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Multilevel Investigation of Higher Tourism Education Service Quality in the Digital Era: Integrating SAMR Framework and Technology Affordance Theory

Abstract

Digital transformation poses significant challenges for higher education institutions in tourism education, where technological integration is crucial. Leveraging the technology affordance theory lens, a multilevel framework posits the concepts of substitution, augmentation, modification, and redefinition (SAMR) as key principles. This model represents a progressive and transformative approach that educators can utilize through digital tools to enhance the quality of educational services by making strategic investments aligned with the needs of digital transformation. Data was collected from 209 faculty members and 2,466 corresponding students across seven Egyptian tourism colleges. Multilevel structural equation modelling results revealed that digital transformation requirements have a positive influence on the enhancement and transformation stages of SAMR, thereby improving educational service quality. Findings demonstrate how institutional requirements shape faculty members' actualization of technological affordances across the SAMR stages, progressing from essential substitution to transformative redefinition.

Keywords: digital transformation, multilevel analysis, higher education services, tourism students, technology affordance theory

1. Introduction

Digital transformation is recognized as a priority for higher education institutions (HEIs) (Arantes, 2022), driven by a worldwide increase in technology usage, exemplified by innovative classroom systems (Wang et al., 2024). Higher Education Institutions (HEIs) invest in digital transformation to provide educational solutions and optimize the utilization of digital resources and learning environments (Selem et al., 2025). This transformation involves integrating digital tools necessary for educational delivery in higher education institutions (HEIs) (Alenezi, 2023). Integrating educational technologies continues to encounter significant obstacles, rendering hospitality and tourism curricula inadequately prepared.

According to Selem et al. (2025), factors contributing to this issue include the absence of digital transformation requirements (e.g., digital business transformation strategy and workplace digital proficiency). The SAMR (Substitution, Augmentation, Modification, and Redefinition) framework illustrates how digital

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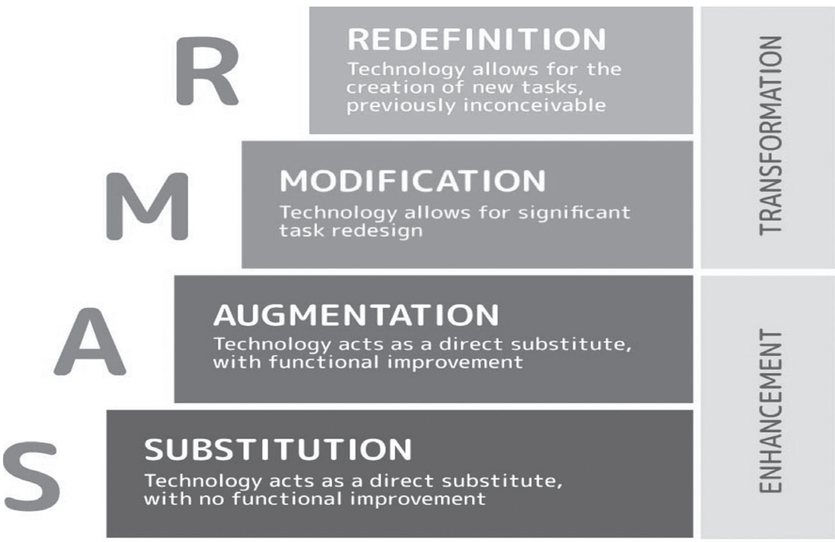
Original Research Article
Vol. 73/ No. 3/ 2025/ 465 - 486
UDC: [338.48 6:378.014.61]:004; https://doi.org/10.37741/t.73.3.5

technology can enhance or transform educational methodologies (Blundell et al., 2022) and support educators in creating and implementing impactful e-learning experiences (Selem et al., 2025). This paper adopts the SAMR model as a way for educators to utilize technologies to transform students' learning experiences (Arantes, 2022), informed by the digital transformation requirements of strategy, culture, human capacity, and technical, security, and legislative considerations.

The SAMR model is depicted as rungs on a ladder (see Figure 1), illustrating the myriad practices that technology can enhance and transform in educational settings. It categorizes technology as a direct tool substitute for specific pedagogical methods without functional change, as an augmentation that improves functionality (Wang et al., 2024), and as a modification that entails significant task redesign (Selem et al., 2025) and practices' redefinition through previously inconceivable technological functions (Blundell et al., 2022).

Furthermore, the tourism and hospitality education sector presents a compelling context for studying these dynamics. The industry's rapid digital transformation has created new demands for graduates with sophisticated technological competencies (Kainthola & Singh Kaurav, 2024). Traditional approaches to tourism education must evolve to incorporate virtual reality tours, digital mapping tools, and collaborative online platforms (Bashir et al., 2022). Besides acknowledging the possibilities that digital technologies can be afforded through SAMR, this paper suggests that affordances should also incorporate digital transformation requirements.

Figure 1
SAMR model with two stages



Accordingly, this paper integrates the SAMR framework with technology affordance theory (TAT) to develop a comprehensive, multilevel model of digital tools' usage in higher tourism education. Specifically, this paper aims to

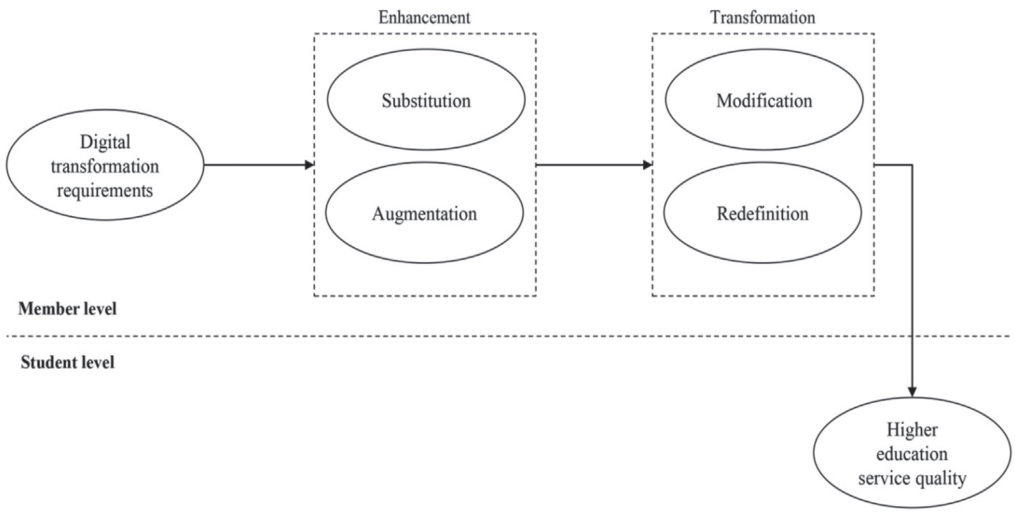
1) Examine how digital transformation requirements at the institutional level influence faculty members' implementation of different SAMR stages,
2) Investigate the mediating roles of enhancement-stage activities (i.e., substitution and augmentation) in enabling transformation-stage practices (i.e., modification and redefinition),
3) Evaluate the serial mediation effects of SAMR stages in translating institutional requirements for digital transformation into improved educational service quality.

2. Literature review and hypotheses

2.1. SAMR framework

The SAMR framework offers a structured lens for understanding how educational technologies, such as Microsoft Office applications, Google Docs, and voice-enabled tools, support teaching and learning processes (Targema-Takema, 2024). As highlighted by Arantes (2022), this framework categorizes technology's educational roles into four progressive stages: substitution and augmentation (enhancement stages) and modification and redefinition (transformation stages). During the substitution stage, technology replaces traditional practices without altering functionality, while augmentation introduces functional improvements to existing pedagogies (Crompton & Burke, 2020). Technologies must advance beyond enhancement to transformative practices, enabling significant redesigns of learning and knowledge-generation activities (Arantes, 2022; Targema-Takema, 2024). Accordingly, this paper proposes the TAT-based SAMR model that demonstrates how digital transformation requirements drive improvements in service quality. Figure 2 presents a multilevel model exploring how institutional digital transformation requirements influence faculty practices across the SAMR stages and their subsequent impact on student learning outcomes.

