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Integrating ICT into Career Counseling: An Empirical Study of the TACC Digital Content Model in Malaysian Secondary Education

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Abstract
This study develops and validates the Technology-Assisted Career Counseling (TACC) Digital Content Model, a structured framework integrating AI-driven assessments and career management systems to modernize career guidance in Malaysian secondary schools. Addressing gaps in Malaysia's Digital Education Policy (2023), which lacks actionable ICT frameworks for career counseling, the TACC model replaces outdated practices with scalable digital tools. Adopting a Design and Development Research approach, the study progressed through three phases: (1) needs analysis via surveys of 65 Sabah school counselors (mean agreement = 4.68/5.0, SD = 0.47), (2) model development validated by 15 experts using Fuzzy Delphi Method (consensus threshold ≥0.70; achieved fuzzy scores ≥0.887) and Interpretive Structural Modeling to establish hierarchical relationships among TACC's four core components (career assessment, information, management, guidance systems), and (3) usability evaluation by 21 Digital Career Counselor via Modified Nominal Group Technique, yielding an 89.3% usability score (SD = 0.72). Results confirm strong counselor support for digital integration, expert consensus on model components, and high practicality for implementation. As the first study to synergize Fuzzy Delphi and Interpretive Structural Modeling within a DDR framework for career counseling, the TACC model offers a validated, scalable blueprint aligned with national digital education goals. Its implementation empowers counselors with AI-driven tools, equips students for Industry 4.0 demands, and provides policymakers with a replicable framework for ICT integration across educational domains.
Keywords: Technology-Assisted Career Counseling, TACC Model, Fuzzy Delphi Method, Digital Career Guidance

Introduction

Malaysia's education system is evolving rapidly in response to Industry 4.0, with digitalization becoming central to national reform efforts. The Malaysia Digital Education Policy (Ministry of Education Malaysia, 2023) reflects this shift but lacks concrete frameworks for integrating technology-assisted career guidance in schools. Current counseling practices remain outdated, often relying on manual tools and non-interactive methods, which leave students inadequately prepared for an increasingly digital workforce (Zainudin et al., 2022; Omar et al., 2022). This gap underscores the urgent need for evidence-based, scalable digital solutions that integrate both pedagogical and psychological perspectives. The Social Cognitive Career Theory (SCCT) provides a foundation for personalized student decision-making, while the Unified Theory of Acceptance and Use of Technology (UTAUT) offer insights into how users adopt and engage with educational technology (Lent et al., 1994; Venkatesh et al., 2003). Addressing this need, the present study introduces the Technology-Assisted Career Counseling (TACC) Digital Content Model, an empirically validated, theory-informed framework that integrates AI-powered assessments, digital career systems, and online guidance tools into Malaysian secondary school counseling. The model is aligned with current findings on digital competency, institutional readiness, and long-term technology adoption in education (Cabero et al., 2023; Tan & Kiflee, 2022), making it not only a response to national policy priorities but also a potentially scalable and globally relevant innovation in the field of educational technology.

Literature Review

The integration of technology into career counseling has reshaped educational guidance, particularly in secondary education. A growing body of evidence supports Technology-Assisted Career Counseling (TACC) as a means of enhancing student engagement, decision-making, and access to career information (Kosunen et al., 2021; Nelson, 2023). These tools represent a shift from static, paper-based systems to interactive, data-informed platforms designed for broader educational inclusion. Theoretical foundations for TACC include the Social Cognitive Career Theory (SCCT) (Lent et al., 1994), which highlights self-efficacy and goal-setting in career decisions, and the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003), which explains technology adoption in educational contexts. These frameworks provide a robust basis for designing tools that are both pedagogically sound and technologically effective. Contributions from constructivist learning theory and Leung's Big Five Career Theories further support learner-centered and culturally responsive development (Leung, 2008).

In Malaysia, school-based career counseling has evolved from vocational orientation to holistic services, but remains constrained by limited digital infrastructure and practitioner readiness (Zainudin et al., 2022). The TACC model responds to this gap by offering a structured, scalable solution aligned with national digital policy initiatives (MOE, 2023). Earlier calls for computer-assisted guidance (Krumboltz, 1979) are now realized through tools enhanced by AI and interactive media, such as virtual reality and career simulations (Johnson, 2023; Westman et al., 2021). A systematic literature review (SLR) conducted for this study reviewed over 50 peer-reviewed sources across Scopus, PsycINFO, and ERIC. The findings confirm that TACC interventions consistently improve students' career exploration, planning, and self-efficacy (Jones, 2023; Zainuddin et al., 2022; Smith, 2023). Platforms that incorporate self-assessment, real-time information, and adaptive content were particularly effective (Osborn et al., 2014; Sampson et al., 2020). The use of AI is emerging as a key driver for personalized career guidance, enabling dynamic assessments and real-world simulations (Venable, 2022).

