the primary users of the SPACE website (<https://space.utm.my/>), which offers essential information about various academic programmes. Usability and user experience (UX) are critical to ensuring effective user interaction with the system. Cultural factors, especially those explored in Human-Computer Interaction (HCI) studies, significantly affect user behavior. Using Hofstede's cultural dimensions' framework, this study examines the power distance dimension to discover whether cultural values vary based on user generation. The aim is to gain valuable user insights that can inform UI design improvements, enhance usability, and positive user experience. This study represents the first phase: understanding the user. Using VSM94, data were collected from UTMSPACE diploma students ($n=288$) in Nov–Dec 2024 and PDI was computed using Hofstede's formula. The results show that the present findings and Hofstede's initial Malaysian ratings differ significantly. In particular, the Power Distance Index (PDI) dropped significantly from Hofstede's 100 to 18, indicating that Malaysian Generation Z is more interested in equality and participatory communication and less tolerant of hierarchical power structures. These results are consistent with earlier research showing that higher education, technology proficiency, and global connectedness have an influence generational convergence and cultural transition. According to the study's findings, cultural characteristics change over time and vary throughout generations, suggests a possible generational shift when applying national PDI to Gen Z contexts.

Keywords: Website; Culture; Hofstede Cultural Dimensions; Generation Z; Culturability

1. INTRODUCTION

Since 1960's, HCI researchers start to study the importance of human factors, particularly the user, when designing the UI. The studies encompass on user psychology, user needs and requirements, different levels of user skills and

knowledge and many others. The term user friendly listed the following traits: the ability to solve issues efficiently, ease of understanding how to use the system, availability of instructions and guidance, and the system's willingness to accept mistakes from the user. Additionally, the user-centered design that stress the importance of designing the UI based on the user needs and psychology. Usability is to design the UI in a way so to facilitate a user's learning and efficient use of the computer and lastly UX deals with user's emotions and feelings when interacting with the UI. All these concepts and approaches have one main goal which is to accommodate and suit the UI with the user of the system.

Hofstede et al. [1] define culture as “the programming of the human mind by which one group of people distinguishes itself from another group”. Culture is a pattern of way of life for one group where each member shares the same value, believe, perceptions, attitudes, and behaviors. Many studies use culture as one approach to investigate how individuals in a group believe, think, and act. Hofstede's cultural dimensions are the most widely used since they allow for comparisons of cultural values between human groups whether based on nation, race, or ethnicity [1].

UI is a bridge that facilitates interaction between the user and the system. It is crucial to provide an intermediary that create user-friendly environment so that communication between humans and computers can occur efficiently, thus providing maximum performance and productivity. Based on the user's opinion, an appealing UI is crucial since it serves as an early sign of how well your website is seen by the user and can maintain their interest in continuing to use the system.

Many HCI studies prove the importance of web design being tailored in accordance with who is the user to ensure of user friendly, high usability and positive user experience. When the design meets user needs, they can learn quickly, use the system easily, and experience positive emotions and this may lead to increased of productivity and performance, browse and explore the system. In terms of website, it will lead to the user explore the UI without any difficulties and use it efficiently and feel satisfied with it.

Culture can be understood as the shared strategies a group develops to adapt to its environment. More formally, Ferrante [2] defines it as “the way of life of a people,” which includes their methods for responding to the people and other creatures within their surroundings. A generational cohort is defined as an “identifiable group that shares birth years, age, location and significant life events at critical developmental stages” [3]. Lifintsev et al. [4] classify the people generations as follows: “Silent Generation (1928 to 1945), Baby Boomers (1944 to 1964), Generation X (1965 to 1980), Millennials or Generation Y (1981 to 1995) and Generation Z (1996 to 2010)”.

Thus, these cohorts are often studied to comprehend shifts in values, behaviors, and expectations within societies and organizations. In this study, the unit of culture is

the people generation where each generation shares the similar value, behavior and in difference with other generations.

1.1 Literature Review

Approaches to the concept and study of culture have varied between academic disciplines. The word culture has been used in various fields of studies, including sociology, anthropology, business, science, technology and many others. A culture model functions as a basis representing the shared values, beliefs, and behaviors among individuals within an organization. Cultural models are shared perceptions and attitudes about how the world works. It is necessary to take into account the cultures when they are thinking in terms of something, feeling or reacting.

Hofstede et al. [1] identify five dimensions;

1. **Power Distance Index (PDI):** Measures the degree to which a society's weaker members accept and anticipate an unequal distribution of power. Low PDI cultures aim for equality and participatory decision-making, but high PDI cultures readily accept hierarchical order.
2. **Individualism vs. Collectivism (IDV):** A reflection of civilizations in which people are expected to take care of themselves and their immediate family and relationships between people are weak. Societies with strong, cohesive in-groups that defend their members in return for allegiance are characterized by collectivism.
3. **Masculinity vs. Femininity (MAS):** Competitiveness, aggressiveness, ambition, and material achievement are valued in masculine cultures, whereas relationships, quality of life, and concern for others are valued in feminine cultures.
4. **Uncertainty Avoidance Index (UAI):** evaluates how much ambiguity and uncertainty a society can tolerate. Low UAI cultures are more laid-back and receptive to innovation and change, whereas high UAI cultures have strict rules of belief and behavior and are less at ease with change.
5. **Long-Term vs. Short-Term Orientation (LTO):** Cultures that are long-term oriented emphasize thrift, tenacity, and future benefits. Traditions, the established social order, and meeting social responsibilities are valued in short-term focused civilizations.

Geert Hofstede's cultural dimension theory is a foundational framework within the study of intercultural communication. Hofstede's theory helps in understanding cultural differences and their implications for communication, management, and

cooperation in a global context. Hofstede assumed that the "software of the mind" is formed throughout the socialization process, which is impacted by the culture in where the individual lives [5]. Cultural dimensions are an attempt to give a framework for studying cross-cultural differences among societies.

Hofstede et al. [1] has studied cultural values in 104 countries, the evaluation framework assesses each country on various dimensions using a scoring metric from 1 to 100. Within this scale, the highest score signifies the strongest alignment with the attributes of a given dimension. Since this research is based on Malaysia, it is important to explain Malaysia in each of the Hofstede Cultural Dimensions score index. The Malaysian cultural dimensions score index is displayed in Table 1.

Table 1. Malaysia score index of the cultural dimensions (Source : [6])

COUNTRIES	PDI	IDV	MAS	UAI	LTO	IVR
MALAYSIA	100	27	50	36	47	57

Malaysia is renowned for its cultural diversity, which serves as a major attraction for tourists and showcases the country's rich multicultural heritage. Malaysia is a plural society composed of various ethnic groups, each with its own language, religion, beliefs, values, customs, and cultural heritage. Racial and cultural diversity are defining characteristics of Malaysian society. This diversity includes cultures, religions, races, and ethnicities, making it a significant feature of the nation. Cultural practices in Malaysia are rooted in concepts such as learning, sharing, universality, inheritance, variability, symbolism, and an understanding of nature [7] of using these apps.

Since Malaysia's power distance score of 100 is the highest among the countries surveyed in Table 1, indicating a culture where the unequal distribution of power is widely accepted. In such high-power distance societies, social hierarchies are normative [8]. A cultural trait that has also been identified as a primary focus in previous studies of Malaysian websites.

In this case, Generation Z or iGeneration, consisting of individuals born between 1994 and 2010 is the newest employee group in the workforce and the current college population [9]. This generation is characterized by their birth into the digital era, making it difficult for them to imagine life without digital technologies [10]. Generation Z is a highly educated, tech-savvy, inventive, and creative group. Unlike their predecessors, Gen-Z is characterized by a heightened awareness of global issues, a strong inclination towards social justice, and an expectation for immediate access to information and services. However, people in the same generation often share similar beliefs and understandings, which influence their decisions and behaviors. These common traits help identify and understand the members of that generation [11]. The perception of generations is not just a demographic

categorization but it is a framework to understand variations in attitudes and behaviors across different age groups. Generations is very important because they offer insights into growing cultural norms and can foresee future trends.

Hence, there are studies on the characteristics of generation z and computers. Generation Z has always had access to information, internet and gadgets [9]. This generation relies and uses mobile devices to access the internet since 98% of them own a smartphone, tablet or laptop. Technology is not merely an instrument to them; it is part of life [12]. The emphasis of Generation Z concerns more on swiftness than accuracy. This generation grown up in a time of rapid technological advancement, user-friendly apps, iconography, and social media marketing [9], they have been found to have more daily visits to YouTube, Instagram, Tik Tok and other related apps compared to Millennials [13] where they favour a website with user friendly navigation structure [14].

Therefore, in understanding the growing dynamics of power and authority in contemporary settings is very important. Given their unique upbringing and values, it is related to examine whether Gen-Z's attitudes support the traditional cultural expectations of power dynamics or if they signify a shift towards new paradigms. Understanding Gen-Z's perception on power and authority is crucial as they increasingly influence and reform the global workforce and cultural landscapes. This research contributes to the larger discourse on generational studies and cultural dimensions, offering valuable insights for leaders and organizations aiming to adapt and thrive in a developing cultural environment.

2. MATERIALS AND METHODS

This study uses the Value Survey Module (VSM 94), an instrument used by Geert Hofstede to identify the cultural dimensions values. The VSM-94 is employed in this research to emulate and maintain consistency with prior studies conducted within the same context, thereby ensuring methodological alignment, comparability of findings, and the validity of cross-study interpretations. It contains 20 items to measure power distance, uncertainty avoidance, masculinity, term orientation, and individualism scores, and 6 demographic items. For power distance, the questions are in items No. 3, 6, 14 and 17 in the table below.

Table 2. Power Distance' Items

Item No	Power Distance Question
Q3	Have a good working relationship with your direct superior
Q16	Be consulted by your direct superior in his/her decisions

Q14	How frequently, in your experience, are subordinates afraid to express disagreement with their superiors
Q17	An organization structure in which certain subordinates have two bosses should be avoided at all cost

Table 3 below contains the formula to be utilized.

Table 3. Cultural Dimensions' Formular

Cultural Dimensions' Formulars
$PDI = -35m(Q3) + 35m(Q6) + 25m(Q14) - 20m(Q17) - 20$
$IDV = -50m(Q1) + 30m(Q2) + 20m(Q4) - 25m(Q8) + 130$
$MAS = +60m(Q5) - 20m(Q7) + 20m(Q15) - 70m(Q20) + 100$
$UAI = +25m(Q13) + 20m(Q16) - 50m(Q18) - 15m(Q19) + 120$
$LTO = -20m(Q10) + 20m(Q12) + 40$

The study focused on full-time diploma students at UTM's Kuala Lumpur campus. There are 769 such students in total. Based on Krejcie and Morgan table, a good number of sample sizes would be 260. We collected data using a Google Form from November 1st to December 15th, 2024. In the end, 288 students responded to our survey.

3. RESULTS AND DISCUSSION

According to the survey results, these are the latest Hofstede' scores based on the formula in Table 3.

