Journal of Information System and Technology Management
EISSN: 0128-1666
JISTM
Volume 10 Issue 41 (December 2025) PP. 238-249
DOI: 10.35631/JISTM.1041015

JOURNAL OF INFORMATION SYSTEM AND TECHNOLOGY MANAGEMENT (JISTM)
www.jistm.com

DESIGNING THE INVISIBLE: RETHINKING GRAPHIC ARTS EDUCATION WITH AR

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Article Info:

Article history:
Received date: 30.09.2025
Revised date: 20.10.2025
Accepted date: 30.11.2025
Published date: 09.12.2025

To cite this document:

Abdullah, N. A., & Abdullah, M. F. W. (2025). Designing the Invisible: Rethinking Graphic Arts Education with AR. *Journal of Information System and Technology Management, 10* (41), 238-249.

DOI: 10.35631/JISTM.1041015

Abstract:

This mini-review studies the transformative power of the Augmented Reality (AR) technology in graphic arts learning within the context of accelerated digital shift, and outlines the role of this technology in providing immersive, interactive and student-centered learning. This study synthesises recent literature from 2020 to 2025 in terms of key pedagogical capabilities, the integration of pedagogical theoretical frameworks and technology acceptance models, technological constraints, and learning outcomes resulting from the integration of AR in graphic design and visual arts learning. Marker-based AR platforms like Adobe Aero and Vuforia are particularly covered in terms of the ease of experiencing increased spatial awareness, live manipulation of design, and creative experimentation as a satisfying balance between theoretical instruction and hands-on practice. The present review also emphasises the importance of integrating theoretical frameworks such as Kolb's Experiential Learning Framework, Cognitive Load Theory, and the Technology Acceptance Model (TAM) to enhance the understanding of AR pedagogy and user acceptance. The mini-review also reflects on the use of AR in the studio-based and blended learning contexts, identifying that it holds the potential of increasing the motivation of students, enhancing their conceptual learning, and facilitating autonomy of students. Nonetheless, challenges outlined in the review, such as steep learning curves, insufficient educator training, device accessibility challenges, and lack of standardized pedagogical models, as well as long-term evaluation frameworks provide major challenges. Through the integration of challenges and the emphasis on the need for 3D skills, specifically, this review addresses underexplored topics such as the use of AR in three-dimensional modelling, motion graphics, animation, and AR accessibility in less resourceful environments. By highlighting the importance of scalable teaching steps, longitudinal studies, and intensive capacity-building programs, as well as distinguishing between technological innovation,

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pedagogical innovation, and institutional support, this mini review concludes with fundamental principles to maximise the educational potential of AR.

Keywords:

Augmented Reality (AR); Graphic Arts Education; Studio-Based Instruction; Immersive Learning; Interactive Learning Environments

Introduction

Throughout the present rapid digitalization, augmented reality (AR) has developed as a powerful resource that can potentially revolutionize learning in many spheres inclusive of graphic arts. Within the last several years, studies have become actively interested in the potential of both AR and virtual reality (VR) to be used in engaging and interactive learning environments that increase student engagement, retention, and a more thorough comprehension (Capone & Lepore (2020; Zhao et al., 2023); Seyman & Kismet, 2023) These technologies offer their learners the chance of experiencing content in multidimensional and dynamic designs, which traditional pedagogies find it hard to offer in the world of art and design education (Zhang et al., 2022). AR and AI are also playing an important role in fostering skills in creativity and mental imagination in students as art education embraces technological innovation (Miralay, 2024). Although this great potential exists, gaps still remain in developing a holistic curriculum and responsive pedagogy. Therefore, the integration of pedagogical theoretical frameworks and technology acceptance models is required to enhance the understanding and effectiveness of AR usage. This enables future research to focus not only on the technology itself but also on the suitability of pedagogy and the readiness of students and teachers.

Nevertheless, as the interest in the use of AR increases, some serious knowledge gaps have been identified especially in embedding holistic curricula responsive to various design fields including product and graphic design. As evidenced in the current literature, there is a gap in pedagogical models that can help facilitate these areas of education (Mohamed & Sicklinger, 2022). In the meantime, a wide pool of digital materials that can be used in AR application development has increased considerably including not only videos and audios but also three-dimensional models and interactive diagrams thus providing new creative tools used by educators (García, et al., 2024).