Despite these advances, researchers caution against the complete replacement of face-to-face counseling. Instead, TACC should be framed as a complementary innovation, enhancing scalability and access while preserving the human dimension of counseling (Sampson et al., 2020; Pelling, 2002). Ethical concerns, digital literacy gaps, and system biases remain important considerations in implementation (Osborn et al., 2014). In summary, the literature strongly supports TACC as an evidence-based, theoretically grounded, and policy-relevant model for transforming career counseling in education. It aligns with both Malaysia's digital transformation goals and the global movement toward competency-based, technology-enhanced learning ecosystems.

Methodology

This study adopts a rigorous Design and Development Research (DDR) approach, as established by Richey and Klein (2007), to effectively develop, validate, and evaluate the usability of the Technology-Assisted Career Counseling (TACC) Digital Content Model. The DDR method is structured into three interconnected phases: Needs Analysis, Model Design and Development, and Usability Evaluation, as per the educational research method proposed by Saedah et al. (2013).

Phase 1: Needs Analysis

The initial phase decisively uncovers the critical requirements for the TACC model aimed at enhancing career guidance in Malaysian secondary schools. 65 school counselors from the West Coast Zone of Sabah actively participated in this vital phase. The demographic breakdown included 44.6% males and 55.4% females, with an impressive 92.3% holding at least a Bachelor's degree, underscoring the high qualifications of the participants. A structured questionnaire was employed, organized into three sections: Section A, demographic information, Section B explored the specific digital career counseling needs, and Section C assessed the respondent's agreement with proposed TACC components. This instrument was rigorously adapted from validated tools, including the Technology-Assisted Career Counseling Needs Assessment Questionnaire (TACC-NAQ) devised by Merca & Dislere (2018), along with frameworks established by Kettunen et al. (2015) and Barnes et al. (2010). Comprehensive descriptive analysis was conducted using SPSS 29.0, mean scores and percentage distributions that unequivocally illustrated the counselors' readiness and demand for integrating digital resources into their counseling practices.

Phase 2: Model Design and Development

This pivotal phase is further divided into two decisive phases. In the design phase, the structural elements and items of the TACC model were systematically formulated based on an exhaustive literature review. The validation of these components was conducted using the Fuzzy Delphi Method (FDM). A select group of 15 subject-matter experts specializing in career counseling and educational technology was chosen to provide their authoritative insights. This consensus-building process was paramount in identifying the core elements of the TACC model, which include TACC Assessment System (TACC-AS), TACC Information System (TACC-IS), TACC Career Guidance Content Structure (TACC-CGCS), and TACC Media Components (TACC-MC). The FDM process involved precise conversions of expert judgments into triangular fuzzy numbers, rigorous calculations of threshold values, and the application of defuzzification techniques. Items achieving fuzzy scores of ≥0.70 and consensus levels exceeding 75% were definitively retained in the model.

Fuzzy Delphi Method (FDM) Approach

The Delphi method is a widely accepted and frequently used approach for collecting data in research studies, particularly those that rely on consensus among a panel of experts on a specific issue (Hsu & Brian, 2007). One of the strengths of this method is its evolution into various empirical data collection techniques, such as the Fuzzy Delphi Method (FDM). The FDM is a modified version of the classic Delphi method. It was introduced by Kaufman and Gupta in 1988 as a hybrid technique that combines fuzzy set theory with the traditional Delphi process (Murray, Pipino, & Vangigch, 1985). This means that although it incorporates fuzzy logic principles, it is not an entirely new approach; rather, it builds on the classical Delphi method, where participants must be experts in a specific domain relevant to the context of the study.