Power Distance Index (PDI)

$$PDI = -35m(Q3) + 35m(Q6) + 25m(Q14) - 20m(Q17) - 20$$

$$PD \text{ Index} = -35(1.79) + 35(2.06) + 25(3.24) - 20(2.16) - 20 = \mathbf{18.25}$$

Individualism Index (IDV)

$$\text{IDV} = -50m(Q1) + 30m(Q2) + 20m(Q4) - 25m(Q8) + 130$$

$$\text{IDV Index} = -50(1.66) + 30(1.70) + 20(1.59) - 25(1.87) + 130 = \mathbf{83.05}$$

Masculinity Index (MAS)

$$\text{MAS} = +60m(Q5) - 20m(Q7) + 20m(Q15) - 70m(Q20) + 100$$

$$\text{MAS Index} = 60(1.66) - 20(1.60) + 20(3.32) - 70(2.75) + 100 = \mathbf{41.5}$$

Uncertainty Avoidance Index (UAI)

$$\text{UAI} = +25m(Q13) + 20m(Q16) - 50m(Q18) - 15m(Q19) + 120$$

$$\text{UAI Index} = 25(2.93) + 20(2.91) - 50(2.54) - 15(2.28) + 120 = \mathbf{90.25}$$

Table 4. New Cultural Dimensions' Score and Hofstede' Scores

CULTURAL DIMENSIONS	HOFSTEDE SCORES	RESULTS
Power Distance	100	18
Uncertainty Avoidance	36	90
Masculinity	50	41
Individualism	27	83
Long Term Orientation	47	40

The scores between our and Hofstede scores are presented in Table 4. Our Power Distance score is low when compared to Hofstede's results. Individualism and Uncertainty Avoidance have scores ranging from low to high. In contrast, the results for Long Term Orientation and Masculinity are rather comparable. We shall focus only on the dimension of Power Distance.

Several studies support the observed changes in Power Distance [8], [15]–[18]. Eringa et al. [15] found that differences from Hofstede's original scores have decreased, while de Mooij and Beniflah [16] highlighted differences in cultural values across generations. Beugelsdijk and Welzel [17] also found that education and occupation influence Power Distance, with higher levels of skilled employment associated with lower scores. In Malaysia, Nordin et al. [8] and Shaed et al. [18] reported a decline in the PDI from Hofstede's original score of 100, potentially due to globalization and increasing educational attainment. These changes suggest that traditional hierarchical and feudalistic values may be less pronounced among younger generations, particularly Generation Z.

In terms of generations, [19] stated that Generation X values independence and direct communication, Millennials prioritize meaningful work and collaboration, and Generation Z prefers digital interaction, flexibility, and authenticity while Baby Boomers value loyalty and job stability, prefer structured environments with

face-to-face communication, and favor traditional methods over rapid change so that recognizing generational differences is essential to improve synergy and enhance workplace performance. This is one of the reasons why there is a difference in convergence with Hofstede's original result.

The PDI results suggest that users from this context respond better to UI designs that minimise hierarchical structures, which supports more user-driven and exploratory interactions, ultimately influencing usability outcomes.

4. CONCLUSION

Examining our understanding of culture is important since different generations have different cultural views. Future cultural research utilizing Hofstede's theories must always consider the viewpoints of different generations. By understanding these differences, which show how cultures are always changing throughout time, researchers may gain a considerably more thorough and accurate understanding of how cultures operate. The need for implementing low PDI into the Malaysian context lies in encouraging more user autonomy, reducing hierarchical barriers, and enhancing overall usability and engagement in digital interfaces.

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REFERENCES

- [1] G. Hofstede, G. J. Hofstede, and M. Minkov, "Cultures and Organizations: Software of the Mind", 3rd ed. New York, NY, USA: McGraw-Hill, 2010.
- [2] J. Ferrante, "Sociology: A Global Perspective", 7th ed. Belmont, CA, USA: Thomson Wadsworth, 2008.
- [3] B. R. Kupperschmidt, "Multigeneration Employees: Strategies For Effective Management", *The Health Care Manager*, vol. 19, no. 1, pp. 65-76, 2000.
- [4] D. Lifintsev, C. Fleşeriu, and W. Wellbrock, "A Study Of The Attitude Of Generation Z To Cross-Cultural Interaction In Business", *Information & Media*, vol. 86, pp. 41-55, Dec. 2019.
- [5] M. Żemojtel-Piotrowska and J. Piotrowski, "Hofstede's Cultural Dimensions Theory", In *Encyclopedia Of Sexual Psychology And Behavior*, Springer International Publishing, 2023.
- [6] M. Minkov and A. Kaasa, "Do Dimensions Of Culture Exist Objectively? A Validation Of The Revised Minkov-Hofstede Model Of Culture With World Values Survey Items And Scores For 102 Countries", *Journal of International Management*, vol. 28, no. 4, p. 100971, Dec. 2022.
- [7] Zulkefli, "The Development Of The Malaysian Cultural Elements Framework", in *Proceeding of International Conference on Communication, Culture and Media*, 2019.

- [8] H. Nordin, N. L. M. Noor, and A. Nordin, "Impact of Power Distance Cultural Dimension In E-Learning Interface Design Among Malaysian Generation Z students", *IEEE Access*, vol. 10, pp. 64198–64210, June 2022, doi: 10.1109/ACCESS.2022.3182855.
- [9] A. J. Nicholas, "Preferred Learning Methods Of Generation Z," *Proc. Northeast Business & Econ. Assoc.*, pp. 208-211, 2020.
- [10] A. Ivanova and A. Smrikarov, "The New Generations Of Students And The Future of e-Learning In Higher Education", in *Proc. Int. Conf. e-Learning and the Knowledge Society (e-Learning '09)*, 2009, pp. 28–29.
- [11] Julisar, "Text-Book Versus E-book: Media For Learning Process In Generation Z", in *Proc. 2017 Int. Conf. Inf. Manage. Technol. (ICIMTech)*, Yogyakarta, Indonesia, 2017, pp. 139–143, doi: 10.1109/ICIMTech.2017.8103522.
- [12] D. Kalkhurst, "Untangling The Digital Generation: Gen Z Is Here", *Barnes & Noble Coll. Next*, 2018.
- [13] K. Claveria, "Generation Z: Characteristics And Educational Preferences", *Salesforce Quotable*, Aug. 2017.
- [14] J. Nielsen, "10 Usability Heuristics For User Interface Design", *Nielsen Norman Group*, Nov. 15, 2020.
- [15] K. Eringa, L. N. Caudron, K. Rieck, F. Xie, and T. Gerhardt, "How relevant are Hofstede's dimensions for inter-cultural studies? A replication of Hofstede's research among current international business students", *Research in Hospitality Management*, 5(1), 89–98.
- [16] M. de Mooij and J. Beniflah, "Measuring Cross-Cultural Differences Of Ethnic Groups Within Nations: Convergence Or Divergence Of Cultural Values? The Case Of The United States", *J. Int. Consum. Mark.*, vol. 28, no. 5, pp. 310–322, 2016.
- [17] S. Beugelsdijk and C. Welzel, "Dimensions And Dynamics Of National Culture: Synthesizing Hofstede With Inglehart", *J. Cross-Cult. Psychol.*, vol. 49, no. 10, pp. 1469–1505, 2018.
- [18] N. Shaed et al., "National Culture And Employee Participation In Decision-Making In Malaysia: A Conceptual Review", in *Proc. 7th Int. Conf. Soft Comput. Data Mining (SCDM)*, 2021, pp. 1–10.
- [19] S. Budhe, S. Verma, and P. Sharma, "Generational Differences In Technology Behavior: A Systematic Literature Review On The Preferences Of Generations X, Y And Z", *International Journal of Social Ecology and Sustainable Development (IJSESD)*, vol. 14, no. 1, pp. 1–20, 2023, doi: 10.4018/IJSESD.329312.

THE IMPACT OF ONLINE BANKING USAGE ON FINANCIAL MANAGEMENT BEHAVIOR AMONG UNIVERSITY STUDENTS

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ABSTRACT - This study reviews the impact of online banking usage on financial management behaviour among university students. A systematic literature review (SLR) was conducted using the PRISMA 2020 guidelines. Relevant studies were identified through the Scopus database between 2020 and 2025 using keywords related to online banking, financial behaviour, university students, and mobile banking. After the screening and eligibility process, five empirical studies were selected for analysis. The findings indicate that online banking positively influences financial management behaviour by improving saving habits, budgeting discipline, spending control, and financial awareness among university students. Digital financial literacy was found to strengthen the effectiveness of online banking, while perceived usefulness and ease of use encouraged greater adoption of mobile banking services. However, differences in technological access, socioeconomic background, and financial literacy levels may affect the extent of these benefits. Overall, the review highlights the importance of online banking and digital financial literacy in promoting responsible financial management among university students. The findings provide useful insights for universities and financial institutions in developing strategies to enhance students' financial well-being.

Keywords: Online Banking; Financial Behaviour; University Students; Mobile Banking; Digital Literacy.

1. INTRODUCTION

Online banking has changed the way university students handle personal financial activities. The increasing digitalization of banking services has made online banking an important tool for handling personal finances among young adults. Students often use the online banking systems to transfer money, monitor their spending, pay bills, or put aside savings regularly. These platforms provide speed, convenience, and real-time access to information on finance issues, ideal for transitioning students toward financial independence [1].

However, online banking influences financial management of student's behaviour in a way that is relatively complex. Most of the literature has cited that online banking

enhances budgeting discipline, financial awareness, and saving behaviour [1], [2]. On the other hand, some studies have revealed that the ease of digital transactions can lead to impulse spending. Students with lower financial literacy might misuse online banking features or fail to engage in appropriate financial planning. The ability of students to manage online banking has been proven to depend on digital financial literacy [3]. With such mixed findings, the true influence of online banking on financial behaviour is questionable among university students.

The current study reviews empirical literature analysing how the use of online banking influences saving behaviour, budgeting practices, spending control, and financial decision-making among university students. A review of the available empirical studies provides a more coherent insight into the various associations between online banking and financial management behaviours [1], [2], [3], [4], [5].

The current research reviews the empirical literature that analyses how online banking use influences saving behaviour, budgeting practices, spending control, and overall financial management behaviours.

2. MATERIALS AND METHODS

The literature search was carried out through Scopus between 2020 and 2025. The core search strings used were ("financial behaviour" OR "spending behaviour") AND ("university student" OR "college student"). Inclusion criteria were empirical peer-review studies involving university or college students that focus on online banking and report at least one financial behavioural outcome. Exclusion criteria included sources outside the years 2021 to 2025, non-articles, non-English sources, and sources that are not all open access. The PRISMA 2020 framework has been followed in guiding the process of this systematic review. This approach allows for the transparency and minimization of bias across the stage of the literature identification and screening. The use of PRISMA necessitated the pre-definition of search strategies and databases to ensure that all procedural steps, from initial database search to final inclusion of studies, were documented. Scopus was selected because it is one of the largest and most comprehensive databases for peer-reviewed academic literature, ensuring the quality and reliability of the studies included in this review.

2.1 PRISMA 2020 Flow Diagram

The search approach was designed to identify pertinent and accessible empirical research regarding university students' utilization of internet banking and financial management. This was done to make sure that the review was complete and organized.