Figure 2
Research model



The enhancement stages of SAMR (substitution and augmentation) emphasize incremental improvements to teaching practices through the use of digital tools (Targema-Takema, 2024). At the substitution stage, technologies primarily replace analogue or less efficient digital tools without altering pedagogical methods (Drugova et al., 2021). For instance, educators might transition from physical handouts to PDF documents or digital slides (Chandra et al., 2022). On the other hand, augmentation represents functionalities that enrich the educational experience (Rampa & Parmentier, 2024). For example, instructors may incorporate blogs for real-time updates (Drugova et al., 2021) or assign students internet-based research tasks to explore diverse perspectives on a shared topic (Miklosik et al., 2023). Such practices foster deeper engagement and facilitate dynamic learning environments.

The transformation stages of SAMR signify more profound shifts in pedagogical design (Arantes, 2022) facilitated by ICT integration. At the modification stage, digital tools enable significant changes to instructional approaches, transcending traditional classroom constraints (Blundell et al., 2022). For example, cloud-based platforms allow collaborative document creation and asynchronous participation, fostering flexibility and inclusivity in learning experiences (Miklosik et al., 2023). Redefinition represents the pinnacle of the SAMR model, where technology enables new pedagogical possibilities (Alenezi, 2023). Students engage in tasks such as developing apps or creating original content addressing real-world challenges. These practices enhance student creativity and cultivate essential skills for enriching educational experiences (Miklosik et al., 2023).

2.2. Digital transformation requirements

Digital transformation is no longer optional for higher education institutions (HEIs); it is a prerequisite for meeting global demands and evolving student expectations (Alenezi, 2023). The COVID-19 pandemic accelerated the adoption of digital tools, fundamentally reshaping institutional processes and learning methodologies (Chen et al., 2024). However, successful digital transformation requires more than technological investment—it demands cultural shifts and systematic support (Alenezi, 2023). For instance, implementing chatbots fosters skill development. Moreover, digital tools enable sophisticated analyses and improve forecasting (Miklosik et al., 2023). The relationship between digital transformation requirements and SAMR stages is critical. Institutional support for technology adoption impacts faculty implementation of substitution and augmentation (Chen et al., 2024), the foundational stages of SAMR. Hence, this paper assumes that:

> *H1:* Digital transformation requirements positively affect a) digital substitution and b) augmentation at the member level.

The integration of digital tools into contemporary education has become ubiquitous, yet several challenges persist that affect students' engagement with technology-enhanced resources (Aithal & Aithal, 2023). These challenges include inadequate access to multimedia tools and a lack of supportive systems, which hinder equitable learning experiences (Dąbrowska et al., 2022). Digital transformation initiatives within higher education institutions (HEIs) are complex, involving diverse training programs and a significant scale of implementation (Miklosik et al., 2023). These initiatives impact a broad spectrum of students and faculty, demanding substantial investments in information technology infrastructure for adoption and upgrades (Aithal & Aithal, 2023).

The success of these efforts hinges on effectively managing the resources, training, and cultural shifts required to support digital innovation. Miklosik et al. (2023) emphasized that overcoming these challenges is crucial to realizing the full transformative potential of digital technologies in higher education. Given the foundational role of substitution in the SAMR framework, this stage enables the transition from traditional methods to digital alternatives (Demir et al., 2021), setting the groundwork for more transformative practices. Therefore, this paper assumes that:

> *H2:* Digital substitution has a positive impact on both a) digital modification and b) digital redefinition at the member level.

The growing integration of innovative technologies in education has brought significant opportunities for transforming learning experiences. These technologies offer students dynamic and engaging educational environments, fostering active participation and enhancing outcomes (Aithal & Aithal, 2023). By enriching traditional lectures with multimedia presentations, images, and interactive quizzes, digital tools enhance instructional delivery, making lessons more interactive and impactful (Blundell et al., 2022; Saarikko et al., 2020). One notable application is in language learning, where translation apps provide real-time assistance (Alenezi, 2023), thereby facilitating comprehension during lectures.

Additionally, mobile apps and QR codes enable students to access supplementary content and engage in interactive learning experiences at tourism sites (Islam et al., 2024), broadening the scope of experiential education (Miklosik et al., 2023). These tools complement classroom learning, enhancing the relevance and practicality of the curriculum. Instructors can further harness digital tools by assigning collaborative projects (Saarikko et al., 2020) that enable asynchronous participation, thereby fostering global perspectives and inclusivity among students (Aithal & Aithal, 2023). By leveraging these collaborative features, students engage in meaningful exchanges of ideas, enhancing their critical thinking and teamwork skills (Blundell et al., 2022). These enhancements illustrate the potential of digital augmentation to transition educational practices toward transformative stages. Hence, this paper proposes that:

> *H3:* Digital augmentation positively affects a) digital modification and b) digital redefinition at the member level.

2.3. Higher education service quality

In the rapidly evolving landscape of higher education, ensuring and enhancing service quality has become a crucial goal for higher education institutions (HEIs) (Demir et al., 2021). Today's higher education institutions (HEIs) operate within a competitive environment characterized by internationalization, the proliferation of private universities, and declining state funding for public institutions (Singh & Jasial, 2021; Demir et al., 2021). These strategies emphasize the importance of systematically measuring service quality, which enables higher education institutions (HEIs) to identify and address gaps in their offerings, thereby fostering student satisfaction and loyalty (Chen et al., 2024). The integration of digital technologies has further redefined the concept of service quality in higher education. Digital tools and platforms empower universities to extend beyond traditional educational boundaries by facilitating ubiquitous learning and fostering collaboration (Chen et al., 2024). These technologies enhance course portfolios, streamline operational processes, and strengthen universities' value chains (Demir et al., 2021). For example, digital platforms have made library services, examination results, and administrative functions more accessible (Saidakhror, 2024) while also enabling personalized learning experiences (Chen et al., 2024).

Moreover, the transformative potential of digital tools lies in their ability to elevate academic standards and enrich learning experiences. For instance, learning management systems, collaborative platforms, and real-time analytics allow educators to design more engaging, data-informed curricula (Chandra et al., 2022). Communication technologies have become instrumental in boosting student engagement—a core component of digital transformation strategies (Aithal & Aithal, 2023). Hence, this paper proposes that:

> *H4:* Digital modification at the member level will positively affect higher education service quality at the student level, both through a) digital modification and b) redefinition at the member level.

2.4. Mediating roles of SAMR stages

A fundamental principle of TAT is the demand to explore the interactions between technologies and users rather than evaluating them in isolation. Hence, it is vital to consider the compatibility of platforms' technological affordances, as shown by users' familiarity (Drugova et al., 2021). Likewise, hotel employees perceive the affordance characteristics based on their proficiency and comfort in utilizing robots, noting distinctions in adaptability between robots with physical affordances (e.g., room-service robots) and those with cognitive affordances (e.g., concierge robots) in service provision (Mishra et al., 2024). Existing research on the various affordance functions of educational technologies exists restricted regarding how the enhancement function (e.g., substitution and augmentation) mediates the relationship between the requirements for digital transformation and the stages of transformation usage (e.g., modification and redefinition). Nonetheless, considering that technological complexity and associated concerns may impede the adoption of digital transformation (Wang & Zhang, 2025), organizations and technology advocates must adopt a gradual approach to learning and mastering technological competencies, recognizing each technological affordance advantages (El-Akhras et al., 2024) as compelling motivations for early adopters, early majority, and late majority.