Data Analysis Based on the Fuzzy Delphi Method (FDM)

There are two primary components in the FDM approach: the Triangular Fuzzy Number (TFN) and the Defuzzification Process. The Triangular Fuzzy Number consists of three values: m1, m2, and m3. Here, m1 represents the minimum or lowest plausible value, m2 signifies the most reasonable or likely value, and m3 indicates the maximum or highest plausible value. These values form a triangular shape, as illustrated in Figure 3.3, which plots the average score against the triangular fuzzy values. According to Figure 3.3, the three TFN values fall within a range of 0 to 1, which is consistent with the principles of fuzzy numbering (Ragin, 2007).

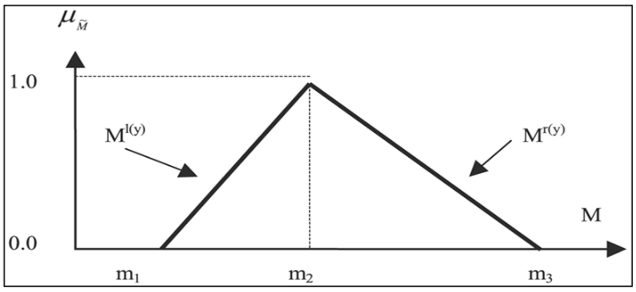

Figure 1 Triangular Graph of Mean versus Triangular Fuzzy Values

At the Triangular Fuzzy Number stage, two main conditions must be satisfied to determine whether a particular element is accepted based on expert consensus. The first condition involves the threshold value (d), and the second relates to the percentage of expert agreement for a given element. The determination of the threshold value (d) is based on a predefined mathematical formula. Both of these conditions will be further explained in the subsequent section on the procedures for conducting research using the Fuzzy Delphi Method (FDM). The Defuzzification Process refers to the process of ranking each construct, component, element, issue, variable, and sub-variable examined in the study. The purpose of this process is to assist the researcher in determining the level of necessity for each variable and sub-variable under investigation. Additionally, it enables the prioritization of each element, producing a ranked list based on expert consensus. There are three defuzzification formulas that researchers can choose from to determine the rankings in their study. These formulas are as follows:

i. $A_{max} = 1/3 * (a_1 + a_m + a_2)$
ii. $A_{max} = 1/4 * (a_1 + 2a_m + a_2)$
iii. $A_{max} = 1/6 * (a_1 + 4a_m + a_2)$

At this stage, a final condition must be met to confirm expert agreement, which involves using the median value, also known as the alpha-cut (α-cut). This alpha-cut value is used to indicate acceptance of the elements being studied.

Procedure for Conducting Research Using the Fuzzy Delphi Method (FDM)

To obtain research findings using the Fuzzy Delphi Method (FDM), specific procedures must be followed. Adhering to these procedures ensures the collection of reliable and empirical data. Figure 3 presents the flowchart outlining the step-by-step process involved in conducting a study using the FDM approach.

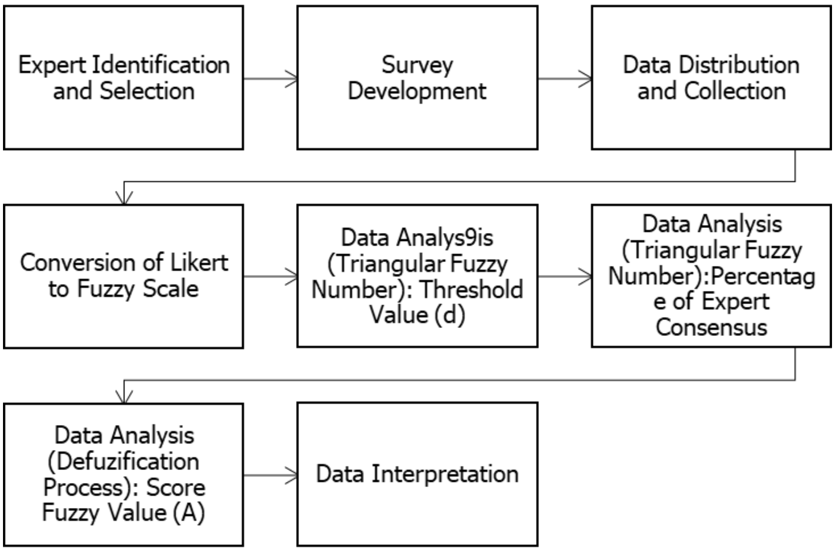

Figure 2 Flowchart of the Fuzzy Delphi Method (FDM) Procedure

Data Analysis Based on Triangular Fuzzy Numbers

This step involves analyzing data using triangular fuzzy numbers, with the aim of calculating the threshold value (d). The first condition that must be fulfilled is that the threshold value (d) must be less than or equal to 0.2, as suggested by Cheng and Lin (2002). The vertex method is used to compute the distance between the average fuzzy numbers rij. The threshold value (d) between two fuzzy numbers, m = (m1, m2, m3) and n = (n1, n2, n3), is calculated using the following for $d\left(\tilde{m},\tilde{n}\right) = \sqrt{\frac{1}{3}\left[(m_1 - n_1)^2 + (m_2 - n_2)^2 + (m_3 - n_3)^2\right]}$.