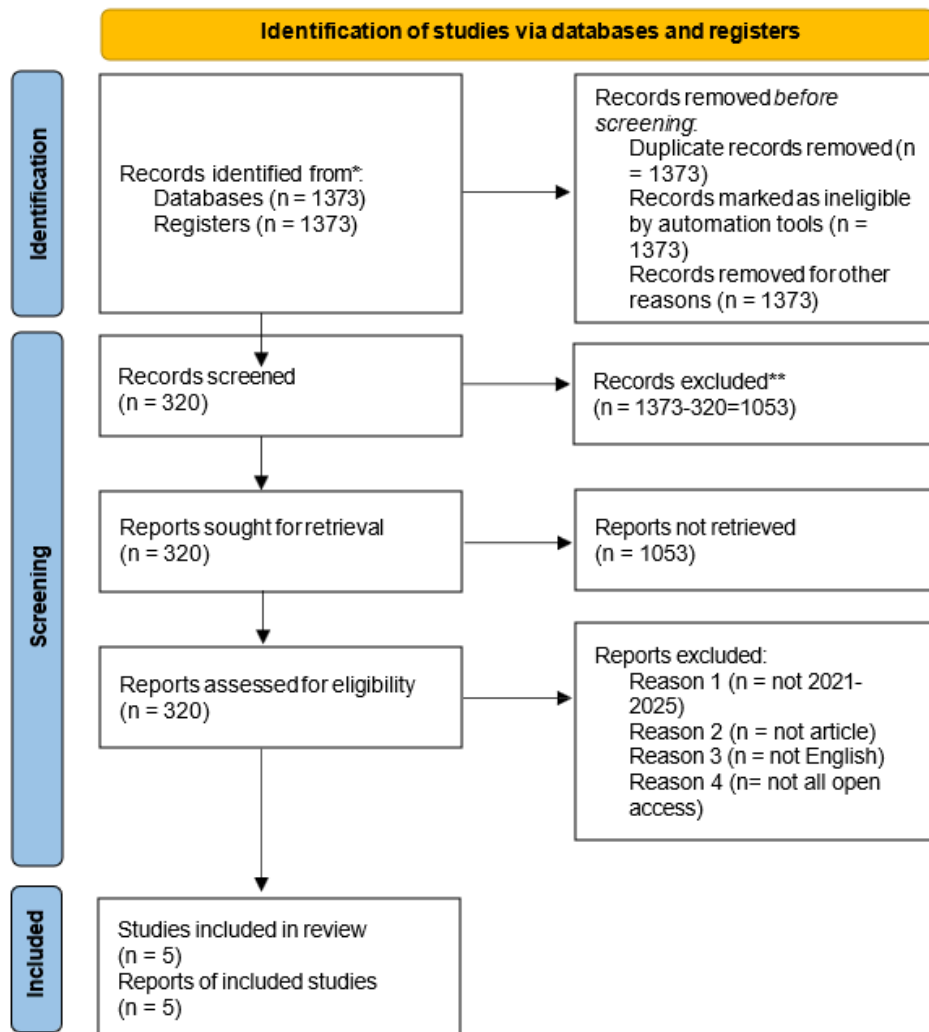


Figure 1. PRISMA Flow Diagram

The PRISMA 2020 flow diagram illustrates the systematic process used to identify, screen, assess, and select the studies included in this review. A total of 1,373 records were initially identified through the Scopus database. After screening the titles and abstracts, 320 records remained for further assessment. Full-text eligibility assessment was then conducted, and studies that did not meet the inclusion criteria, including those published outside the selected period, non-journal articles, non-English publications, and studies without open access, were excluded. Finally, five empirical studies satisfied all inclusion criteria and were included in the systematic literature review. This systematic selection process ensured that only relevant and high-quality studies were included in the final analysis.

3. RESULTS AND DISCUSSION

3.1 Study Selection

The systematic review used PRISMA guidelines, which led to the inclusion of five studies following screening. The initial search on Scopus found 1373 items. By carefully reading the titles and abstracts, the number of possible publications was narrowed down to 320. The full-text review of these 320 articles served as the final filter, where studies were excluded primarily for lacking a clear financial management behaviour outcome or for using non-student populations. This selection process, which resulted in five relevant studies, ensured that the foundation of this review contained only empirical evidence.

The studies included in the Compare-Contrast Matrix are varied but crucial as a whole for addressing the research objectives. The study was found in various contexts and employs varied theoretical lenses necessary in identifying the conditions of online banking usage. Each study directly or indirectly informs the relationships between the key constructs in Online Banking Use (OBU), Digital Financial Literacy (DFL), and Financial Management Behaviour (FMB). The matrix structure makes it easier to compare approaches and results in a systematic way. It enables critical synthesis in the subsequent subsections, demonstrating that DFL occupies a complicated and mediating function within the suggested conceptual.

Table 1. Compare-Contrast Matrix

Study	Context	Theory/ Lens	Key Constructs	Method/ Design	Sample size (<i>n</i>)
[3]	Ghana	Digital Financial Literacy Theory	Examine digital financial literacy and financial behaviour	Digital literacy, financial behaviour	<i>n</i> =350
[2]	Uganda	Saving Behaviour Theory	Online banking usage, saving behaviour	Quantitative survey	<i>n</i> =342
[4]	Latin America	Financial Behaviour Framework	Budgeting behaviour, saving habits, spending control	Quantitative, structured questionnaire	<i>n</i> =557
[5]	Nepal	Technology	Perceived	PLS-SEM	<i>n</i> =410

		Acceptance Model (TAM)	usefulness, ease of use, mobile banking adoption		
[1]	Malaysia	Digital Banking Behaviour	Digital banking services, saving discipline	Quantitative survey	<i>n</i> =280

These studies included in the review were conducted within a diverse set of geographical contexts, theoretical standpoints, and methodological approaches related to online banking usage among university students. Boateng and Sekyi [3] pointed out the role of digital financial literacy. Kisibo [2] incorporated the Saving Behaviour Theory to study saving behaviour in Uganda and demonstrated how online banking helped reinforce financial discipline. Mendoza-Ávila et al. [4] relied on the Financial Behaviour Framework for the study of budgeting, saving, and spending control and contributed with a larger sample and a strong measurement scale. Pokharel [5] utilized the Technology Acceptance Model to explain the students' adoption of mobile banking based on perceived usefulness and ease of use. Meanwhile, Rahman and Karim [1] focused their study on digital banking services and saving discipline within the Malaysian context.

The selected studies consistently report the positive effects of online banking on enhancing saving habits, financial awareness, and budgeting behaviour. The powerful means for empirical insights into regularities in financial conduct include quantitative surveys, structured questionnaires, and PLS-SEM. Aggregately, several variables from those studies outline the contribution of online banking usage to the determination of financial management behaviour among university students. These are the bases for further discussion on the influence of students' financial decisions as shaped by behavioral, technological, and literacy-related factors.

3.2 Theoretical Implications

This review enumerates the relevance of various behavioural and technological theories in explaining university students' adoption and usage of online banking platforms. It strongly verifies the Technology Acceptance Model, with perceived usefulness and ease of use found to influence the adoption of mobile and online banking across continuous student populations. The theory of saving behaviour has also been quite important. Students who regularly check their accounts and use digital saving tools are found better at saving money. The Digital Financial Literacy Theory explains the role of knowledge and skills in budgeting, spending, and saving decisions among students. The analysis of the assumptions collectively suggests that online banking serves a transactional tool and also a behavioural intervention that improves financial literacy and self-regulation. These augment traditional ideas of financial behaviour by highlighting psychological and technical factors that

affecting modern money management among young adults. This review contributes to the existing literature by integrating the Technology Acceptance Model, Saving Behaviour Theory, and Digital Financial Literacy Theory into a single framework for understanding students' financial management behaviour. The findings suggest that online banking adoption is not only influenced by technology acceptance factors but also by financial knowledge and behavioural self-regulation.

3.3 Why Differences Exist

These studies vary because of differences in the cultural contexts, technological infrastructures, and levels of financial literacy within the student groups under scrutiny. For example, students within technologically advanced environments are more likely to adopt online banking at a faster rate and use a greater range of services compared to others in less technologically advanced environments. In addition, there are differences in saving behaviors because students from lower-income backgrounds rely on online banking as a tool for tracking budgets, while other students use it more for convenience without any substantial impacts on their financial discipline. Variations in methods are also a consideration, such as cross-sectional designs versus structural equation modelling, and change the level of richness available within the behavioral insights. It is for these reasons that some studies observe rather strong positive impacts from online banking, while others yield mixed or weaker findings. The findings also provide practical implications for universities and financial institutions. Universities should strengthen financial literacy programmes and encourage students to use digital financial management tools. Financial institutions should develop user-friendly online banking applications and educational initiatives that promote responsible spending, budgeting, and saving behaviour among university students.

3.4 Limitations and Future Research

This review has limitations because it is based on a small number of empirical studies, and thus the generalization of findings is limited due to reliance on only one database. All the included studies were published in English, possibly excluding relevant research undertaken in non-English-speaking regions. The majority of the studies also utilized a cross-sectional design, which offers limited observation for detecting long-term changes in financial behaviour. The future studies should employ the experimental designs capable of capturing how online banking use to affects financial behaviour over time. Comparing regions may also help us learn about cultural and economic factors that shape how students handle money online. The further investigation of advanced digital financial tools could also broaden the understanding of financial behaviour within an increasingly digital financial landscape.

4. CONCLUSION

This review found that online banking positively influences financial management behavior among university students, particularly in saving, budgeting, and financial awareness. Digital financial literacy and perceived usefulness further strengthen these positive outcomes. Therefore, universities and financial institutions should continue promoting financial literacy and user-friendly digital banking services to support responsible financial behavior among students.

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REFERENCES

- [1] M. A. Rahman and M. R. Karim, "The effect of digital banking services on saving behaviour among university students," *International Journal of Digital Finance*, vol. 4, no. 3, pp. 112–125, 2022.
- [2] A. Kisibo, "Impact of online banking on saving behaviour among university students," *Journal of Finance and Digital Economy*, vol. 5, no. 2, pp. 45–58, 2023.
- [3] R. Boateng and F. Sekyi, "Digital financial literacy and financial behaviour among young adults," *Journal of Financial Capability*, vol. 7, no. 2, pp. 55–70, 2022.
- [4] J. R. Mendoza-Ávila, A. M. Erazo, G. A. Aguilar, F. S. Melgar, and H. G. Cáliz, "Analyzing financial behavior in undergraduate students in economics, administration and accounting sciences," MDPI, 2025.
- [5] S. Pokharel, "Factors influencing mobile banking adoption among university students: An application of the Technology Acceptance Model," *Journal of Digital Banking Research*, vol. 8, no. 1, pp. 23–37, 2023.

SOCIAL MEDIA PEER INFLUENCE AND ITS IMPACT ON CONSUMER PURCHASE INTENTION AMONG YOUNG ADULTS

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ABSTRACT – Peer pressure is increasingly influencing what young adults buy because the Internet is what they turn to most for learning, acceptance, and decision-making. Currently, peer cues outweigh the traditional advertisement because the Internet provides an opportunity for individuals to link up with others in a visible manner, including likes, comments, reviews, and sharing content. This article will use key theoretical perspectives related to the subject of peer-driven consumption behaviours of young adults by linking the Theory of Planned Behaviour, Social Influence Theory, Source Credibility Theory, and value perspectives contributed by consumers. A detailed analysis of existing empirical evidence related to the subject area will be synthesised using thematic analysis in order to identify key themes related to peer cues, psychological components, and web-based activity processes. Results indicate that peer influence is a factor which contributes positively to the aspiration of becoming a buyer. Psychological factors such as attitudes, trust, value, and credibility increase this impact. Reviews and content available on social platforms act as excellent examples of social proof. This impact may differ based on certain factors, including age, gender, culture, industry type, and the social platform being used. For example, Gen Z prefers visually engaging platforms, where the impact is always greater. This review highlights the importance of peer marketing, including genuine peer endorsement, social-media engagement, and user content campaigns, and offers a conceptual framework explaining the role of social-media peer influence on the psychological and technological aspects of young adults' purchasing behaviours. Additionally, this article provides a methodology for studying peer marketing on the Internet in future research.

Keywords: Social Media; Peer Influence; Purchase Intention; Young Adults; Digital Consumer Behaviour

1. INTRODUCTION

Young adults make their purchasing decisions based on social media peer influence which represents a critical business research concern both theoretically

and practically. The research investigates three social media influence mechanisms which previous studies demonstrated effectiveness but failed to establish standardized measurement methods. Previous studies proved that conformity to norms and injunctive norms are both associated with higher purchase intentions [1], [2]. Peer effects also influence food choices at the workplace [3]. The studies have shown that online reviews and brand image have essential roles in digital marketing outcomes [4], [5]. The results of research are not consistent because, while some studies point to the credibility of celebrities as the most important factor, others show that peer validation and communication provide better results. Research studies using hypothetical scenarios and regional samples also face obstacles when trying to achieve wide applicability. The research project will investigate how Southeast Asian young adults make buying decisions due to peer influence on social media regarding variations in product exposure and age. This research uses Theory of Planned Behaviour (TPB) and social influence theory to study digital environments without dependence on celebrity endorsement to deliver both theoretical insights and marketing strategies for peer-based market environments.