Consequently, enhancement functions (e.g., substitution and augmentation) might serve as catalysts for the subsequent phase of transformative advancement when consumers attain proficiency in technology functionalities and derive benefits. From a behavioural motivation standpoint, enhancing the functions of the SAMR model in educational technologies represents a legitimate advancement (Bashir et al., 2022) from digital transformation requirements to the SAMR transformation stage. When HEIs implement robust digital transformation requirements, they initially foster a condition conducive to fundamental technology adoption—such as substituting conventional tourism lectures with digital presentations or physical maps with their digital counterparts (Kainthola & Singh Kaurav, 2024). These basic substitutions and augmentations then become stepping stones that partially enable more sophisticated modifications of teaching methods.

Nonetheless, digital transformation requirements can also directly affect advanced stages through mechanisms such as industrial alliances or institutional regulations (Lončarić et al., 2022). For instance, tourism faculty members must first acquire proficiency in fundamental digital tools (substitution), such as virtual classroom platforms, before utilizing these skills to develop interactive virtual hotel tours (modification) or to create immersive destination experiences (redefinition) (Bashir et al., 2022). The foundational knowledge of basic affordances establishes the technical and pedagogical groundwork for realizing more advanced affordances. Consequently, this paper proposes that:

> *H5:* Digital substitution partially mediates the nexus between digital transformation requirements and a) digital modification and b) redefinition.

> *H6:* Digital augmentation partially mediates the nexus between digital transformation requirements and a) digital modification and b) redefinition.

During the redefinition level, technology-facilitated paradigm shifts that were incredible in tourism education (Muslimin et al., 2024). For instance, fundamental digital skills in utilizing virtual reality tools can evolve into developing immersive destination experiences that revolutionize the understanding of tourist destinations. Furthermore, the transformative potential of educational technology, including immersive VR learning functions, can promote collaborative learning (Huang & Macgilchrist, 2024). Selem et al. (2025) asserted that this collaborative and transformative learning exemplifies service learning pedagogy rooted in experiential learning theory. This theory posits that learners enhance their knowledge by engaging with their environment through discovery enabled by VR learning technology, improving the quality of educational services. Correspondingly, tourism education that excels in substitution and augmentation functions (El-Akhras et al., 2024) might create unique pedagogical approaches that transform educational experiences (e.g., simulation-based learning of hotel operations and virtual field excursions to tourism sites) (Bashir et al., 2022). Consequently, this paper postulates that:

> *H7:* Digital modification partially mediates the nexus between higher education service quality and a) digital substitution and b) augmentation.

> *H8:* Digital redefinition partially mediates the nexus between higher education service quality and a) digital substitution and b) augmentation.

TAT suggests that users' ability to realize sophisticated technological benefits often follows a cumulative, multi-stage process (Strauss et al., 2024). In tourism higher education, this sequential progression from digital transformation requirements through enhancement stages (substitution and augmentation) to transformation stages (modification and redefinition) influences service quality through multiple interconnected pathways. The serial mediation process begins when digital transformation requirements create foundational conditions for technology adoption. For instance, when tourism institutions invest in digital infrastructure and training (Aithal & Aithal, 2023), faculty members first master fundamental digital tools, such as learning management systems (substitution) or enhanced presentation technologies (augmentation) (Bashir et al., 2022). These enhancement capabilities then enable more sophisticated modifications of teaching methods. For instance, creating interactive virtual tours enhances service quality through improved student engagement and learning outcomes (Muslimin et al., 2024).

Huang and Macgilchrist (2024) demonstrated how this serial progression manifests through affordance actualization chains. Initial digital transformation requirements enable the adoption of technology, facilitating more advanced and transformative practices. For instance, implementing digital assessment tools (substitution) leads to enhanced feedback mechanisms (augmentation), enabling personalized learning experiences (modification) and transforming how tourism students demonstrate competency (redefinition). The relationships between these stages are complex and interconnected rather than strictly linear. While serial mediation pathways exist, direct effects between variables likely persist at each stage of the process.

Digital transformation requirements can influence service quality through institutional policies and resource allocation, regardless of the actualization of technological affordances (Rampa & Parmentier, 2024). Similarly, enhancement stages may directly affect service quality while enabling transformation stages. The complexity of these relationships is evident in tourism education, where industry-specific requirements often necessitate multiple simultaneous pathways of technological integration (Lončarić et al., 2022). For example, the need to teach global distribution systems might trigger the concurrent development of basic digital skills (substitution), enhanced features (augmentation), modified teaching approaches (modification), and redefined learning experiences (redefinition). Therefore, this paper assumes that:

> *H9:* The nexus between digital transformation requirements and higher education service quality will be serially mediated by a) digital substitution and modification, b) digital substitution and redefinition, c) digital augmentation and modification, and d) digital augmentation and redefinition.

3. Methods

3.1. Instruments

Before being distributed to respondents, the English version of this survey was translated into Arabic. A reverse-translation approach was employed to verify semantic equivalency, utilizing three tourism professors fluent in both Arabic and English as journal editors at their esteemed college to assess content and face validity (see Appendix A). At the faculty member level, digital substitution was assessed using a six-item scale. Seven items were employed to gauge digital augmentation. The digital modification was assessed using five items, while the other five items were used to evaluate digital redefinition. All items cited from Drugova et al. (2021) were used to determine the stages of the SAMR framework.

Digital transformation requirements were assessed using 25 items developed by Dąbrowska et al. (2022) and Saarikko et al. (2020). This scale consists of seven sub-scales: digital transformation strategy (five items), digital transformation culture (four items), digital transformation funding (four items), human requirements (two items), technical requirements (three items), security requirements (four items), and legislative requirements (three items). At the student level, 28 items were employed to gauge higher education service quality, derived from Demir et al. (2021) and Singh and Jasial (2021). This scale consists of five sub-scales: administrative quality (five items), physical environment quality (six items), core educational quality (seven items), support facilities quality (five items), and transformative quality (five items). We employed a 7-point Likert scale to assess each item of the construct.

3.2. Data gathering process

Data were collected from members and corresponding students of Egyptian tourism and hospitality colleges, all of whom were affiliated with the same department. Although tourism education has proliferated in recent years (Rampa & Parmentier, 2024), maintaining students' high cognitive abilities through educational augmentation phases using digital transformation tools still requires providing higher education services of a better calibre (Alenezi, 2023). Therefore, datasets on how to raise the quality of higher education services for faculty members and students were obtained from seven tourism and hospitality colleges in Egypt. Faculty members and students in the tourism studies department were invited to serve as the analysis unit. Therefore, datasets on how to raise the quality of higher education services among faculty members and services were acquired from seven tourism and hospitality colleges in Egypt. These colleges are essential for the adoption of digital transformation in education processes and for enhancing higher education services in the tourism sector (Rampa & Parmentier, 2024).

A snowball sampling method was employed to achieve an acceptable research sample. The existing paper employed this sampling approach to gather data in response to these earlier investigations. Initially, researchers established connections with seven Egyptian colleges specializing in tourism and hospitality through faculty members and student lists from each college, as well as directors of quality and accreditation, heads of the tourism studies department, and student union presidents. Hence, 280 faculty members and their 2,800 corresponding students were asked to participate in this survey. As such, one faculty member is assigned to each student in the Department of Tourism Studies. Regarding the involvement of faculty members and students in the survey objectives, three questions were used to screen the required sample size: First, do you enroll in the tourism studies department? Second, do you agree to integrate technology into educational processes?

A Google Form was used to gather data from December 20, 2024, to January 2, 2025. As such, 2,469 students completed the student questionnaire, yielding a response rate of 88.18%. Meanwhile, 219 faculty members completed the faculty member questionnaire, resulting in a response rate of 78.21%. Researchers paired student responses with responses from faculty members to generate meaningful dyadic responses. Three students who did not complete their questionnaire and ten faculty members who did not complete the member questionnaire were excluded. Across the board, 209 faculty members and 2,466 students provided valid dyadic responses, forming the final sample. Hence, the sample size for structural equation modelling (SEM) exceeded thirty times the total number of scale items (i.e., 76 items) to ensure adequacy.