The purpose of this mini-review is to synthesize recent findings on the role of AR in graphic arts education, focusing on three key areas: (1) the pedagogical affordances and cognitive benefits of AR in teaching design; (2) technological and practical challenges in classroom implementation; and (3) the evidence supporting its impact on learning outcomes. Notably, studies indicate that AR can significantly improve student performance, foster deeper cognitive engagement, and reduce mental load, underscoring its value for visual arts instruction (Chen & Mokmin, 2024).

This review also focuses on several differing perspectives, particularly concerning accessibility, instructional design, and long-term sustainability, indicating that further research and cross-disciplinary discussions are necessary. Although AR holds great potential to transform graphic arts education, its successful implementation requires well-planned evidence-based practices to ensure equitable access and meaningful use.

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Methods

To ensure a comprehensive understanding of the current research landscape, a comprehensive literature search was conducted using two major academic databases: **Scopus** and **Google Scholar**. The search strategy employed a combination of Boolean operators and a set of targeted keywords to capture relevant studies at the intersection of augmented reality (AR) and graphic arts education. The primary search terms included:

("augmented reality" OR "AR" OR "virtual reality" OR "mixed reality") AND ("graphic arts" OR "visual arts" OR "design" OR "art education") AND ("education" OR "learning" OR "teaching" OR "instruction") AND ("interactive" OR "immersive" OR "simulation" OR "experience") AND ("technology" OR "tools" OR "applications" OR "methods").

In addition to the structured query, supplementary keywords such as *Augmented Reality in Education, Augmented Reality in Art Education, Immersive Learning Technologies, Interactive Design Pedagogy, Graphic Arts,* and *Student Engagement in Visual Arts* were used to identify further relevant sources. This additional step ensures comprehensive coverage, linking search strategies to relevant outcomes to build continuity in the analysis.

This search aimed to include a wide range of scholarly contributions to capture a nuanced view of the field. Therefore, diverse types of literature were considered, including **original research articles, systematic reviews, meta-analyses, case studies**, and **peer-reviewed journal publications**. Articles were selected based on their relevance to the integration of AR in visual arts education and its implications for pedagogy, student engagement, and technological implementation.

Inclusion Criteria

The chosen studies written in 2020-2025 considered the use of Augmented Reality (AR) as one of the leading technologies in art education and graphic design. Articles applied were all written in English and published by international peer-reviewed journals. The evidence demonstrates that AR promotes activities among students, spatial awareness, and original learning due to the introduction of real-time 3D visualization and interactive designing experiences. This allows for a more systematic assessment of the impact of AR and the challenges of its implementation.

AR also facilitates combining traditional design techniques with digital design techniques. Nevertheless, a number of challenges were noted, such as the costs of implementation, insufficient access to the compatible equipment as well as proper software training. The studies observed practical applications such as portfolios with the support of AR, virtual gallery rooms, and participatory sessions of critique. These observations indicate the increased responsibility of AR in the visual arts education improvement and the significance of the creation of more friendly and flexible AR tools to be applied in the field of education in general.

Exclusion Criteria

A number of exclusion criteria were used to make sure that the focus and quality of the review are achieved. To begin with, research which talked of art education or graphic design but did not mention Augmented Reality (AR) explicitly was avoided since they were not in the scope of the technology in this study. Research works where AR was not the major technology used in the particular research were also not included in order to have uniformity in the analysis of the key 1st nature of AR. The linguistic regularity and convenience were achieved by including studies published on English only, and any works defined as grey and thus, not peer reviewed,

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such as conference abstracts, unpublished publications and reports and the like, were discarded in order to preserve the academic integrity and credibility. Table 1 refers to the Inclusion and Exclusion criteria used in this study. This approach ensures that emphasis is placed on studies that are relevant and have a clear pedagogical impact.