1.1 Objective

The study explores how social media peer influence shapes the purchasing decisions of young adults in Southeast Asia. Focusing on conformity, digital validation and user-generated content provide social proof authenticity in an online environment.

1.2 Research Questions

RQ1: To investigate the direct effort of social media peer influence on consumer purchase intention among young adults.

RQ2: To determine the moderating role of product type on the relationship between peer influence and purchase intention.

RQ3: To examine how generational differences within young adults influence the strength of peer-driven purchase intention.

2. MATERIALS AND METHODS

The study was carried out in the form of a systematic literature review, based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Studies on the social media peer influence and its effects on consumer purchase intention among young adults were identified using Scopus. The Boolean search string used was: ("social media peer influence" OR "peer recommendation") AND ("purchase intention") AND ("young adults" OR

"Gen Z"). Journal articles published in English between 2021 and 2025 and published in peer-reviewed journals were only considered.

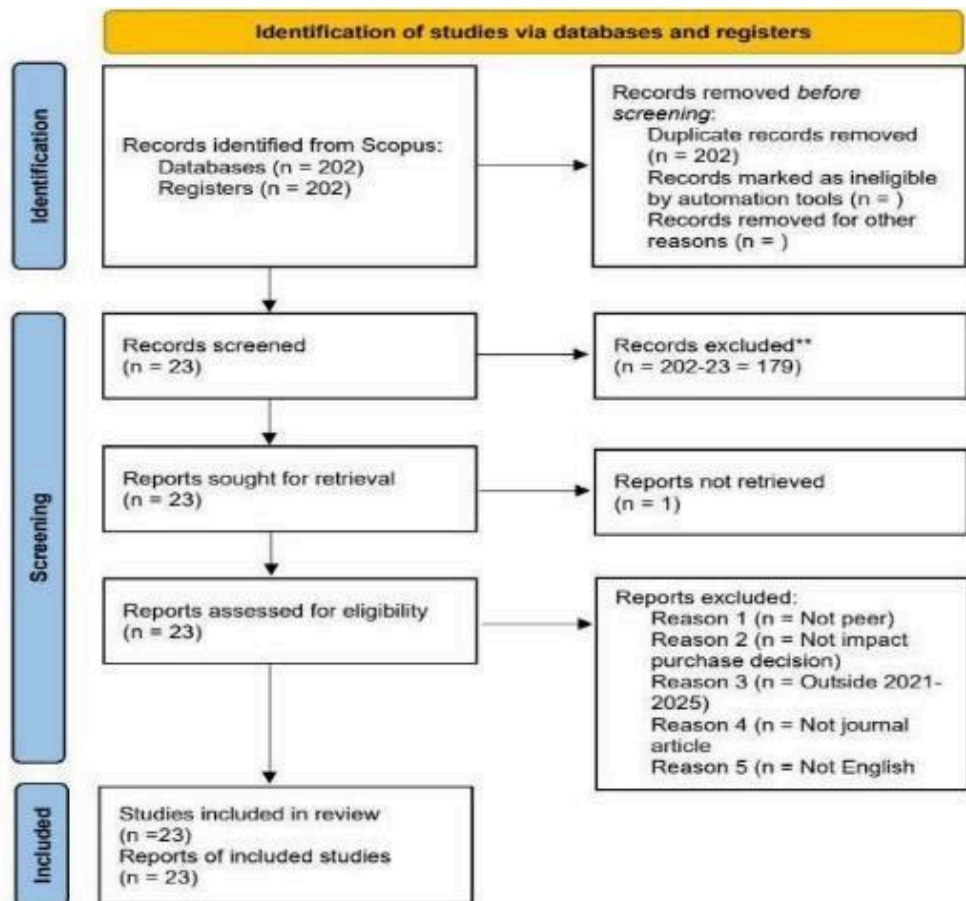


Figure 1. PRISMA Flow Diagram

Studies were included in the analysis if they were empirical, dealt with consumer attitudes, beliefs, peer influence, perceived value, and purchase intention in digital environments. Conceptual papers, non-consumer studies, and articles that did not relate to digital peer influence were not included. After screening titles and abstracts and assessing full text, 23 articles were included in the initial search. The selected studies were evaluated according to their relevance, theory, and methodology. Articles were coded with a compare and contrast matrix that included the theoretical framework, research context, key constructs, methods, findings, and limitations. Thematic analysis was used to analyze the coded data, which led to the identification of four main themes that were used to develop the conceptual framework.

Table 2. Compare-Contrast Matrix

Study (Year)	Theory/ Lens	Country / Context	Key Constructs	Methods	Main Finding	Notes (quality/ limits)
[8], (2024)	Theory of social comparison process. Human Relations	India, 120 Urban Consumers, Coimbatore City. Social media and brand engagement	Measured trust, attitude, norms, value, price, influencer impact, user content and brand engagement in the social media consumer decisions	Mixed methods, questionnaire, Principal Component Analysis, Regression, ANOVA T-test	Electronic Word-of-Mouth (eWOM), the influence of social media influencers (SMI), and perceived trust significantly increase a consumer's decision-making process, which ultimately leads to purchase intention	Limited to Coimbatore City, focus only on garment consumers and may not generalise to the broader populations or other sectors
[7], (2025)	Theory of generational cohort behaviour. Howe and Strauss	India, 343 Millennials and Gen Z consumers, Tamil Nadu. Dairy products and buying behaviour	Measured attitude, brand loyalty, price sensitivity, health concern, convenience, product variety, social media influence, peer impact, and sustainability values in dairy product buying decisions	Quantitative, questionnaire, convenience sampling, regression analysis	Peer participants significantly increased the buying behaviour of millennials and gen Z for Aavin dairy products	Limited to Tamil Nadu region, uses convenience sampling and may not generalize to broader populations
[4], (2024)	Theory of Planned Behaviour. Ajzen (1991)	South Africa, 203 Female Millennials, Johannesburg	Measured attitude, purchase intention, celebrity	Quantitative, questionnaire, simple random sampling,	Peer purchase intention is positively influenced	Limited to South African female millennials,

	Brand Equity Theory. Aaker (1991) Social Influence Theory. Bandura (2001), Kelman (1958)	rg. Beauty products and influencer marketing	credibility, celebrity attractiveness, brand loyalty, brand awareness, perceived quality, online customer reviews, and social media influence in beauty product decisions	structural equation modelling (PLS-SEM)	by online customer reviews, social media engagement, and perceived credibility of celebrity influencers, with significant effects on consumer attitude and purchase behaviour	focused on beauty products and may not generalize to other demographics or regions
[6], (2025)	Social Influence Theory. Bandura (2001), Kelman (1958) Social Learning Theory. Bandura (1977) Signaling Theory. Spence (1973)	Spain, 202 Gen Z participants aged 18-35, active social media users. Sustainable fashion consumption and digital peer influence	Measured digital communication exposure, peer influence, sustainable attitudes, sustainable behaviours, brand perception, social validation, and environmental concern in Gen Z fashion consumption	Quantitative, cross-sectional survey, convenience and snowball sampling, correlational analysis using SPSS	Peer purchase intention is positively influenced by digital communication exposure and peer validation, with significant effects on sustainable attitudes and behaviours among Gen Z consumers	Limited to Spanish Gen Z consumers, focused on sustainable fashion and digital engagement, and may not generalize to other age groups, cultures, or offline consumption contexts
[5], (2023)	Social Media Marketing Theory. Kim & Ko (2012), Keller & Kotler (2015) Brand Image Theory.	India, 410 social media active consumers from Delhi NCR. Social media marketing, brand image, and	Measured social media marketing activities, brand image perception, purchase intention, consumer trust, satisfaction, online	Quantitative, primary survey data, confirmatory factor analysis (CFA), structural equation modeling (CB-SEM) using	Peer purchase intention is positively influenced by social media marketing via brand image, with significant mediation	Limited to Indian social media users in Delhi NCR, focused on brand image and digital marketing and may not generalize to offline

	Malik et al. (2016), Johnson et al. (2001) Purchase Intention Framework k. Martins et al. (2019), Shaouf et al. (2016)	purchase intention in the consumer goods and digital marketing sector	engagement behaviour and information sharing frequency across digital platforms	AMOS, convenience sampling	effects. The direct impact of social media marketing on purchase intention is non-significant	consumers or other geographic regions
[10], (2022)	Social relations theory, Behavioural Constellations of Deprivation (BCD)	Singapore, low-income children's mobile phone decision-making	Interpretive activity (individualistic, dyadic, communal), strategic action (individualistic, relational, future-oriented)	Qualitative data analysis using NVivo	Digital divide, relational agency, scholarship-based purchasing dilemma	Limited of generalizability based on hypothetical scenario

According to the analysis, social media peer influence and digital marketing activities are important external factors that influence young adults' purchase intention based on the compare-and-contrast matrix. The results indicate that consumers are not only affected by formal marketing communications but also by recommendations from their peers, online conversations, and social interactions within digital platforms. The recurring patterns confirm the hypothesis that peer influence positively influences the purchase intention of consumers and guides the conceptual framework.

3. RESULTS AND DISCUSSION

3.1 Theme A – Peer Influence & Social Norms

Peer influence and social norms can be seen as consistently important predictors of purchase intention in young adults. For example, social media factors such as 'likes', 'comments', 'recommendations', and actual peer behaviour tend to affect consumer behaviour, proving that cues from peers affect the actual intention to make purchases [1], [4], [6]. These verified facts support relevant significant behavioural theories such as the Theory of Planned Behaviour or Social Influence Theory, which state that subjective norms can affect an individual's behavioural intention. Nevertheless, the degree of peer influence can vary based on several factors surrounding the peer cues, nature of the online platform, and demographic characteristics of the online users. Peer influence was found to be

more significant in online settings because when people interact online, such interactions are viewed by all, and they occur frequently.

3.2 Theme B – Attitude, Trust, and Value Drivers

In addition to perceived peer influence, various psychological factors are found to reinforce purchase intention. For instance, Ali and Naushad [5] as well as Rajalakshmi and Golden [7] discovered that consumers with favourable attitudes toward the brand or product are more likely to be converted into purchasing, particularly when adding further trusted peer endorsements. These variations arise mainly from the diversity of industries and particular groups of consumers analysed. Trust especially seems to matter more on the internet as consumers base trust largely on peer reviews and user opinions as they judge online credibility. The results indicate that the psychological factors complement peer influence in facilitating consumer confidence increases and risk perception decreases.

3.3 Theme C – Digital Peer Mechanisms

The review recognises too that digital channels greatly increase the force of peer pressure. User-generated content, online reviews, peer interactions and social media interactions are the leading contemporary channels through which peer influence is disseminated. Work such as that of Macheka et al. [4] and Reshma and Selvam [8] demonstrate that online reviews, by their nature user generated content, are sources of peer information which tend to be particularly credible when compared to traditional advertising. These mechanisms have the characteristic of "social proof", i.e. that users use the behaviour of others to guide their own decision making. Content developed for Gen Z responds strongly to visuals and short form content, while older generations prefer detailed reviews. In general, the results provide support for the notion that digital peer interaction is critical in shaping young adults' consumer behaviour.