3.3. Data aggregation and analytical strategy

Since the member-level constructs of digital transformation requirements, education enhancement stage dimensions, and education transformation stage dimensions were obtained from faculty members, student-level constructs of higher education service quality were acquired from corresponding students as a self-report measure. Therefore, it was crucial to confirm that datasets at the member and student levels were aggregated. The higher education service quality, enhancement, and transformation stage dimensions, as well as digital transformation requirements, have ICC (1) values of 0.29, 0.39, 0.36, and 0.31, respectively, which exceed the 0.12 criterion (LeBreton et al., 2023).

Additionally, these four constructs have ICC (2) values of 0.87, 0.76, 0.55, and 0.81, respectively, which exceed the permissible threshold of 0.40. These four constructs had average Rwg values of 0.92, 0.87, 0.79, and 0.87 above the 0.70 cutoff (LeBreton et al., 2023). Data aggregation was reinforced by good ICC(1), ICC (2), and average Rwg values. Multilevel structural equation modelling (MSEM) and confirmatory factor analysis (CFA) were run to evaluate the research model at the faculty member and student levels. Hence, MSEM and CFA were conducted using Mplus 8.3 in this paper. The multi-respondent strategy was utilized to reduce common method bias (CMB). Furthermore, CMB was estimated using Harman's test. The pivotal effect of CMB was deemed acceptable since the variation was 32.88%, which was lower than the maximum permissible value of 50%. The variance inflation factor (VIF) was also calculated to quantify CMB further. Thus, the VIF values fell between 1.315 and 1.982, below the 3.3 threshold, confirming the CMB-free dataset.

4. Findings

4.1. Respondent profile

Among 209 faculty members, 81.8% were female, 50.7% were lecturers, and 45.9% were 30 to below 35 years old (see Appendix B). Further, most faculty members (39.7%) used Microsoft Teams as the most common platform for transmitting educational content within the university campus. Besides, 38.8% of faculty members used Google Classroom as the most common learning platform. Lastly, most respondents were faculty members at Alexandria University (21.1%), followed by 19.1% of those affiliated with Fayoum University. Among 2466 students, most respondents (81%) were females. Besides, most students attend the second level (32.4%), followed by those attending the first level (27.9%). Lastly, most respondents were students at Mansoura University (17.1%), followed by 15.7% of those affiliated with Alexandria University.

4.2. Validity and reliability

The CFA findings demonstrated that the dataset had an acceptable model fit, fitting the proposed six-factor model ($\chi 2/df$ = 1354.377/1.76, CFI = 0.98, TLI = 0.97, RMSEA = 0.05, SRMR = 0.04). Appendix C proved that the proposed six-factor model had the best standard structure and the most significant model fit compared to other models. Cronbach's alpha was used to estimate the reliability of each scale (LeBreton et al., 2023). As shown in Table 1, internal consistency and strong scale reliability were verified using Cronbach's alpha values that exceeded the minimum threshold of 0.70. Convergent and discriminant validity measurements were estimated using average variance extracted (AVE) and composite reliability (CR) to evaluate scale validity. Table 1 demonstrates that all scales exhibit good convergent validity, with Cronbach's alpha (CR) values exceeding 0.70 and average variance extracted (AVE) values exceeding 0.50. In multivariate analysis of variance (MANOVA), Wilks' lambda (λ) is a test statistic that assesses how effectively a collection of construct items can distinguish between various groups of their scales. The findings in Table 1 provide evidence that the λ test values exceeded 0.70.

Table 1
Reliability and validity

Constructs	Code	λ	CR	Alpha	AVE
Digital substitution	DSB1	0.816	0.934	0.928	0.703
	DSB2	0.809			
	DSB3	0.910			
	DSB4	0.863			
	DSB5	0.821			
	DSB6	0.805			
Digital augmentation	DAG1	0.833	0.933	0.916	0.666
	DAG2	0.789			
	DAG3	0.824			
	DAG4	0.836			
	DAG5	0.845			
	DAG6	0.804			
	DAG7	0.777			
Digital modification	DMD1	0.874	0.917	0.886	0.689
	DMD2	0.865			
	DMD3	0.802			
	DMD4	0.808			
	DMD5	0.798			

Table 1 ***(continued)***

Constructs	Code	λ	CR	Alpha	AVE
Digital redefinition	DRD1	0.816	0.920	0.909	0.699
	DRD2	0.823			
	DRD3	0.843			
	DRD4	0.793			
	DRD5	0.900			
Digital transformation strategy	DTS1	0.753	0.904	0.889	0.655
	DTS2	0.872			
	DTS3	0.825			
	DTS4	0.816			
	DTS5	0.774			
Digital transformation culture	DTC1	0.778	0.910	0.904	0.718
	DTC2	0.874			
	DTC3	0.888			
	DTC4	0.845			
Digital transformation funding	DTF1	0.826	0.919	0.912	0.739
	DTF2	0.871			
	DTF3	0.853			
	DTF4	0.887			
Human requirements	HRQ1	0.822	0.840	0.827	0.651
	HRQ2	0.879			
Technical requirements	TRQ1	0.854	0.886	0.868	0.722
	TRQ2	0.833			
	TRQ3	0.862			
Security requirements	SRQ1	0.891	0.937	0.925	0.787
	SRQ2	0.902			
	SRQ3	0.875			
	SRQ4	0.879			
Legislative requirements	LRQ1	0.812	0.862	0.844	0.675
	LRQ2	0.826			
	LRQ3	0.827			
Administrative quality	AQL1	0.876	0.926	0.913	0.714
	AQL2	0.823			
	AQL3	0.836			
	AQL4	0.851			
	AQL5	0.837			
Physical environment quality	PQL1	0.798	0.937	0.925	0.714
	PQL2	0.834			
	PQL3	0.823			
	PQL4	0.817			
	PQL5	0.905			
	PQL6	0.886			
Core educational quality	CQL1	0.834	0.934	0.928	0.669
	CQL2	0.865			
	CQL3	0.873			
	CQL4	0.783			
	CQL5	0.856			
	CQL6	0.777			
	CQL7	0.725			

Table 1 ***(continued)***

Constructs	Code	λ	CR	Alpha	AVE
Support facilities quality	SQL1	0.817	0.919	0.902	0.695
	SQL2	0.825			
	SQL3	0.839			
	SQL4	0.822			
	SQL5	0.864			
Transformative quality	TQL1	0.821	0.912	0.907	0.674
	TQL2	0.798			
	TQL3	0.821			
	TQL4	0.809			
	TQL5	0.856			

The Fornell-Larcker criteria were used to assess discriminant validity. According to the correlation matrix (see Table 2), the square root of the average variance extracted (AVE) for each construct exceeded its correlation coefficient with other variables. As a result, discriminant validity was established, as evidenced by findings (accessible in parentheses) that satisfy the Fornell and Larcker criteria. Furthermore, the findings in Table 2 revealed intercorrelations between the faculty member- and student-level constructs. As such, all intercorrelations were positively and significantly associated with each other, as their correlation values exceeded 0.30 and their p-values were less than 0.05.