Table 1: Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
Study discussing AR technology used in the art education/graphic design field	Studies that discuss art education/graphic design without reference to AR were excluded
AR used as a primary technology	AR not the leading technology used in the study
Analyzing strength, limitation, potential application /software of augmented technology in art education/graphic design field	Studies published in languages other than English were excluded
Study publishes in English and publishes in an international peer-reviewed journal	Grey literature (e.g., conference abstracts, unpublished reports) was excluded
Publish between 2020-2025	-

Source: (Nur Adilah 2025)

Discussion

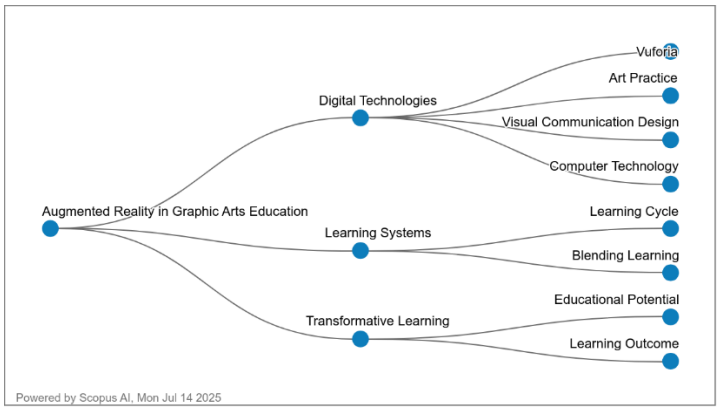

Figure 1: Augmented Realities in Graphic Arts Education generated by Scopus AI
Source: (Scopus AI, 2025)

Current Status of Augmented Realities in Graphic Arts Education

The development of Augmented Reality (AR) in graphic arts education is increasingly showing a significant shift, driven by advancements in digital technology and the need for more interactive pedagogical approaches. The Figure 1 generated by Scopus AI (2025) outlines three main domains that shape the current landscape of AR usage, namely Digital Technologies, Learning Systems, and Transformative Learning. Overall, the diagram illustrates that AR is no longer merely a visual support tool, but has evolved into an essential component in visual communication design, computer technology training, and more holistic 4IR learning approaches. These findings align with the referenced texts indicating that AR is increasingly embraced in visual arts education, design education, and digital graphics training due to its ability to create more immersive and contextual learning experiences.

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Integration of AR Digital Technologies in Graphic Arts Education

Graphic arts education involving integration of Augmented Reality (AR) technologies has found tremendous growth in the recent years. Technologies like Unity 3D and Vuforia are increasingly applied to combine physical and digital design space, making it possible to create interactive and immersive learning experience (Chen & Mokmin, 2024). Such devices facilitate real time 3D visualization, use of animation overlays and interactive interface design which enriches the visual communication, design in computers and studio art practice.

Korani et al. (2021) also suggest introducing AR tools such as Adobe Aero to the graphic design curriculum. Adobe Aero offers an accessible interface of spacetime creation in interactive AR assets and acts as a prototyping tool in terms of interactivity with objects before being created in full-scale engines like Unity or Unreal. Such technologies enable students to engage in hybrid design thinking, which is the intersection between the conventional artistic skills and computational techniques. The study conducted by Islam (2025) revealed that although AR tools such as Unity with Vuforia and Spark AR were fairly advanced, they are coded and designed to be used in 3D but not in simple, 2D-oriented tasks. **Adobe Aero** was selected because of convenience in its use and tools that allow creating interactive stories and animation even when it comes to the lack of programming knowledge.

Studies are also pointing out the pedagogical effectiveness of AR to increase the retention and engagement of knowledge. Sovhyra (2020) points out that the traditional approach to teaching art is usually limited in practice because it strongly focuses on theoretical teaching. AR and other immersive technologies can be seen to tackle this problem because it provides the opportunities to learn through experience, which mirrors the real world as closely as possible. Likewise, Zhao et al. (2023), citing Bansal et al. (2022), claim that AR may provide engaging and tactile learning experiences in which students may directly engage in digital recreation.

Implementation Challenges

There are various barriers to successful implementation. Effective AR implementation requires robust technological infrastructure, including appropriate devices and relevant software training. Mohamed and Sicklinger (2022) emphasise the need for foundational 3D modeling instruction in programs and continuous development to achieve more complex AR applications. These barriers can be explained through several key theoretical frameworks.