3.4 Theme D – Demographic & Contextual Moderators

The influence of peers also impacts on demographics and context. Research reveals that age, gender and culture are interpreted by consumers. For instance, Macheka et al. [4] showed that female millennials of beauty markets are more impacted by peer endorsement whereas Rajalakshmi and Golden [7] found influence of authenticity and sustainability concern in Gen Z consumers. Situational factors, such as collectivist versus individualist cultures also determine the extent of peer influence. Peer effects in collectivist nations such as China and India, are stronger than in Western settings. Differences in methodological approaches, such as experiments versus surveys, also result in differences across studies. This suggests that peer norms are not uniform and their interpretation

should be contextualized within the social, cultural and demographic characteristic of the target population.

3.5 Conceptual Framework

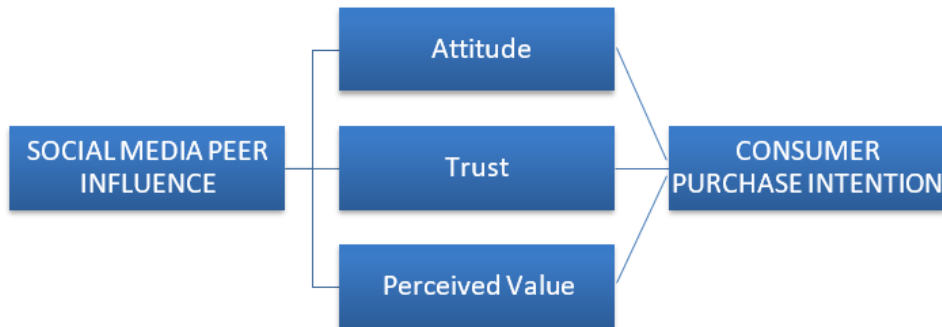


Figure 2. Conceptual Framework for Social Media Peer Influence and Purchase Intention

The conceptual framework illustrates how social media peer influence shapes young adults purchase intention. The results show that social media peer influence acts as the most critical factor regarding predicting attitude, trust, and perceived value. These models will in turn impact consumer purchase intention, which demonstrates how young adults make decisions when then are exposed to peer-forceful cues. This structure aligns with, for example, the Theory of Planned Behaviour, Social Influence Theory and value-based consumer models.

Peer influence is as also a significant factor in establishing credibility, because the trust consumers place in peer-generated content frequently exceeds their belief of company's marketing messages. Moreover, perceived value by showing the real-world uses cases, benefits and contentment through peer generated content. Purchase intention is influenced by attitude, trust and perceived value; consumers who form a good estimation, trust on information and perceive useful benefits tend to purchase the goods. Internet reviews and user-generated contents reinforce these relationships by magnifying the salience, credibility, and influence of peer actions in social networks.

3.6 Techniques and Tools Justification

The use of a quantitative survey is suitable as it enables efficient collection of responses from a large sample of young adults, who are social media users. This technique is commonly used in equivalent studies and is appropriate for psychological constructs such as attitude trust, and perceived value. The use of

validated Likert-scale instruments increases the reliability, since such scales have already been applicated in peer influence and consumer behaviour studies.

Online convenience sampling is appropriate for this sample since yound adults are the primary social media users. Regression analysis or SEM (Structural Equation Modelling) can be used to test the strength and significance of relationships that are hypothesised in the framework. SEM is particularly advantageous in that it can test several pathways at once and assess the fit of a model. Where the goal is to obtain qualitative interpretations, a thematic coding can be used in addition to quantitative findings to provide more complete views of digital peers' interactions. The methodological decisions are also consistent with work in the literature reviewed, again indicating the validity and comparability of results.

4. CONCLUSION

In conclusion, social media peer influence significantly affects young adults purchase intention. Understand this influence helps marketers design effective peer-based strategies and perceived value among consumers. These insights contribute to developing more authentic and engaging social media marketing approaches.

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REFERENCES

- [1] J. Wan, H. Ma, W. Zhou, M. Qin, and P. Li, "The study of female college students' consumer psychology mechanism toward male celebrity endorsed products: Tempted or coerced?," *Heliyon*, vol. 10, no. 9, Art. no. e30401, 2024, doi: 10.1016/j.heliyon.2024.e30401.
- [2] E. A. Wilhelms, E. Kirsch, and P. G. Brust-Renck, "What you think people do supersedes environmentalist beliefs when making sustainable purchases," *Journal of Community & Applied Social Psychology*, vol. 35, no. 6, 2025, doi: 10.1002/casp.70183.
- [3] D. E. Levy, M. C. Pachucki, A. J. O'Malley, B. Porneala, A. Yaqubi, and A. N. Thorndike, "Social connections and the healthfulness of food choices in an employee population," *Nature Human Behaviour*, vol. 5, no. 10, pp. 1349–1357, 2021, doi: 10.1038/s41562-021-01103-x.
- [4] T. Macheka, E. S. Quaye, and N. Ligaraba, "The effect of online customer reviews and celebrity endorsement on young female consumers' purchase

- intentions,” *Young Consumers*, vol. 25, no. 4, pp. 462–482, 2024, doi: 10.1108/YC-05-2023-1749.
- [5] I. Ali, M. Naushad, and H. Alasmri, “Effect of CSR activities on customers’ purchase intention: The mediating role of trust,” *Innovative Marketing*, vol. 19, no. 2, pp. 155–169, 2023, doi: 10.21511/im.19(2).2023.13.
- [6] J. L. Del Olmo Arriaga, M. Pretel-Jiménez, and C. Ruiz-Viñals, “From fast fashion to shared sustainability: The role of digital communication and policy in Generation Z’s consumption habits,” *Sustainability*, vol. 17, no. 18, Art. no. 8382, 2025, doi: 10.3390/su17188382.
- [7] R. Rajalakshmi and S. A. R. Golden, “Click, trust, purchase: The roles of attitude, subjective norms, perceived behavioural control and trust in shaping online consumer buying behaviour,” *Journal of Business and Economics Review*, vol. 9, no. 7, pp. 4302–4312, 2025.
- [8] K. Reshma and M. Selvam, “The impact of user-generated content on food purchase intention through TikTok,” *Journal of Contemporary Issues in Communication*, vol. 9, no. 1, pp. 89–102, 2024. [Online]. Available: <https://jcicom.usim.edu.my/index.php/journal/article/view/89>
- [9] S.-Z. Liang, J.-L. Xu, and E. Huang, “Comprehensive analysis of the effect of social influence and brand image on purchase intention,” *SAGE Open*, vol. 14, no. 1, pp. 1–13, 2024, doi: 10.1177/21582440231218771.
- [10] E. C. L. Goh and L. Kuczynski, “Relational dimensions in poor children’s decisions to obtain a mobile phone – the case of Singapore,” *Journal of Children and Media*, vol. 16, no. 1, pp. 41–57, 2022, doi: 10.1080/17482798.2021.1905675.

DESIGNING AN EXPLORATORY TVET CERTIFICATION FRAMEWORK FOR SPORTS PERFORMANCE ANALYSTS: A NETBALL-BASED MODEL FOR TEAM SPORTS

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ABSTRACT - Sports performance analysis has become a critical element in achieving competitive success. Information derived from the analysis must be transformed into actionable strategies that improve team dynamics and gameplay. As demand for certified sports performance analysts continues to grow, there is an urgent need for specialized educational programs tailored to sports with specific technical and tactical demands. This paper proposes an exploratory framework for a Technical and Vocational Education and Training (TVET) course designed to certified sports performance analysts based on netball game model. Netball, a sport predominantly played by women in Malaysia, presents complex technical and tactical challenges that require specialized competencies in analytical skills and strategic thinking, especially in the high stake's environment of contact-team sports. Based on netball game analysis the proposed courses within this exploratory framework emphasizes essential performance metrics such as shooting accuracy, passing efficiency, player positioning, decision-making under pressure, and offensive-defensive transitions. The main component of course are hands-on learning experiences allowing the students to analyse live or recorded game scenarios which support the development of practical skills needed for accurate and impactful analysis in real-world settings. With a strong foundation in big data analytics, the TVET course underscores the importance of certification in ensuring proficiency, consistency and reliability in sports analysis. By equipping analysts to address the specific demands of professional netball, this curriculum aims to elevate the quality and effectiveness of performance analysis in team sports, contributing to the border goal of cultivating a highly skilled workforce in the sports industry.

Keywords: Certified Sports Performance Analysts; TVET Course Development; Performance Analysis; Netball Analysis; Hands-On Learning

1. INTRODUCTION

Various options are available for obtaining tertiary education, with students choosing between technical and vocational education and training (TVET) institutions or higher education institutions. Although these two types of institutions represent different educational traditions, universities focusing on academic knowledge and TVET institutions on skills development for employability [1], both are essential for future development. Internationally, the trend of massification in higher education has transformed it from an 'elite' system into one that accommodates a larger number of students, particularly school leavers. This shift reflects a move away from a sole emphasis on transmitting academic knowledge, with a growing focus on skills development to enhance employability [1], [2]. In response to the demands of Industry 4.0, the Malaysian government has committed to rebranding its TVET sector under the initiative "TVET Malaysia." This initiative brings together TVET institutions from various ministries to adopt a unified approach, training young Malaysians with the necessary skills for a highly skilled technical workforce [3], including those needed in the sports industry.

Equipping individuals with technical and practical skills has become increasingly vital in the sports industry. *Kementerian Belia dan Sukan*, (KBS) has taken a significant step by introducing Sports TVET at the *Institusi Latihan Kemahiran Belia dan Sukan* (ILKBS) to strengthen skilled talent within the national sports sector [4]. As an initial effort, TVET in the Malaysian sports industry has been in place since 2015, beginning with courses such as Sports Therapy and Massage, as well as Golf Caddy Services. Additionally, KBS is set to expand Sports TVET programs to include Sports Facility Construction and Maintenance, Motorsports Technology (both 4-wheel and 2-wheel), and Sports Photography. Furthermore, the KBS has agreed to transform the *Institut Kemahiran Belia Negara* (IKBN) Kuala Langat into the *Institut Kemahiran Sukan Negara* (IKSN) to accelerate the development of sports-focused TVET program. In addition, the KBS and *Kementerian Kemajuan Desa dan Wilayah* also agree to choose one of their TVET institutions will be transform into a training centre for TVET e-sports [5]. The special TVET e-sports program will include skills in journalism, e-sports commentary, broadcast production, team management, coaching, event organization, and technical work.

The emergence of Artificial Intelligence (AI), Virtual Reality (VR), Augmented Reality (AR), data analytics, and other emerging technologies is transforming the landscape of sports training and performance analysis. These innovations provide athletes with advanced training environments that simulate real-world conditions, enhancing skill development. Moreover, real-time data visualization offers instant feedback on performance, helping athletes make immediate adjustments. These technologies also aid in preventing overtraining by monitoring and providing performance data in real time. During gameplay, AI and AR can deliver immediate visual feedback, supporting both players and coaches in making more informed and strategic decisions [6], [7]. As such, sport performance analysis has become a

crucial area of focus within the sports industry, particularly in the context of TVET, which should be explored further to meet the industry's evolving needs [8].

The objective of this article is to propose an exploratory TVET course framework tailored to the demands of the sports job market, specifically in the field of sports performance analysis. The exploratory framework is designed to develop certified sports performance analysts by integrating fundamental principles of performance analysis with practical skills in data collection, statistical tools, and reporting, applied to sport-specific contexts in real-world scenarios. This article uses netball as a case study to provide contextual insights applicable to team sports. It emphasizes incorporating internships, case studies, and project-based learning to ensure practical readiness for learners. Additionally, the article integrates a concept paper with example data derived from the performance analysis of a netball team competing at a regional-level competition. The data is presented and analysed to illustrate practical applications. By embedding data-driven insights into the curriculum, this exploratory framework addresses the evolving demands of the sports industry while fostering innovation and excellence in the field of performance analysis.