Table 2
Discriminant validity and intercorrelations

Constructs	1.	2.	3.	4.	5.	6.
1. Digital augmentation	**(0.868)**					
2. Digital modification	0.576** (0.365)	**(0.821)**				
3. Digital redefinition	0.522** (0.321)	0.692** (0.432)	**(0.836)**			
4. Digital substitution	0.431** (0.321)	0.601** (0.322)	0.598** (0.321)	**(0.867)**		
5. Digital transformation requirements	0.556** (0.226)	0.627** (0.432)	0.583** (0.428)	0.683** (0.245)	**(0.855)**	
6. Higher education service quality	0.687** (0.217)	0.588** (0.415)	0.622** (0.387)	0.628** (0.187)	0.544** (0.354)	**(0.834)**

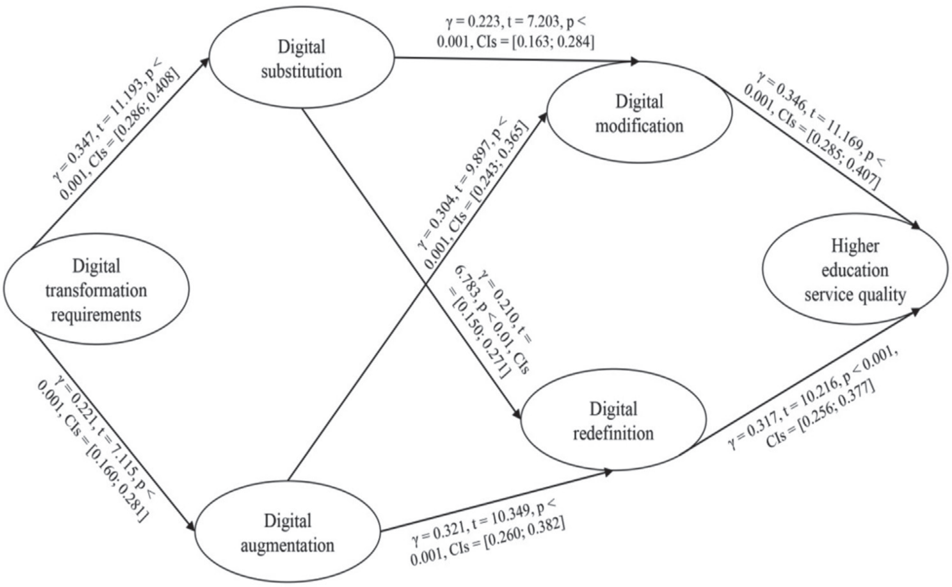
4.3. Model validation

Using bootstrapping with 10,000 iterations (see Table 3 and Figure 3), digital transformation requirements positively affected digital substitution ($\gamma = 0.347$, $t = 11.193$, $p < 0.001$, CIs = [0.286; 0.408]) and digital augmentation ($\gamma = 0.221$, $t = 7.115$, $p < 0.001$, CIs = [0.160; 0.281]), supporting hypotheses H1a-H1b. Likewise, digital substitution positively affected digital modification ($\gamma = 0.223$, $t = 7.203$, $p < 0.001$, CIs = [0.163; 0.284]) and digital redefinition ($\gamma = 0.210$, $t = 6.783$, $p < 0.01$, CIs = [0.150; 0.271]), supporting hypotheses H2a-H2b. In addition, digital augmentation positively affected digital modification ($\gamma = 0.304$, $t = 9.897$, $p < 0.001$, CIs = [0.243; 0.365]) and digital redefinition ($\gamma = 0.321$, $t = 10.349$, $p < 0.001$, CIs = [0.260; 0.382]), supporting hypotheses H3a-H3b. Lastly, higher education service quality was positively affected by digital modification ($\gamma = 0.346$, $t = 11.169$, $p < 0.001$, CIs = [0.285; 0.407]) and digital redefinition ($\gamma = 0.317$, $t = 10.216$, $p < 0.001$, CIs = [0.256; 0.377]), supporting H4a-H4b.

Table 3
Direct effects' findings

Paths	γ	t-value	p-value	BC 95% CI		Supported?
				LL	UL	
H1a. Digital transformation requirements → Digital substitution	0.347***	11.193	0.000	0.286	0.408	Yes
H1b. Digital transformation requirements → Digital augmentation	0.221***	7.115	0.000	0.160	0.281	Yes
H2a. Digital substitution → Digital modification	0.223***	7.203	0.000	0.163	0.284	Yes
H2b. Digital substitution → Digital redefinition	0.210**	6.783	0.002	0.150	0.271	Yes
H3a. Digital augmentation → Digital modification	0.304***	9.897	0.000	0.243	0.365	Yes
H3b. Digital augmentation → Digital redefinition	0.321***	10.349	0.000	0.260	0.382	Yes
H4a. Digital modification → Higher education service quality	0.346***	11.169	0.000	0.285	0.407	Yes
H4b. Digital redefinition → Higher education service quality	0.317***	10.216	0.000	0.256	0.377	Yes

Figure 3
Direct effects' findings



For enhancement stage of SAMR model, Figure 4 and Table 4 findings proved that digital substitution partially mediated the positive effect of digital transformation requirements on digital modification (γ = 0.077, t = 2.496, p < 0.05, CIs = [0.017; 0.138]) and digital redefinition (γ = 0.073, t = 2.351, p < 0.05, CIs = [0.012; 0.134]), supporting hypotheses H5a-H5b. Otherwise, Table 4 and Figure 4 confirmed that digital augmentation does not mediate the positive effect of digital transformation requirements on digital modification (γ = 0.049, t = 1.590, p > 0.05, CIs = [-0.011; 0.110]) and digital redefinition (γ = 0.046, t = 1.497, p > 0.05, CIs = [-0.014; 0.107]). Hence, H6a and H6b were not supported.

For the transformation stage of the SAMR model, Figure 5 and Table 4 findings proved that digital modification partially mediated the positive effect of digital substitution (γ = 0.077, t = 2.489, p < 0.05, CIs = [0.016; 0.138]) and digital augmentation (γ = 0.105, t = 3.393, p < 0.05, CIs = [0.044; 0.166]) on higher education service quality. These findings indicated that H7a and H7b were supported. Otherwise, Figure 5 and Table 4 proved that digital redefinition partially mediated the positive effect of digital substitution (γ = 0.067, t = 2.147, p < 0.05, CIs = [0.006; 0.127]) and digital augmentation (γ = 0.102, t = 3.282, p < 0.05, CIs = [0.041; 0.163]) on higher education service quality. These findings indicated that H8a and H8b were supported.

Figure 4
Partial mediation effect results of SAMR model's enhancement stage

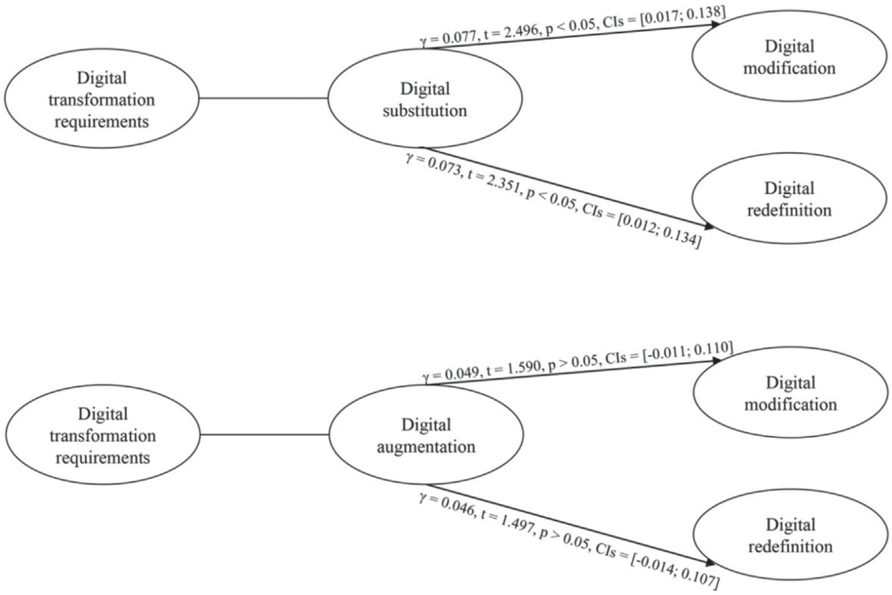
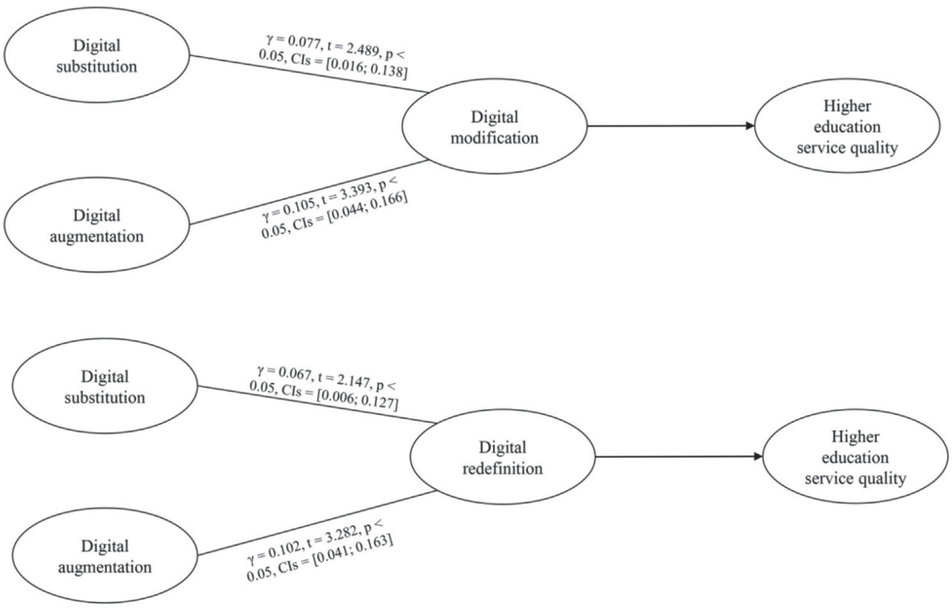