From the perspective of the Technology Acceptance Model (TAM), the level of AR acceptance is directly influenced by perceived usefulness and perceived ease of use, as highlighted by Davis (1989). If teachers and students consider the technology difficult to access, requiring additional training, or not providing significant learning benefits, their intention to use it will decrease. A lack of infrastructure, limited digital skills, and technical difficulties can lead to these negative perceptions, thereby reducing the effectiveness of AR implementation despite its high potential. Therefore, consistent technical support, systematic training, and user-friendly platform design are critical requirements to enhance the acceptance of new technology in the context of arts education.

Moreover, Cognitive Load Theory (Sweller, 1988; Sweller et al., 2011) also explains the challenges in using visually dense AR. AR can increase intrinsic cognitive load when students need to process complex visuospatial information within a short period. If the interface design structure is not well-organised, extraneous cognitive load also increases, causing students or users to struggle in understanding the relationships between virtual objects, the surrounding

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environment, and learning tasks. Therefore, pedagogical and curatorial planning needs to consider elements of cognitive load reduction, such as the use of visual cues, step-by-step guidance, optimisation of digital displays, and phased structuring of AR tasks.

From the perspective of Kolb's Experiential Learning Framework, digital and technical skills are required to enable students to progress through the cycle of concrete experience, reflection, conceptualisation, and active experimentation (Kolb, 1984). If students or teachers lack sufficient digital literacy foundations, they may become stuck in the initial experience phase and fail to advance to the exploration and idea creation phases through AR. This barrier indicates the need for more systematic interventions, such as modular training, tiered 3D modeling workshops, and project-based learning exposure that supports skill development from simple to complex.

The challenges of AR implementation involve not only technical aspects, such as infrastructure and software capability, but also pedagogical and user psychological dimensions. The integration of these theoretical frameworks allows a more comprehensive assessment of factors that support or hinder AR usage, thereby providing a solid foundation for future improvement strategies in digital arts education.

Future Needs

In the future, more accessible Augmented Reality (AR) platforms to educational institutions with low technological and financial capabilities are urgently needed. The application of AR-based technologies in the classroom can change the classical learning conditions and make the in-class experience more interesting, give better access to information, and help follow the non-standard learning modes that are not often considered with the traditional methods (Zhang et al., 2022). Because of the changes experienced in education practices, an increase in the need of new tools capable of enhancing the learning process experienced in schools amongst students has been noticed. AR is one of the most promising new technologies that allows users to overlay on the physical environment with contextual 3D data, which can enhance sensory and cognitive experiences with learning material (Wang et al., 2021).

Nevertheless, the implementation of the AR has been still impeded with financial and technical issues despite its potential in pedagogical practice. These consist of a high price of implementation, a restricted access to hardware that is compatible, and the necessity to have the institutional support and digital infrastructure (Mohamad et al., 2024). In order to overcome these shortcomings, it should be best to stress the acquisition of practical digital skills in curriculum development with an accent on 3D modelling and interactive media designing. Providing students with essential AR skills will not only enhance their academic experiences but also be ready to work in the creative industries that rely more on digital solutions in the future.

Augmented Reality in Learning Systems for Graphic Arts Education

graphic arts that supplement traditional models of learning with interactive experiences through immersion. AR enables the students to have a sense of spatial awareness and creative problem-solving as they can manipulate the digital elements in real-time by reinforcing experiential learning patterns especially active experimenting and reflective observation. According to Wang et al. (2025), one of the benefits of AR is that it intensifies student participation and benefits visual learning by transforming the abstract design concepts into less abstract and more meaningful.

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The concept of AR supported by blended learning models also helps embrace learning preference variability and additional flexibility in instruction. These are interactions of face-to-face education and digital materials, where AR acts as an active expansion of the classroom. According to the study by Sonjaya et al. (2025) blended learning with AR and gamified measures proves beneficial in motivating students, reinforcing knowledge, and offering learners an opportunity to develop at their own pace. The creative disciplines especially benefit more on this blended format since practice and visual feedback are a vital part of them.

The study by Lee et al. (2021) showed the AR-blended learning context can induce the flow and contextual understanding among learners especially in the context where visual storytelling and interpretive work are prominent. These results imply that AR is not merely a supplement to the learning process but a reformation of it that links the cognitive theory and digital innovation. Overall, the studies reviewed support the fact that the use of AR in learning systems should be considered a progressive way of teaching and learning graphic arts, finding the balance between pedagogical and technological involvement.