Table 1
Sample Threshold (d) Values for 3 Items Evaluated by 12 Experts

Expert	**Item 1**	**Item 2**	**Item 3**
1	0.059	0.110	0.072
2	0.059	0.045	0.072
3	0.059	0.045	0.072
4	**0.300**	0.045	0.072
5	0.095	0.045	0.082
6	0.059	0.045	0.082
7	0.095	0.045	0.082
8	0.095	0.045	0.082

Expert	Item 1	Item 2	Item 3
9	0.095	0.045	0.082
10	0.095	0.045	0.082
11	0.095	0.045	0.082
12	0.059	**0.347**	**0.311**
Average Threshold (d) per Item	**0.101**	**0.027**	**0.073**

Table 1 displays sample threshold (d) values generated for three items evaluated by a panel of 12 experts. The table presents the individual threshold values for each item as assessed by each expert, along with the overall threshold (d) value for each item. The bolded values in the table indicate threshold values that exceed the acceptable limit of 0.2.

Table 2
Sample Percentage of Expert Consensus

Item	Item 1	Item 2	Item 3
Number of Experts with d ≤ 0.2	9	9	9
Percentage of d ≤ 0.2	90.0%	90.0%	90.0%

Data Analysis Using Average of Fuzzy Numbers (Defuzzification Process)
This step involves the analysis of data through the defuzzification process, which aims to calculate the fuzzy score value (A). To satisfy the third condition, the fuzzy score value must be equal to or [illegible] n is 0.5 (Tang & Wu, 2010; Bodjanova, 2006). Meeting this requirement indicates that the element has been accepted based on expert consensus. Beyond acceptance, the fuzzy score value (A) can also be used to rank the importance and priority of each item or element according to expert evaluations. The formula used to calculate the fuzzy score (A) is as follows:

$$A = (1/3) *(m_1 + m_2 + m_3)$$

Table 3
Sample Fuzzy Score (A) Values

Item	m1	m2	m3
Item 1	0.780	0.930	0.990
Item 2	0.880	0.990	1.000
Item 3	0.820	0.960	1.000

Number of Experts in the Fuzzy Delphi Method (FDM)
Adler and Ziglio (1996) argue that an appropriate number of experts for the Delphi method ranges between 10 and 15, especially when there is a high level of consistency among expert opinions. However, Jones and Twiss (1978) suggest that the number of experts involved in a Delphi study can range from 10 to 50, depending on the scope and nature of the study. In the context of this research, 15 experts were appointed, all of whom were directly involved and relevant to the subject matter under investigation.

Interpretive Structural Modeling (ISM) Approach

The Interpretive Structural Modeling (ISM) approach was employed in this study to determine the hierarchy and prioritization of elements within the TACC digital content system model. Originally introduced by Walfred (1973), ISM serves as a powerful qualitative tool to deconstruct complex problems and systematically organize expert opinions into a structured model. It supports collaborative decision-making by mapping interrelationships among key factors through expert voting, typically assisted by specialized software. In this study, ISM was implemented through three key stages: identifying relevant issues, establishing contextual relationships, and developing the Self-Structural Interaction Matrix (SSIM) to construct a hierarchical model. Seven carefully selected experts participated in this process. Their insights were used to create a conceptual framework that visually represents the influence and connectivity of each element. ISM has proven to be a highly effective method for clarifying ambiguous structures, enabling the development of robust, expert-driven models in complex domains such as career counseling.