Figure 5
Partial mediation effect results of SAMR model's transformation stage



Next, Table 4 proved that digital substitution and modification cannot serially mediate the effect of digital transformation requirements on higher education service quality (γ = 0.039, t = 1.242, p > 0.05, CIs = [-0.022; 0.099]). Thereby, H9a was not supported. Additionally, digital substitution and redefinition cannot serially mediate the effect of digital transformation requirements on higher education service quality (γ = 0.036, t = 1.149, p > 0.05, 95% CI = [-0.025; 0.096]). Hence, H9b was not supported. Likewise, Table 4 proved that digital augmentation and modification cannot serially mediate the effect of digital transformation requirements on higher education service quality (γ = 0.028, t = 0901, p > 0.05, CIs = [-0.033; 0.089]). Thus, H9c was not supported. Otherwise, digital augmentation and redefinition cannot serially mediate the effect of digital transformation requirements on higher education service quality ($\gamma = 0.023$, $t = 0.732$, $p > 0.05$, CIs = [-0.038; 0.083]). Thereby, H9d was not supported.

Table 4
Indirect effects' findings

Paths	γ	t-value	p-value	BC 95% CI		Supported?
H5a. Digital transformation requirements → Digital substitution → Digital modification	0.077*	2.496	0.037	0.017	0.138	Yes
H5b. Digital transformation requirements → Digital substitution → Digital redefinition	0.073*	2.351	0.039	0.012	0.134	Yes
H6a. Digital transformation requirements → Digital augmentation → Digital modification	0.049	1.590	0.064	-0.011	0.110	No
H6b. Digital transformation requirements → Digital augmentation → Digital redefinition	0.046	1.497	0.071	-0.014	0.107	No
H7a. Digital substitution → Digital modification → Higher education service quality	0.077*	2.489	0.036	0.016	0.138	Yes
H7b. Digital augmentation → Digital modification → Higher education service quality	0.105*	3.393	0.021	0.044	0.166	Yes
H8a. Digital substitution → Digital redefinition → Higher education service quality	0.067*	2.147	0.040	0.006	0.127	Yes
H8b. Digital augmentation → Digital redefinition → Higher education service quality	0.102*	3.282	0.024	0.041	0.163	Yes
H9a. Digital transformation requirements → Digital substitution → Digital modification → Higher education service quality	0.039	1.242	0.084	-0.022	0.099	No
H9b. Digital transformation requirements → Digital substitution → Digital redefinition → Higher education service quality	0.036	1.149	0.092	-0.025	0.096	No
H9c. Digital transformation requirements → Digital augmentation → Digital modification → Higher education service quality	0.028	0.901	0.163	-0.033	0.089	No
H9d. Digital transformation requirements → Digital augmentation → Digital redefinition → Higher education service quality	0.023	0.732	0.187	-0.038	0.083	No

5. Discussion

Our findings reaffirm the transformative potential of digital technologies in reshaping educational practices in academic tourism and hospitality settings. Hence, this aligns with the growing body of literature emphasizing the role of digital transformation in enhancing service quality and educational effectiveness (Bashir et al., 2022; Lončarić et al., 2022). Specifically, the significant effects of digital transformation requirements on digital substitution and augmentation underline the importance of institutional readiness in promoting foundational digital practices. These findings are consistent with the Technology Acceptance Model (Arantes, 2022), which highlights that well-articulated digital transformation goals—encompassing strategy, culture, and infrastructure (El-Akhras et al., 2024)—facilitate the successful adoption and integration of technology in educational settings (Miklosik et al., 2023).

By fostering digital readiness, higher education institutions (HEIs) can address barriers identified in earlier studies, such as inadequate access to technology and insufficient faculty training (Saidakhror, 2024; Selem et al., 2025). As evidenced by the SAMR framework, these foundational practices lay the groundwork for more advanced and transformative educational approaches. Our results confirm that digital substitution and augmentation stages are critical precursors to transformative practices such as digital modification and redefinition. This progression reflects the conceptual ladder proposed by SAMR, where incremental improvements in teaching practices evolve into innovative pedagogical designs (Blundell et al., 2022). For example, the initial use of digital slides (substitution) increases convenience.

Additionally, it prepares educators to incorporate more interactive tools, such as collaborative platforms (augmentation), enabling virtual simulations and real-world problem-solving exercises (modification and redefinition) (Miklosik et al., 2023). This finding underscores the importance of equipping educators with robust digital competencies, as highlighted by studies advocating for faculty training programs and institutional support structures (Alenezi, 2023; Targema-Takema, 2024). The positive relationship between digital modification and redefinition and higher education service quality illustrates how advanced digital transformation stages enhance key dimensions of service quality (Saidakhror, 2024).

By embracing virtual reality (VR) tours and real-time analytics, higher education institutions (HEIs) can create immersive learning environments and tailored educational experiences that meet the evolving needs of students in tourism education (Bashir et al., 2022). These findings align with conceptual models that emphasize transformative practices lead to sustained competitiveness in higher education (Demir et al., 2021) by bridging the gap between traditional education methods and modern digital demands. Higher Education Institutions (HEIs) that invest in advanced technologies and redefine pedagogical practices are better positioned to attract and retain students, thereby enhancing their overall reputation and impact (Miklosik et al., 2023).

Our mediation analyses provide valuable insights into the role of intermediate SAMR stages (substitution and augmentation) in facilitating higher-order transformation stages (modification and redefinition). Hence, this suggests that foundational practices are critically inadequate for achieving transformative outcomes. As emphasized by TAT, this highlights the importance of aligning institutional strategies with the practical affordances of digital tools (Rampa & Parmentier, 2024). For instance, replacing physical handouts with digital presentations can lead to meaningful transformation when complemented (Alenezi, 2023) by institutional policies that support ongoing professional innovation (Muslimin et al., 2024).

The lack of significant mediation by augmentation suggests that while enriched functionalities are valuable (Demir et al., 2021), they alone do not guarantee progression to transformation stages. Contrary to expectations, serial mediation analyses did not provide strong evidence for a strictly linear progression from substitution through modification and redefinition in enhancing service quality. These finding challenges traditional interpretations of the SAMR framework, suggesting that digital transformation in higher education may follow more complex and interconnected pathways. Huang and Macgilchrist (2024) highlighted successful digital transformation requires simultaneous investments across multiple SAMR stages rather than a sequential progression.