1.1 Performance Analysis in Sports

1.1.1 Sports in the Era of Industrial Revolution 4.0

The era of digital transformation, driven by the integration of cyber-physical systems, the Internet of Things (IoT), artificial intelligence (AI), and big data analytics, has emerged across various sectors, including sports. This technological shift has revolutionized how sports are played, analysed, and managed. Advancements in smart wearable, real-time performance tracking, and AI-driven analytics have significantly enhanced athlete training, injury prevention, technical skills, tactical approaches, and game strategies. Sports scientists should seize these opportunities, while academia should capitalize on this evolution by expanding research and educational programs to create job opportunities at all qualification levels, including roles such as sports performance analysts.

The integration of AI and data mining presents new opportunities for future research in sports analytics. Non-data scientists in the sports field should explore and understand the impact of AI and machine learning on game strategies, player performance evaluation, and injury prevention [9]. Additionally, emerging technologies and algorithmic advancements contribute to real-time tracking innovations and deep learning models for performance prediction [7]. The incorporation of wearable and IoT devices has further improved real-time data collection, allowing for precise monitoring of player workload and biomechanics, which significantly aids in injury prevention, performance enhancement, and strategic planning in competitive sports. With the ability to automate data collection,

improve predictive modelling, and support decision-making [7], [9], the Fourth Industrial Revolution (IR 4.0) empowers athletes, coaches, and management teams to elevate their approach to game intelligence, data-driven decision-making, and overall performance optimization [10].

However, despite the increasing influence of AI, challenges such as data privacy, computational complexity, and model interpretability continue to be significant concerns [7]. Therefore, it is essential to prioritize the development of ethical AI frameworks, enhance algorithmic transparency, and promote interdisciplinary collaboration between data scientists and sports professionals. These aspects should be emphasized when designing curricula to certify computational experts and sports performance analysts.

1.1.2 Performance analysis in Netball

Netball is a highly popular sport among Malaysian women [11]. It is an intermittent, court-based sport characterized by high-intensity multidirectional movements, interspersed with short periods of lower-intensity activity [12]. The game consists of seven players, each occupying a specific position on the court, which requires a unique combination of physical demands and technical capabilities [13].

Performance analysis has been conducted to explore various aspects of netball, including match-play movement characteristics, passing network characteristics, technical performance and tactical behaviour, style of play, skill expertise, physical, physiological and positional demand, and critical indicators of success in netball [12], [13], [14]. These perspectives are primarily used to provide feedback to coaches, players, and other stakeholders to support the achievement of specific objectives. These studies indicated that the performance analysis research in netball already incorporates the IoT, AI, and big data analytics and applied smart wearable, real-time tracking, and AI-driven analytics to improve various aspects such as training, injury prevention, movement sequences, technical and tactical skills, and game strategies. Findings from above studies offers a foundational understanding of the challenges related to performance analysis in netball and serves as a guide for developing a curriculum for sports performance analysts in team sports competitions.

The diverse perspectives on performance analysis in netball illustrate the need for a comprehensive framework that not only enhances the quality of performance analysis in team sports but also contributes to workforce development within Malaysia's sports industry. An example of embedding performance analysis concepts can be seen in the data derived from a netball team competing in a regional-level competition. The findings highlight the significant contributions of data analytics in improving team strategies, enhancing player performance, and supporting decision-making during competitions.

2. MATERIALS AND METHODS

The research consists of two stages. Stage 1 involves exploring information related to sports performance analysis from a TVET perspective. Stage 2 involves video performance analysis of a selected netball team. As the study focuses on exploring the potential of sports performance analysts as a TVET-related job scope, information was gathered from various sources, including literature, news articles, webpages, academic writings, and informal discussions with TVET and sports experts during Stage 1 of the study. The gathered information was then synthesized, and ideas were constructed to identify important courses or modules and to form the basic structure of the exploratory framework.

In the second stage of study, a selected team of 12 netball players, aged between 20 and 35, competing in a regional netball tournament was recorded. The team participated in four games but was eliminated in the group stage, failing to advance to the next round. The recorded videos have a total duration of approximately 30 minutes, with each match consisting of two 15-minute quarters and a 3-minute interval between them. While various video analysis methods can be used to assess performance, this study manually analysed the footage. The purpose of manual analysis is to establish a fundamental understanding of performance assessment using basic skills before integrating current or emerging technologies. Findings from both stages are integrated to structurally form the exploratory TVET sports performance analysis framework, which consists of proposed suitable courses and modules tailored to current industry demands.

3. RESULTS AND DISCUSSION

3.1 Stage 1 – Exploring sports performance analysis from a TVET Perspective

Based on information exploration, a basic understanding of sports performance analysis and the job scope is essential for developing courses to certify sports performance analysts. The courses or modules should include both theoretical and practical components, with an emphasis on using technology and systematic methods to analyze the technical and tactical aspects of different types of sports. Understanding the nature of the sport, whether it is categorized as team, racket, invasion, target, combat, or other types, is fundamental for developing the structure of sports performance analysis variables. Consequently, the ideas constructed from this stage require further investigation using real performance data. For this purpose, a netball game was used as the case study in this research.

3.2 Stage 2 – Netball video performance analysis

The analysis begins by evaluating the team's Centre Pass (CP) performance in each game. The team demonstrated strong CP execution, successfully converting them into goals in the first and second games as shown in Table 1. However, their performance significantly declined in the third game, preventing them from advancing to the next round.

Table 1. Centre Pass Performance on Each Game

Center pass (CP)	1 st Half			2 nd Half			Score	Result	CP to a successful goal
	Win	Lost	Successful Turnover	Win	Lost	Successful Turnover			
Game 1	3	3	2	3	2	2	10	Draw	10/11 (90.9%)
Game 2	3	2	1	3	3	3	10	Lost	10/11 (90.9%)
Game 3	2	4	1	2	5	0	5	Lost	5/13 (38.5%)

The analysis of shooting accuracy among the shooters reveals that two players maintained a strong performance with accuracy above 80%. Although one shooter recorded a lower percentage, overall, all shooters achieved an accuracy rate exceeding 80% as shown in Table 2. An analysis was also conducted to assess the faults committed by each player as shown in Table 3 and the turnovers that occurred when the team lost possession before attempting a shot as shown in Table 4. The results indicate that obstruction and contact penalties were the most frequent faults leading to loss of possession. Additionally, the analysis of turnovers across the three games identified various causes, including errors (e.g., stepping, held ball, offside, breaking), intercepts by the opposing team, and poor passes (e.g., overthrown or misdirected passes).

Table 2. Shooting Accuracy of Players throughout the Game

Player	Position	Goal Attempt	Goal	Percentage of goal accuracy
Player 1	GS/GA	20	17	85%
Player 2	GA	5	4	80%
Player 3	GS	6	4	67%
TOTAL	GS/GA	31	25	81%

Table 3. Types of Faults by Players

Player	Position	Contact	Obstruction	Offside	Breaking	Turnover (bad pass)
Player 1	GS/GA		2			3
Player 2	GA/C	1	2		1	10
Player 3	GS		1			1

Player 4	C/WA					7
Player 5	WA/WD	2	4	1	1	3
Player 6	WD/GD	3	1			3
Player 7	GD/GK					1
Player 8	GD/GK	1	3			3
Player 9	C/GK	1	1			6
Player 10	GK	1	5			1

Table 4. Types of turnovers (loses possession)

Types of turnovers	Game 1	Game 2	Game 3	TOTAL
Pass intercepted ('clean interception')	3	4	7	14
Poor passing (Outball, Short pass)	10	8	4	22
Dropped ball (replay)	1	-	-	1
Held ball	-	-	2	2

Overall, the findings from the analysis offer valuable insights for the coach and management team regarding key technical skills and tactical behaviours that require improvement. Additionally, further analysis of the opposition's footage could be utilized to strategically refine game tactics for future competitions, as this tournament is held annually.

3.3 Proposed an Exploratory TVET Framework

This section presents a proposed TVET course structure based on information exploration activities, with a focus on team sports, specifically netball. The objective of this exploratory framework is to develop skilled sports performance analysts with expertise in data interpretation, technological proficiency, and sport-specific knowledge. Figure 1 illustrates the initial concept of the exploratory framework, derived from literature and data-driven insights on netball performance analysis.

A sports performance analyst can be defined as a professional who applies sports analytics techniques to extract meaningful insights from data. They serve as interpreters, converting raw statistics and patterns into valuable information that coaches, players, and organizations can use to enhance performance. Their role involves various key responsibilities, including data collection through software, wearable devices, or manual observation, as well as organizing and refining datasets for further analysis. Performance analysts then apply statistical methods to interpret this data, presenting their findings through reports, graphs, and visualizations. Additionally, they provide strategic recommendations, such as tactical adjustments based on opponent analysis or identifying areas where individual players or teams need improvement. Many analysts specialize in specific areas of sports

performance, such as offensive strategies, defensive structures, or player workload management.

In netball, for instance, a sports performance analyst may identify a recurring issue where a team frequently loses possession during the second phase of the centre pass [12]. By analysing data trends, they can suggest targeted drills and strategies to improve player decision-making and positioning in this critical phase of play. Such insights help teams address weaknesses, refine game tactics, and enhance overall performance. The role of a sports performance analyst extends beyond just identifying problems; they also contribute to developing data-driven solutions that directly impact gameplay efficiency and effectiveness.

To successfully integrate data-driven decision-making in netball, performance analysts must collaborate closely with coaches, players, and management teams. This partnership ensures that insights derived from data influence essential aspects such as game strategies, training programs, and injury prevention measures [12], [13], [14]. Real-time performance tracking [12], [14] allows coaches and players to make informed adjustments during matches, while management can leverage data for long-term strategic planning. By fostering a unified approach, teams can fully utilize analytics to optimize performance, enhance training methodologies, and minimize injury risks. Ultimately, the synergy between performance analysts and other stakeholders is crucial for maximizing the benefits of data in the evolving landscape of modern netball.

In addition, sports performance analysts have strong potential for future employment, as several institutions require this expertise. In Malaysia, sports performance analysts are needed at the National Sports Institute (*Institut Sukan Negara*) to analyze various types of sports with different rules and competition structures. As soccer is the most popular sport in Malaysia, sports performance analysts are also needed at state-level and professional football associations. Moreover, sports performance analysts serve in the Malaysian Badminton Association and Malaysian Archery Association, providing informative feedback to coaches and players. The demand for these jobs is further supported by the establishment of professional associations at the Asian level (e.g., International Society of Performance Analysis of Sport Asia – ISPASA) and at the international level (e.g., Association of Sport Performance Analysts – ASPA), highlighting the recognized need for certified sports performance analysts in the global sports industry.