Phase 3: Usability Evaluation

In the final phase, 21 highly trained Digital Career Counsellor Ambassadors (DKKD), Digital Counselors, and Adiwira Counselors were engaged to evaluate the model's usability with the Modified Nominal Group Technique (NGT). The usability evaluation questionnaire was robust and comprehensive, encompassing five key sections: demographics of the respondents, suitability of core model elements, appropriateness of item content, priority ranking of items, and overall perceptions of model usability. The expert feedback was subjected to rigorous quantitative analysis, enabling the calculation of usability scores based on three critical criteria: practicality, feasibility, and user satisfaction. A stringent usability acceptance threshold was established at 80%, ensuring that the model consistently meets the highest standards for implementation. In conclusion, this DDR-based methodological approach offers a thorough, iterative, and theory-driven process that effectively cultivates a practical, valid, and contextually relevant TACC model for secondary school career guidance in Malaysia. Key data analysis methods employed including fuzzy logic, ISM-based modeling, and consensus-driven usability metrics are strategically designed to uphold the model's integrity and ensure its applicability in real-world educational contexts.

Results

The findings of this study highlight a significant demand and professional consensus for the integration of digital content in career counseling services for secondary schools in Malaysia. The study was structured around three core phases. The first phase, Needs Analysis, followed by Design and Development, and finally Usability Evaluation, each provided empirical support for the development and implementation of the Technology-Assisted Career Counseling (TACC) Digital Content Model.

High Demand for Digital Tools

The Needs Analysis phase revealed that full-time school counselors expressed strong support for the development of the TACC Digital Content Model. A five (5) point likert scale showed high agreement levels on the need for the model, approval for its development, and acceptance of its elements and items indicating a clear recognition of the need for technology integration in career guidance.

Table 4
Level of Consensus of School Counselors on the Need Analysis Phase

Research Sub-Question	Mean	Standard Deviation	Level of Consensus
Need for TACC Model Development	4.68	0.47	Very High
Approval for Developing TACC Model	4.62	0.51	Very High
Approval for the Content Elements of the Model	4.55	0.49	High
Approval for the Items in the Content of the Model	4.58	0.45	High

Table 5
Core Elements of the TACC Digital Content Model Based on Fuzzy Delphi (FDM) Analysis

No.	Element	Threshold Value (d)	Expert Agreement (%)	m1	m2	m3	Fuzzy Score (A)	Element Status	Rank
1	Technology-Assisted Career Counseling Assessment System (TACC-AS)	0.035	100.0%	0.873	0.987	1.000	0.953	ACCEPTED	1
2	Technology-Assisted Career Information System (TACC-IS)	0.060	100.0%	0.847	0.973	1.000	0.940	ACCEPTED	2
3	Technology-Assisted Career Guidance and Counseling System (TACC-CGCS)	0.130	100.0%	0.767	0.913	0.980	0.887	ACCEPTED	4
4	Technology-Managed Career Counseling System (TACC-MC)	0.068	100.0%	0.833	0.967	1.000	0.933	ACCEPTED	3