Accordingly, faculty members proficient in the necessary tools may simultaneously adopt augmented functionalities and explore virtual reality trips. In tourism education, this complexity is evident, as industry-specific demands often require parallel integration of basic and advanced technologies. For instance, global distribution systems training might necessitate digital competencies alongside augmented features and redefined pedagogies (Kainthola & Singh Kaurav, 2024). These findings underscore the importance of a holistic approach to digital transformation, where enhancement and transformation stages are aligned to achieve institutional goals. Overall, our findings emphasize that while SAMR provides a reasonable lens for understanding digital transformation, its application in higher education is more dynamic than a strictly linear process. Higher Education Institutions (HEIs) must adopt flexible, multifaceted strategies that simultaneously address foundational and transformative practices.

5.1. Theoretical implications

This paper significantly advances our understanding of the interplay between digital transformation requirements and the quality of higher education services in tourism education. First, by framing our paper through TAT, we elucidate four levels of interrelated pedagogical affordances of technology. TAT asserts that the design and functionalities of technological tools facilitate or restrict specific student and faculty member behaviours and practices (Arantes, 2022). Consequently, prerequisites for digital transformation provide objective-based guidelines for governing behaviours and facilitating technological capabilities (Mishra et al., 2024).

Technological affordances can differ depending on the nature and types of educational technologies. For example, aesthetic affordances are essential if technology apps need to stimulate users' visual senses (Wang et al., 2024), or user control, synchronicity, and bi-communication are essential if technological tools need to help students learn in constructivist ways (Arantes, 2022). Pedagogical affordances were demonstrated through supported hypotheses that elucidate connections between SAMR stages in sequential and serial mediation, thereby enhancing the quality of higher education services. These hypotheses are grounded in TAT. For example, substitution refers to digital alternatives (e.g., utilizing digital technologies to enhance document editing and sharing) (Blundell et al., 2022), which educators employ to streamline administrative tasks and improve organizational efficiency.

Other substitution affordances of education technology include digital whiteboards and e-assessment, which create foundational shifts in educational delivery. These technological and pedagogical functions afford the replacement of traditional educational practices with digital equivalents that enhance engagement. Augmentation affordance of educational technologies enhances learning experiences by integrating additional features that improve existing tasks. For example, PowerPoint can create dynamic presentations that include multi-media elements. This enhancement can increase student engagement and understanding, as learners can interact with the content in different ways. However, affordance enhancement might not lead to new ideas in higher education (Arantes, 2022).

The modification pedagogical function affords collaboration and real-time feedback. In turn, this enables students and faculty members to work together seamlessly, fostering communities of practice. In this way, this paper contributes to the development of community-engaged pedagogies. Additionally, the affordance redefinition of educational technologies through immersive experiences and creative problem-solving abilities offer transformative potential. It enables users to engage in experiential learning, critical thinking, and collaboration (Rampa & Parmentier, 2024), leveraging administrative, physical, core educational, and support facilities, as well as transformative qualities in higher education. Secondly, this paper addresses notable gaps in the tourism education literature by identifying the unique affordances of each SAMR stage. Hence, this overlooks the sequential and cumulative effects of different affordances in educational settings and is suited to Industrial Revolution 4.0 (Mishra et al., 2024) and Education 4.0 (Targema-Takema, 2024).

Third, integrating TAT with SAMR invites a dynamic understanding of educational technology implementation. Hence, this encourages educators to consider the technologies employed and how affordances are leveraged to meet educational objectives. This perspective aligns with social constructivist learning theories, which advocate for learner-centred approaches that emphasize social engagement. Ultimately, HEIs can facilitate collaboration among academics and industry stakeholders to foster environments that promote the improvement of educational methods. Thus, digital transformation requirements enact pivotal roles of resource orchestration and institutional mechanisms.

5.2. Practical implications

This paper offers valuable insights by conceptualizing SAMR stages as functional affordances rooted in the Theory of Action Transformation (TAT). Integrating TAT in educational contexts underscores the importance of designing educational technologies that align with user needs and expectations (Targema-Takema, 2024). For instance, Lee and John (2024) emphasized that neglecting pedagogical beliefs and professional development can derail the intended outcomes of digital transformation in higher tourism education. TAT advocates for a symbiotic relationship between technology design and user interaction (Crompton & Burke, 2020), making it compatible with SAMR as a tool for transformative educational practices (Arantes, 2022).

TAT posits that technology features inherently suggest or afford specific uses and actions, guiding educators and learners in making effective choices for implementation (Islam et al., 2024). This alignment with the SAMR framework is evident as each level offers distinct affordances (Targema-Takema, 2024), ranging from basic efficiencies at the substitution stage to enabling knowledge creation forms during the redefinition stage (Lee & John, 2024). Such insights empower educators to leverage technology purposefully across different stages of the SAMR framework, facilitating effective knowledge transitions and pedagogical transformation.

Accordingly, HEIs should prioritise adopting substitute technologies (e.g., digital assessment) to optimize administrative procedures and enhance accessibility. Digital assessment tools enable faster and more accurate grading of student work. Furthermore, HEIs can leverage the augmentation functions of education technologies (e.g., interactive e-books) (Chandra et al., 2022), as evidenced by the fact that interactive e-books significantly enhance students' learning attention and performance. By promoting collaborative multimedia presentations and digital storytelling among students, faculty members, and administrators, higher education institutions (HEIs) can substantially enhance teamwork and communication skills.

Furthermore, exploring opportunities to transform educational methodologies through emerging technologies, including fostering international partnerships, enhances scientific outputs (Paterson et al., 2024). To successfully implement these initiatives, faculty members and administrative staff must participate in ongoing professional development focused on technology integration. In essence, technology integration through the SAMR framework should be transformative (Targema-Takema, 2024), directly tied to institutional goals and the quality of service delivered by higher education institutions (HEIs). Professional development is crucial for faculty members to transition from traditional content delivery to interactive, student-centered learning approaches. Higher Education Institutions (HEIs) should prioritise engaging digital content that encourages active participation and enhances student satisfaction.

Additionally, HEIs should implement systems for ongoing evaluation and feedback regarding the efficacy of the SAMR process in addressing the holistic requirements of digital transformation and enhancing various aspects of service quality (e.g., administrative, physical, core educational, support facilities, and transformative quality). By employing surveys and gathering feedback from students and administrators that involve SAMR processes (Targema-Takema, 2024), higher education institutions (HEIs) can gain significant insights into how technologies have enhanced students' cognitive levels for transformative change (Selem et al., 2025). These insights inform strategic decision-making and pedagogical practices, emphasizing the need for HEIs to prioritise foundational steps for successful digital transformation.

5.3. Limitations and future research

This paper focused on tourism and hospitality colleges, whose results may benefit universities or private tourism and hospitality institutes. It restricts the possibility of generalization to broader educational contexts. The existing paper focuses on the usage of specific educational tools. This paper also highlights the need for longitudinal studies examining sustainability and the long-term effects of digital interventions, where cross-sectional designs limit causal interpretations. Comparative studies between public and private education, as well as cross-country studies, can be conducted. Qualitative studies can also offer deeper insights into the perspectives of faculty members and students regarding digital integration and educational quality.

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Submitted: August 21, 2024
Revised: March 04, 2025
Accepted: March 11, 2025

Appendix A.