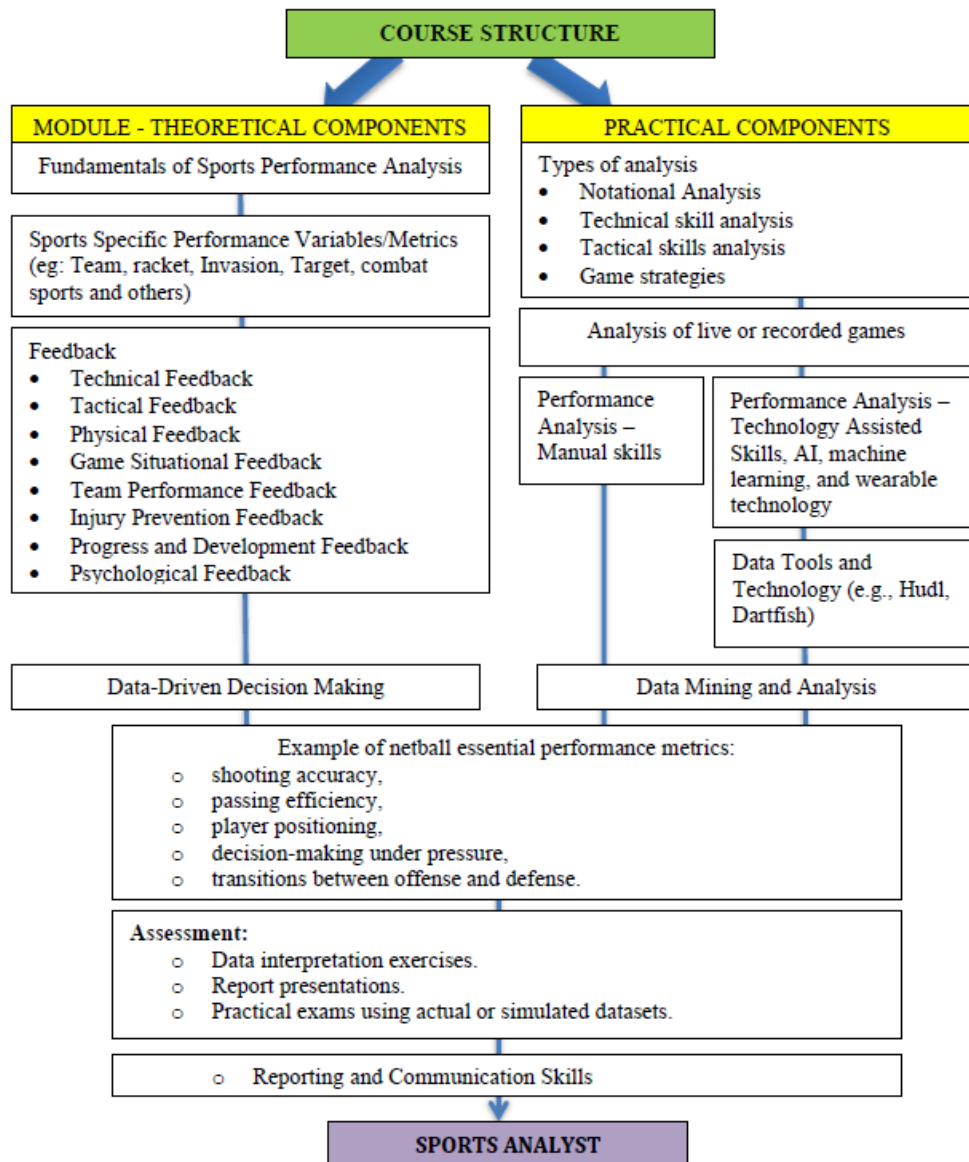


Figure 1. Proposed exploratory TVET course framework based on a netball performance analysis model

4. CONCLUSION

The exploratory framework emphasizes the role of data-driven insights in designing effective TVET programs for sports performance analysts. Collaboration between

TVET institutions, sports organizations, and technology providers is essential to ensure that curricula remain aligned with industry developments. Continuous updates to training programs will help performance analysts stay ahead of emerging trends, equipping them with the necessary skills to adapt to the evolving landscape of sports analytics.

To successfully implement a performance analysis program and develop expert sports performance analysts, the initiative must involve Industry Lead Bodies (ILBs). Additionally, the skill certification curriculum will be overseen by the National Occupational Skill Standards (NOSS) under the *Jabatan Pembangunan Kemahiran* (JPK) (Department of Skills Development), which operates under the Ministry of Human Resources [15]. This exploratory certification framework will ensure that aspiring sports performance analysts receive formal recognition of their skills, further strengthening their professional credibility and employability in the sports industry.

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REFERENCES

- [1] R. Maclean and M. Pavlova, "Skills development for employability (TVET) in higher education: Issues and challenges," *Journal of Asian Public Policy*, vol. 4, no. 3, pp. 321–330, 2011.
- [2] C. Evans, G. Rees, C. Taylor, and S. Fox, "A liberal higher education for all? The massification of higher education and its implications for graduates' participation in civil society," *Higher Education*, vol. 81, no. 3, pp. 521–535, 2021.
- [3] R. Hassan, L. M. Foong, and A. A. Ismail, "TVET in Malaysia," in *Vocational Education and Training in ASEAN Member States: Current Status and Future Development*, pp. 109–132, 2019.
- [4] Kementerian Belia dan Sukan Malaysia, "TVET Sukan: Hasrat baharu Kementerian Belia dan Sukan," Siaran Media Kementerian Belia dan Sukan, KBS:78/2024, 2024. [Online]. Available: <https://www.kbs.gov.my/pusat-media/kenyataan-media/270-kenyataan-media-2024.html?download=2523:tv-et-sukan-hasrat-baharu-kementerian-belia-dan-sukan>
- [5] Bernama, "Sebuah institusi di bawah KBS, KKDW dijadikan pusat latihan TVET e-sports," *Astro Awani*, 2024. [Online]. Available: <https://www.astroawani.com/berita-malaysia/sebuah-institusi-di-bawah-kbs-kkdw-dijadikan-pusat-latihan-tvet-esports-475725>

- [6] V. R. Cossich, D. Carlgren, R. J. Holash, and L. Katz, “Technological breakthroughs in sport: Current practice and future potential of artificial intelligence, virtual reality, augmented reality, and modern data visualization in performance analysis,” *Applied Sciences*, vol. 13, no. 23, Art. no. 12965, 2023.
- [7] I. Ghosh, S. Ramasamy Ramamurthy, A. Chakma, and N. Roy, “Sports analytics review: Artificial intelligence applications, emerging technologies, and algorithmic perspective,” *Wiley Interdisciplinary Reviews: Data Mining and Knowledge Discovery*, vol. 13, no. 5, Art. no. e1496, 2023.
- [8] J. R. Todorovich, *Sport Performance Analytic Methods*. Human Kinetics, 2025.
- [9] N. Chmait and H. Westerbeek, “Artificial intelligence and machine learning in sport research: An introduction for non-data scientists,” *Frontiers in Sports and Active Living*, vol. 3, Art. no. 682287, 2021. [10] B. S. Baumer, G. J. Matthews, and Q. Nguyen, “Big ideas in sports analytics and statistical tools for their investigation,” *Wiley Interdisciplinary Reviews: Computational Statistics*, vol. 15, no. 6, Art. no. e1612, 2023.
- [11] S. Khoo and N. E. Z. Abidin, “Sport in Malaysia: Towards gender equality,” in *Women and Sport in Asia*, R. L. de D’Amico, M. K. Jahromi, and M. L. M. Guinto, Eds. Routledge, 2021, pp. 124–135.
- [12] L. Mackay, B. Jones, D. C. C. J. van Rensburg, F. Hall, L. Alexander, K. Atkinson, P. Baldrey, A. Bedford, S. Cormack, and J. Clarke, “Consensus on a netball video analysis framework of descriptors and definitions by the netball video analysis consensus group,” *British Journal of Sports Medicine*, vol. 57, no. 8, pp. 441–449, 2023.
- [13] A. J. Sweeting, R. J. Aughey, S. J. Cormack, and S. Morgan, “Discovering frequently recurring movement sequences in team-sport athlete spatiotemporal data,” *Journal of Sports Sciences*, vol. 35, no. 24, pp. 2439–2445, 2017.
- [14] R. W. Hodder, W. G. Hopkins, K. A. Ball, J. Bahnisch, and F. R. Serpiello, “Exploration of collective tactical variables in elite netball: An analysis of team and sub-group positioning behaviours,” *PLOS ONE*, vol. 19, no. 2, Art. no. e0295787, 2024.
- [15] R. B. Jamaludin, A. H. A. Hamid, and B. S. Alias, “Empowering technical and vocational education and training (TVET),” *International Journal of Academic Research in Business and Social Sciences*, vol. 13, no. 12, 2023.

GREEN INITIATIVES IN UNIVERSITI TEKNOLOGI MALAYSIA KUALA LUMPUR: CHALLENGES AND SOLUTIONS

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ABSTRACT - In 2022, Universiti Teknologi Malaysia (UTM) demonstrated significant strides towards sustainability, evident through its notable rankings in the UI Green Metrics and THE Impact Ranking. UTM secured the 13th position among Malaysian universities in the UI Green Metrics and attained first place in Sustainable Development Goals (SDGs) 7 and 9 categories in Malaysia according to THE Impact Ranking. These international rating systems serve as valuable tools for evaluating and ranking green campuses based on diverse sustainability criteria, highlighting the pivotal role of such assessments in fostering environmental stewardship within academic institutions. Building upon these achievements, efforts to enhance sustainability at UTM must be intensified to cultivate a robust green campus culture in alignment with the objectives of the Malaysia Green Technology Master Plan 2017–2030. The objectives of this study are to identify existing green initiatives and their challenges at Universiti Teknologi Malaysia Kuala Lumpur (UTMKL). A comprehensive method involving interviews and site visits has been undertaken. This includes interview session with UTM Campus Sustainability (UTMCS) and UTMKL Jabatan Harta Bina to gather information on various sustainability initiatives such as recycling centres, solar systems, micromobility, rainwater harvesting systems, sustainability assessment reports, EV charge stations, urban gardens, and LED lamp installations. By identifying existing green initiatives and their challenges, this study proposes solutions and approaches to further advance sustainability initiatives at UTMKL and foster a thriving green campus culture. Through interdisciplinary collaboration and stakeholder engagement, UTMKL is poised to lead the way in sustainable campus development, contributing to Malaysia's broader sustainability goals.

Keywords: Green Campus; Green Initiatives; Sustainable Development

1. INTRODUCTION

According to Gholami *et al.* [1], in response to the call of the 17 Sustainable Development Goals (SDGs) aimed at "Changing Our World," Higher Education Institutions (HEIs) play a crucial role in achieving sustainable development [1]. Concurrently, they are instrumental in fulfilling the primary objective of Malaysia's Green Technology Master Plan 2017-2030, which emphasizes enhancing sustainability in close collaboration with higher education institutions through

university centres of excellence. This highlights the pivotal role of education, particularly among young people, in fostering sustainable green development. Consequently, the implementation of green initiatives within higher education institutions becomes imperative to ensure ongoing sustainability.

The Green Campus initiative represents an open approach to implementing green development within universities. As suggested by Maria Dimova & Stirk [2], such an initiative can yield long-term benefits by facilitating continuous environmental improvement within the campus community [2]. This can be accomplished through educational initiatives and the execution of projects aligned with various themes, including settings and infrastructure, energy and climate change, waste management, water conservation, transportation, and education. Also, it serves as a platform for advancing the SDG agenda and educating the next generation about the significance of sustainability initiatives, which will have an enormous impact on people, the environment, and the economy.

UTM has established the UTM Sustainability Blueprint 2030 in order to provide clear direction and contribute significantly in developing sustainable campus [3]. UTM demonstrated significant progress in sustainability, as reflected in its commendable rankings in the UI Green Metrics and THE Impact Ranking [4],[5]. The emergence of a rating tool enables universities to incorporate sustainable concepts into their operations within the framework of Sustainability Environmental Assessment (SEA). Consequently, universities can engage in more proactive competition to elevate the sustainability standards on their campuses. Moreover, this rating tool is founded upon a framework encompassing concepts such as environment, economy, equity, green building, and education for sustainable development (ESD) [6]. Hence, the endeavours aimed at cultivating a green campus and fostering a green campus culture among UTMKL campus residents represent the zenith of research. These efforts enable UTMKL to assess the implemented green initiatives and increase the level of awareness regarding green campus culture among its residents, as a study by Sadeli *et al.* [7] showed that the level of green awareness implementation perceived by students on the UTMKL campus was at a moderate level [7]. Simultaneously, they empower the institution to propose enhancements to green initiatives, thereby ensuring that participation and outcomes in sustainability endeavours attain the status of a recognized green campus.