Transformative Learning through Augmented Reality in Graphic Arts Education

The use of Augmented Reality (AR) technology in teaching and learning graphic design and visual arts is a revolutionary method of learning. AR also carries the potential of immersive interaction that allows students to critically process information, debunk existing knowledge and actively rebuild that which is gained through experimentation. It has been established that AR is able to increase a student performance, state of flow, and decrease cognitive load significantly (Chen & Mokmin, 2024). The ability to visualize complicated spatial layouts, handle digital components, and get real-time feedback enables learners to integrate deeper conceptual knowledge and foster creative formation of identity (Egunjobi & Adeyeye, 2024). In contrast to a classic studio experience, AR creates a dynamic learning environment wherein students can experiment on design tenets iteratively, thereby capitalising on enhancing their mastery of skills in design and visual communication.

AR as a pedagogical and a creative tool can generate higher educational achieving and transform the design practice. It has been proven that its use in the project-based learning models can lead to more learner autonomy, motivation, and critical thinking (Crogman et al., 2025). Properly balanced with the conventional rules of graphic design, AR provides added benefits to the learning process and is consistent with modern educational requirements, combining the innovation of digital marketing and the traditional teachings of graphic design (Korani et al., 2021). Furthermore, because it allows the integration of digital graphics with real-life settings, AR has the potential to create a more participatory and receptive learning culture and thus emerges as an essential instrument of producing future-ready design professionals in the digital era (Mohamad et al., 2024; Hidayat & Wardat, 2024).

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Trends in Scholarly Output and Citation Impact (2020–2025)

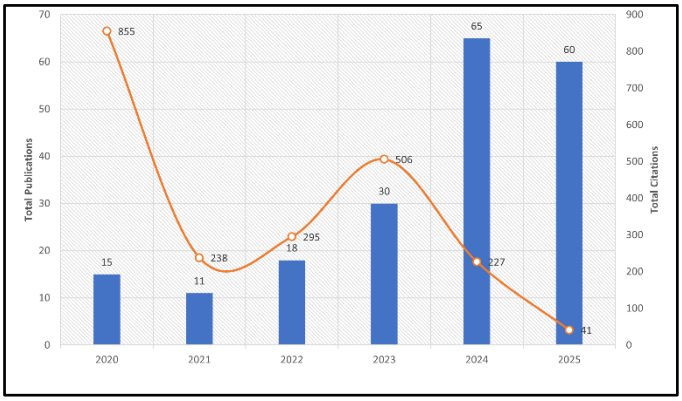

Figure 2: Trends in Total Publications and Citations (2020–2025)

Source: (Nur Adilah 2025)

Note: *Annual distribution of total publications (blue bars) and total citations (orange line) in the observed research domain*

The graph illustrates the yearly trends in total publications and citations from 2020 to 2025. Publication output increased steadily from 15 in 2020 to a peak of 65 in 2024, slightly decreasing to 60 in 2025. After a dip to 11 in 2021, the number of publications rose consistently, indicating growing research activity and interest in the field.

Citation patterns, however, show a different trend. Citations were highest in 2020 at 855, then declined sharply to 238 in 2021. A brief recovery followed in 2023 (506 citations) before falling again in 2024 and 2025 (227 and 41, respectively). This suggests that while publication quantity has increased, citation impact has not kept pace likely due to time lag in recognition or varying research quality.

Keyword Impact and Citation Density in AR/VR Educational Research (2021–2025)