Measurement items

Constructs	Code	Items
Digital substitution	DSB1	Students use Microsoft Office apps available on computers instead of using paper.
	DSB2	Ongoing student applications are made in the form of online files instead of traditional paper.
	DSB3	Digital whiteboards are used to display educational content and write notes instead of traditional blackboard.
	DSB4	Students are encouraged to find up-to-date course information using mobile applications.
	DSB5	Students are assessed electronically instead of using traditional assessment methods.
	DSB6	Digital maps are used to display tourist destinations rather than paper maps.
Digital augmentation	DAG1	Students add images, sound files, and hyperlinks to their PowerPoint projects.
	DAG2	E-books are used with the possibility of highlighting some paragraphs and taking notes.
	DAG3	Teleconference platforms are used for student conferences.
	DAG4	Students share lecture files using Google Docs.
	DAG5	Students use Google Voice Dictionary to enhance their memorization of course words.
	DAG6	VR applications are used to enhance theoretical course contents.
	DAG7	Students use social media platforms to share and vote on their work with classmates.
Digital modification	DMD1	Students create multimedia presentations that combine text and video to communicate their ideas.
	DMD2	Students collaborate on making movies and PowerPoint using interactive whiteboards.
	DMD3	Student applications are evaluated electronically, and results are sent via academic email.
	DMD4	Students edit documents on wikis or blogs and receive feedback from others around the world.
	DMD5	Digital storytelling tools are used to showcase cultural and historical aspects of destinations.
Digital redefinition	DRD1	Students use VR technologies to create educational videos of tourist destinations before visiting them.
	DRD2	Students create pages on Facebook to share their work and have their classmates vote on it.
	DRD3	Students use educational game apps to test their science knowledge.
	DRD4	Create "hashtags" with course names and post them among students as a reference for discussion.
	DRD5	Students collaborate with peers from worldwide on research projects using basic online tools.
Digital transformation strategy	DTS1	Students are provided with skills to deal with digital libraries and databases.
	DTS2	A system of digital interactive tests and an online feedback system are provided.
	DTS3	The process of contacting students and parents and obtaining grades is facilitated through college websites.
	DTS4	Educational programs are revised every five years to become more adapted to the digital transformation.
	DTS5	Students are provided with interactive group learning and problem-solving skills.
Digital transformation culture	DTC1	Faculty members, administrative staff, and students participate in digital transformation programs.
	DTC2	Partnerships are being built inside and outside universities and contribute to spreading the digital culture.
	DTC3	A unit for digital transformation was established under the college dean.
	DTC4	Education and a culture of continuous training in digital transformation skills are being disseminated.
Digital transformation funding	DTF1	Private sector roles in supporting development and change processes are activated.
	DTF2	Attention is given to computer science and information systems in the faculty.
	DTF3	Invite the local community to participate in financing information technology infrastructure development.
	DTF4	Faculty employees are trained on various technologies to keep abreast of current digital developments.
Human requirements	HRQ1	There are college leaders who deal effectively with information technology.
	HRQ2	Teaching staff skills in digital teaching strategies are developed.

Technical requirements	TRQ1	Classroom management systems are provided electronically.
	TRQ2	Radical development of infrastructures for digital transformation is being conducted within colleges.
	TRQ3	A communication network connected to the Internet is provided in all faculty halls.
Security requirements	SRQ1	Information security strategies are developed to ensure cooperation between public and private sectors.
	SRQ2	Systems are put in place to control data and information privacy and quality.
	SRQ3	Monitoring and follow-up mechanisms are established for information systems, networks, and devices.
	SRQ4	Rules are established for use of data and information.
Legislative requirements	LRQ1	University legislations are developed in line with the innovations required by knowledge societies.
	LRQ2	Laws and regulations are being passed that allow for partnerships with universities around the world.
	LRQ3	Legislation and laws are issued that allow ease of digital transformation and meet adaptation requirements.
Administrative quality	AQL1	I find that administrative members are always ready to help students.
	AQL2	I find that members of the administrative body have the ability to solve students' problems.
	AQL3	I find administrative procedures clear and well organized.
	AQL4	Administrative members are courteous and polite.
	AQL5	Faculty member behaviors give me high confidence.
Physical environment quality	PQL1	The appropriate infrastructure is available for my college library.
	PQL2	Suitable lecture halls are available in my college.
	PQL3	Quiet places to study are available on campus.
	PQL4	Appropriate educational tools and equipment (i.e., projector and white boards) are available.
	PQL5	Favorable environmental conditions prevailing within our campus are provided.
	PQL6	Security is available on our campus.
Core educational quality	CQL1	Our faculty members help to ___________ Understand the needs of students.
	CQL2	Give personal attention to students.
	CQL3	Are available to guide and guide students.
	CQL4	Care about student interests.
	CQL5	Use multimedia in teaching using a projector or Power Point presentations.
	CQL6	Engage students in their learning process to encourage communication skills.
	CQL7	Reinforce practical skills through well-designed examinations, quizzes and ongoing assignment.
Support facilities quality	SQL1	Food and beverage services are available at appropriate price on the university campus in my college.
	SQL2	Adequate IT facilities are available in my college.
	SQL3	Adequate photocopying and printing services are available in my college.
	SQL4	Recreational facilities are available in my college.
	SQL5	My college organizes student activities are available.
Transformative quality	TQL1	Our faculty members help to ___________ Increase my self-confidence.
	TQL2	Develop my critical thinking.
	TQL3	Develop my problem-solving skills.
	TQL4	Acquire sufficient knowledge and skills to perform the work in the future.
	TQL5	Increase my knowledge, abilities and skills.

Appendix B

Respondent profile

N_{Member} = 209		
Category	**Frequency**	**%**
Gender		
Male	38	18.2
Female	171	81.8
Academic job		
Lecturer	106	50.7
Assistant Professor	66	31.6
Professor	37	17.7
Age-wise		
30-Less than 35 years	96	45.9
35-Less than 45 years	74	35.4
45-Less than 55 years	23	11
Above 55 years	16	7.7
The technology used by you in transmitting educational content within the university campus ___________		
Zoom Meeting	49	23.4
Microsoft Teams	83	39.7
ThingLink	59	28.2
Quizizz	12	5.7
Plickers	6	2.9
Learning platforms that you used _________		
Blackboard	11	5.3
Twiducate	15	7.2
Edmodo	35	16.8
Moodle	67	32.1
Google Classroom	81	38.8
The university you belong to ___________		
Helwan	25	12
Suez Canal	29	13.9
Mansoura	33	15.8
Luxor	28	13.4
Alexandria	44	21.1
Fayoum	40	19.1
Beni Suef	10	4.8

$N_{Student}$ = 2466		
Category	**Frequency**	**%**
Gender		
Male	468	19
Female	1998	81
Academic level		
First	687	27.9
Second	799	32.4
Third	651	26.4
Fourth	329	13.3
The university you belong to ___________		
Helwan	324	13.1
Suez Canal	376	15.3
Mansoura	421	17.1
Luxor	344	14
Alexandria	387	15.7
Fayoum	365	14.8
Beni Suef	249	10.1

Appendix C

Comparison of measurement models

Models	χ^2	χ^2/df	$\Delta\chi^2_a\ (\Delta df)$	**CFI**	**TLI**	**RMSEA**	**SRMR**
Hypothesized six-factor model (Digital substitution, Digital augmentation, Digital modification, Digital redefinition, Digital transformation requirements, Higher education service quality)	1354.377	1.76	-	0.98	0.97	0.05	0.04
Alternative five-factor model (Digital substitution, Digital augmentation + Digital modification, Digital redefinition, Digital transformation requirements, Higher education service quality)	3651.435	6.112	3421.66	0.72	0.65	0.12	0.11
Alternative four-factor model (Digital substitution, Digital augmentation + Digital modification, Digital redefinition + Digital transformation requirements, Higher education service quality)	4665.115	7/376	5187.98	0.51	0.49	0.23	0.24
Alternative three-factor model (Digital substitution, Digital augmentation + Digital modification + Digital redefinition + Digital transformation requirements, Higher education service quality)	6998.187	9.115	6554.47	0.34	0.37	0.41	0.42