2. MATERIALS AND METHODS

Interviews and site visit were conducted with multiple stakeholders to ascertain the green initiatives undertaken at UTMKL. Additionally, the interviews aimed to identify any challenges encountered in implementing these initiatives and solicit suggestions for future improvements in campus sustainability. This includes site visit to UTM Campus Sustainability (UTMCS) and UTMKL Jabatan Harta Bina.

Interview sessions with Mr. Mokhtar, a civil engineer at the UTMKL Jabatan Harta Bina, and Prof. Assoc. Ir. Dr. Shamsul Bin Sarip, the deputy director of UTM Campus Sustainability (UTMCS) was conducted to gather information on various sustainability initiatives in UTMKL campus. Site visit includes UTM solar carpark system and rainwater harvesting system in MJIT building. The findings from this initial investigation are pivotal in recognizing the efforts towards developing a green campus and engaging students, as well as obtaining input from stakeholders on enhancing green awareness on campus.

3. RESULTS AND DISCUSSION

Following the data collection and site visits, eight green initiatives have been identified at UTMKL, as visually represented in Figure 1. These include:

1. Solar carpark system
2. Rainwater harvesting system
3. Micromobility
4. Sustainability assessment (UTM Green Leaf)
5. Re-fabricate recycling
6. Installation of LED lamps
7. EV charging stations
8. Digital urban garden

There are 70,640 square feet of solar panels installed on top of the parking lot at UTMKL. With 3283 panels installed, the total installed capacity of the panels is one megawatt and 3440 KWH of energy is produced on average each day. This solar panel has been made from silicon. The silicon atoms' electrons will excite with the photons when the sun's rays hit the panel, creating an electric current. After leaving the panel and entering the inventor, the direct electric current (DC) will change into alternating current (AC). The generated AC will first pass via a transformer to increase its voltage to 11 kV, after which it will enter the TNB distribution grid directly.

A rainwater harvesting system is a technological innovation that gathers precipitation from various surfaces, such as highways, man-made sheet runs, rooftops, and catchment areas, in order to preserve water. Then, it will proceed through the steps of storing, purifying, and supplying water to the following system. The rainwater harvesting systems in UTMKL are only used in the UTMKL mosque and the MJIT building. Rainwater will be gathered via the roof and directed towards the water storage section at the structure's base. The rainwater collection system will power the toilet flush system, and this has led to water savings at UTMKL and a decrease in water expenses.



Re-fabricate recycling



Solar carpark system



Rainwater harvesting system



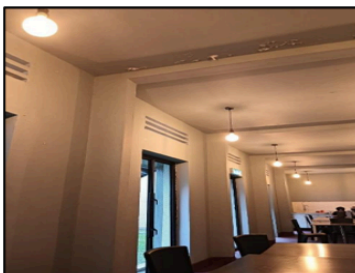
Digital urban garden at Sungai Bunus



EV charging stations



Micromobility (Electric Scooter)



Installation of LED lamps



Sustainability Assessment (UTM Green Leaf)

Figure 1. Green Initiatives in UTMKL

One of UTMKL's initiatives to meet the SDG's demand for net-zero emissions is micromobility. It's a recent addition to the campus's green initiatives. Micromobility describes light, compact vehicles like electric scooters or bicycles. This vehicle can only be used by one person at a time and has a speed limit of 25 km/h. BEAM is an electric scooter used at UTMKL. The university community, particularly students, uses these scooters to get around the campus instead of using big cars that can emit more greenhouse gases when they travel from place to place. Therefore, the UTMCS is making an effort to support this net-zero carbon endeavour.

An eco-friendly project called Refabricate Recycle encourages the recycling of items including shoes, purses, clothing, and other items. The UTMKL Residence is host to this recycling facility. The goal is to educate students on better ways to handle their used clothing and to encourage people to discard old clothing. Working with DRB-HICOM has also resulted in this ecological project. All recyclable materials will be given to charitable organizations. The most recent green project implemented at UTMKL is the EV Charge Station. This station is situated in the parking lot of the UTMKL Residence. This may encourage initiatives to encourage more people on campus to drive electric vehicles. This is due to the fact that the presence of this EV charging station will raise public awareness of the benefits of using electric vehicles and strengthen efforts to reach net zero emissions.

One of UTMKL's energy-saving initiatives is the installation of LED lighting. LED lights are widely recognised for their effective energy-saving features. Therefore, it can more successfully reduce the rate of electricity use. We can observe that LED lights have been installed in the student lounge building at UTMKL. This is the study area with an open space where it is installed. Since the area is designed to be open, sunlight is the primary source of light, and LED lights are only used when the light becomes dim. As a result, the lights will only be on when the area is completely dark. As we can see, this green approach contributes significantly to energy savings.

Among the green efforts that the UTMKL campus community is rarely aware of is the digital urban garden at Sungai Bunus, located in Kuala Lumpur city centre. It's an attempt to preserve the environment for future generations. The development of 1,114 square metres is the responsibility of UTMKL and other stakeholders. This effort aims to contribute to the current SDG agenda and cultivate a love of the environment within the local community. There are many different kinds of herbs in the UTMKL garden, and we are working on a digital garden where visitors can learn more about the plants by just scanning the QR code. There was also UTMCS-cultivated kelulut honey in this garden.

UTM Campus Sustainability (UTMCS) also introduced the sustainability evaluation report in order to address the campus sustainability agenda. Another name for this assessment is Green Leaf, whereby each department must take part and submit a sustainability assessment for their green initiatives every year. With this assessment, the UTMCS is better able to support actions leading to true sustainability and may

also utilize it as a sustainability database to improve the present system. Furthermore, this practice has the potential to encourage new green initiatives or enhance existing ones. The department profile, management, education and innovation, community, environment, and well-being are the six key components of this report. The UTMCS will assess each of these factors and give the department an award for their diligent efforts in advancing the campus sustainability goal [8].

Based on the insights gathered from the interview sessions with Mr. Mokhtar, a civil engineer at the UTMKL Jabatan Harta Bina, and Prof. Assoc. Ir. Dr. Shamsul Bin Sarip, the deputy director of UTM Campus Sustainability (UTMCS), several issues have been identified in the implementation of green efforts. These challenges include:

1. Lack of awareness from stakeholders
2. Insufficient financial support
3. Limited space for installing solar panels
4. Maintenance issues

At Universiti Teknologi Malaysia Kuala Lumpur, the primary barrier to implementing green projects is a lack of awareness among the stakeholders. This is the point at which the majority of campus community, particularly UTMKL students and employees, are unaware of the significance of sustainability to the university. They show less interest and are unaware of the numerous advantages this green initiative offers. Since the majority of them lack prior experience in sustainability education, it can be challenging to raise their awareness of and encourage their participation in campus sustainability initiatives. They are also unable to completely engage in this green effort due to their hectic schedules.

The second obstacle preventing green program from being implemented is a lack of funding. The financial issue is not a major concern; yet, none of these projects had an allocated budget to guarantee its long-term viability. Majority of these green initiatives only seek to get funding from scholars who also wish to start green programs. Furthermore, issues of budget for maintenance can arise from having to buy replacement parts for systems like the rainwater harvesting system where the more expensive and distinct components are needed, particularly for green technology in comparison to standard construction.

Furthermore, there is issue related to the rainwater harvesting system where there is no information that has been gathered to determine the volume of water kept in the rainwater collection tank. This makes challenging for them to analyse the percentage of used water and determine how beneficial it is to use this rainwater in an attempt to reduce water usage. Consequently, this issue must be priority as the effort will continue to be ineffective without the data.

Lack of space for solar panel installation is one of the challenges in implementing green initiatives. According to Encik Mokhtar, initially there was a suggestion to open another solar farm, such as in the car park near the UTMKL Mosque. However, there is no suitable area for the proposal because of the lack of place and space on the UTMKL campus. Therefore, the university needs to identify other alternatives to implement the green technology. This finding supports a study by Gholami *et al.* [1], which states the university's limited space and resources are some of the challenges faced in implementing the green projects on campus.

Base on the finding above, the reality that every project, particularly those focused on sustainability, encounters its own set of challenges. Consequently, prioritizing the resolution of these issues becomes crucial to ensuring the successful implementation and sustainability of green initiatives. Consequently, future research can examine and discover information regarding the reasons behind the lack of awareness among campus community in the current green initiatives, as well as improvements in terms of data collection for a system and creating new ideas for green initiatives based on this campus's unique environmental features. For example, the development of green rewards apps for green initiatives is reliable in increasing green awareness in the campus community [9]. This could help create a more sustainable green program and raise the bar for UTM's green campus ranking globally. Through innovation, interdisciplinary collaboration and stakeholder engagement, will lead UTM in sustainable campus development.

4. CONCLUSION

In conclusion, this research has successfully identified the green initiatives implemented at Universiti Teknologi Malaysia Kuala Lumpur. The initiatives include solar panels, rainwater harvesting systems, micromobility solutions, EV charge stations, sustainability assessment reports, LED lamp installations, and re-fabrication recycling programs. Additionally, the project has shed light on several challenges faced in the implementation of these initiatives, such as the lack of stakeholder awareness, financial constraints, space limitations, and maintenance issues. Valuable insights have been gained regarding green initiatives. One key takeaway is the overarching goal of these efforts, such as striving for net-zero carbon emissions. This highlights the importance of sustainable practices and the commitment to achieving environmental goals within the university community.

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REFERENCES

- [1] H. Gholami, M. F. Bachok, M. Z. M. Saman, D. Streimikiene, S. Sharif, and N. Zakuan, “An ISM approach for the barrier analysis in implementing green campus operations: Towards higher education sustainability,” *Sustainability*, vol. 12, no. 1, 2020.
- [2] C. M. Dimova and P. M. R. Stirk, “Strategic challenge UiTM Perak,” vol. 19, no. 2, pp. 9–25, 2019.
- [3] Universiti Teknologi Malaysia, *UTM Sustainability Blueprint 2030*. [Online]. Available: <https://sustainable.utm.my/>
- [4] U. GreenMetric, “UI GreenMetric: Criteria and indicators.” [Online]. Available: <https://greenmetric.ui.ac.id/about/criteria-indicator>
- [5] Times Higher Education, “Impact rankings,” Oct. 18, 2023. [Online]. Available: <https://www.timeshighereducation.com/impactrankings>
- [6] A. Lauder, R. F. Sari, N. Suwartha, and G. Tjahjono, “Critical review of a global campus sustainability ranking: GreenMetric,” *Journal of Cleaner Production*, vol. 108, pp. 852–863, 2015.
- [7] S. Sadeli, R. Ismail, E. S. M. Ishan, S. Z. A. Hamed, M. M. Fadil, and R. Bahari, “Green campus awareness among diploma students in UTM Kuala Lumpur: Preliminary investigation,” *Journal of Technical & Social Studies (JUTEKS)*, vol. 20, no. 2, pp. 52–57, 2021.
- [8] UTM Campus Sustainability, “Green Leaf 2022.” [Online]. Available: <https://sustainable.utm.my/green-leaf-2022>
- [9] S. Sadeli, R. Ismail, E. S. M. Ishan, S. Z. A. Hamed, M. M. Fadil, R. Bahari, A. I. Suhaimi, and Arizal, “Development of the green mobile application prototype for green campus initiatives. Case study: Diploma SPACE UTM Kuala Lumpur,” *AIP Conference Proceedings*, vol. 2746, no. 1, Art. no. 020002, 2023.

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