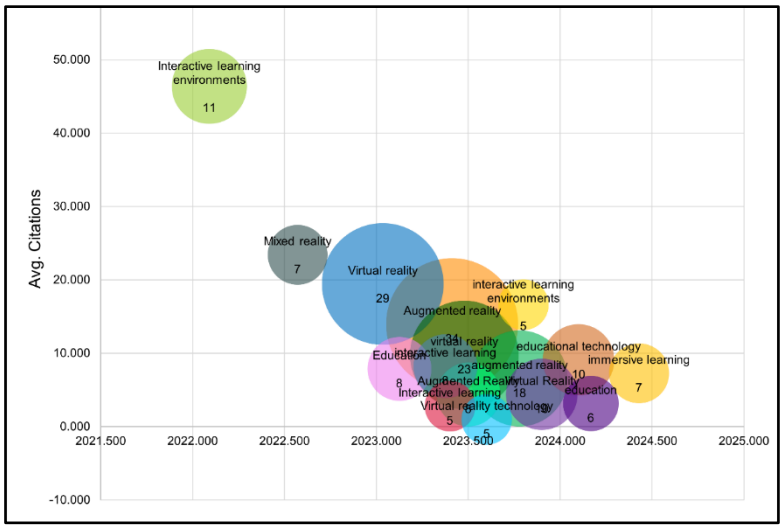

Figure 3: Keyword Impact and Citation Density in AR Educational Research (2021–2025)

Source: (Nur Adilah 2025)

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The chart highlights that **Augmented Reality (AR)** remains a growing focus in education-related research between 2023 and 2024. Although AR does not reach the highest average citation levels, it maintains a steady presence with multiple studies across both years. In 2023, AR-related topics such as *virtual reality*, *interactive learning*, and *education* show moderate citation impact, while in 2024, terms like *augmented reality*, *educational technology*, and *immersive learning* cluster together with modest citation averages. This suggests that AR is gaining traction as a research topic, though its full scholarly impact is still developing compared to earlier high-impact themes like *interactive learning environments*.

Conclusion

This mini review emphasises the revolutionary power of AR in graphic arts education, particularly in enhancing illustrative learning, creativity, and student engagement within immersive environments. Marker-based tools such as Adobe Aero and Vuforia enable layered storytelling, real-time editing, and clearer connections between theory and design practice (Hu, 2024). This approach aligns with Kolb's Experiential Learning Framework, in which students engage directly in concrete experiences before progressing to reflection, conceptual development, and active experimentation in design (Kolb, 1984). Students benefit from enhanced spatial awareness, visuospatial skills, and intrinsic motivation, while educators gain experimental formats to present and evaluate innovative materials through experience-based design and self-directed exploration. However, AR implementation remains low due to steep learning curves, difficulties of use for novice students and educators, and the absence of established implementation standards (Alhebaishi & Stone, 2024). From the perspective of the Technology Acceptance Model (TAM), these challenges may negatively affect perceptions of ease of use and perceived usefulness of a platform, thereby reducing user intention and acceptance (Davis, 1989). A lack of training, technical support, and early exposure also contributes to slow adoption, despite its significant pedagogical potential.

Furthermore, intensive visual AR usage increases cognitive load, especially when students must process visual information, text, and spatial navigation simultaneously. If AR tools are poorly designed, extraneous cognitive load rises, impairing students' focus on learning tasks (Sweller, 1988; Sweller et al., 2011). The absence of progressive guidance, visual cues, and clearly structured tasks further diminishes learning effectiveness. In addition, the lack of longitudinal research limits the ability to assess the long-term effects and scalability of AR implementation across various educational contexts (Koumpouros, 2024; Sovhyra, 2020). Future studies should focus on large-scale research across multiple AR modalities and the development of modular training for educators to ensure more organised and sustainable learning delivery. Efforts to enhance implementation sustainability also require affordable solutions, protection of student privacy, and clear curriculum integration guidelines.

Overall, realistic strategies for integrating AR into foundational courses, particularly for 3D modelling, digital illustration, and animation topics, need to be promoted to create inclusive, experience-based learning environments that are prepared for future needs (Hui et al., 2024). Approaches supported by theories such as Kolb, TAM, and Cognitive Load Theory allow AR implementation to be carried out more systematically, coherently, and pedagogically effectively.

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Acknowledgements

I would like to express my sincere gratitude to Universiti Pendidikan Sultan Idris (UPSI) in Tanjong Malim, Malaysia, for providing the academic environment, resources, and opportunities that made this research possible, and to my supervisor, Dr. Muhammad Fadhil Wong Abdullah, whose expert guidance, unwavering support, and insightful feedback throughout every stage of my study have been invaluable

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Journal of Information System and Technology Management
EISSN: 0128-1666
JISTM
Volume 10 Issue 41 (December 2025) PP. 238-249
DOI: 10.35631/JISTM.1041015

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