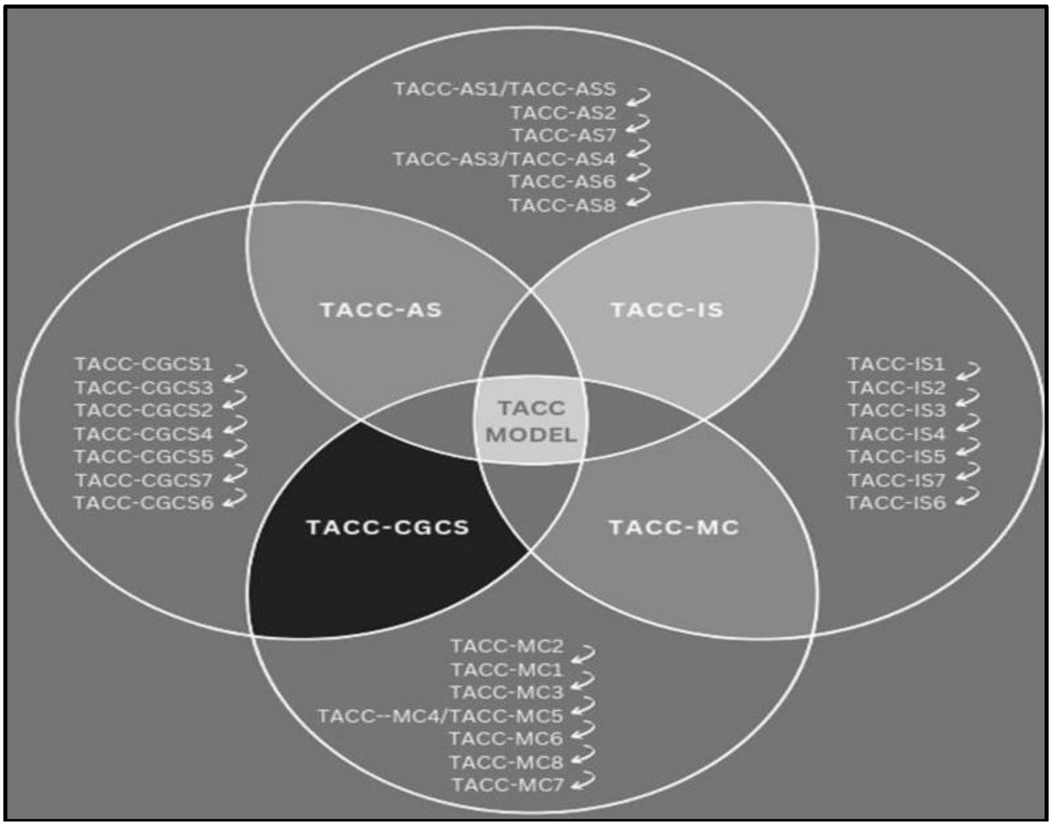

Figure 4 The TACC Digital Content System Model

Figure 4 presents the structure of the TACC Digital Content Model, which comprises four core components: the Technology-Assisted Career Assessment System (TACC-AS), the Technology-Assisted Career Information System (TACC-IS), the Technology-Managed Career Counseling System (TACC-MC), and the Technology-Assisted Career Guidance and Counseling System (TACC-CGCS). Each component contains specific digital elements designed to enhance various aspects of school-based career counseling, such as digital assessment tools, career information platforms, automated management systems, and interactive guidance technologies. This integrated framework reflects a holistic, technology-driven approach to modernizing career services in secondary education.

High Usability of the Model

The final usability evaluation involved 21 Digital Career Counsellor Ambassadors using the Modified Nominal Group Technique (NGT). The results demonstrated high usability across all four core components, with scores ranging from 78.9% to 81.0%. The overall model scored 89.3% (SD = 0.72), affirming its practicality and applicability in real-world settings.

Table 6
Expert Evaluation of TACC Model Components Using Modified Nominal Group Technique (NGT)

Flow and Priority of Items for Each Core Element	**A (n=7)**	**Expert Group Score B (n=7)**	**C (n=7)**	**Total Score**	**Percentage (%)**	**Evaluation Status**
Flow and Priority of Items for the Technology-Assisted Career Assessment System (TACC-AS)	39	38	42	119	81.0%	Suitable
Flow and Priority of Items for the Technology-Assisted Career Information System (TACC-IS)	41	40	38	119	81.0%	Suitable
Flow and Priority of Items for the Technology-Managed Career Counseling System (TACC-MC)	43	39	36	118	80.3%	Suitable
Flow and Priority of Items for the Technology-Assisted Career Guidance and Counseling System (TACC-CGCS)	41	38	37	116	78.9%	Suitable

Table 6 summarises the results of the Modified Nominal Group Technique (NGT) conducted with three expert groups (A, B, and C), each comprising seven participants. The table reflects expert evaluations of the flow and prioritisation of items within the four main components of the TACC Digital Content Model. The Technology-Assisted Career Assessment System (TACC-AS) and Technology-Assisted Career Information System (TACC-IS) both received the highest total scores of 119, corresponding to 81.0%, indicating strong agreement on item structure and sequence. The Technology-Managed Career Counseling System (TACC-MC) followed closely with a score of 118 (80.3%), while the Technology-Assisted Career Guidance and Counseling System (TACC-CGCS) scored 116 (78.9%). All scores exceed the usability threshold of 70%, confirming that the item flow and priorities across all components are deemed suitable for implementation by expert consensus.

Discussion
This study began by investigating the current state of school-based career counseling through a structured needs analysis involving 65 guidance teachers in secondary schools across Sabah. High mean scores ranging from 4.55 to 4.68 across indicators such as perceived necessity, model approval, and item acceptance reflected strong practitioner support for digital integration, reinforcing the urgency for scalable, evidence-based solutions aligned with Malaysia's Digital Education Policy (MOE, 2023). These results highlight that technology adoption in education must be rooted in local context, user readiness, and pedagogical clarity—principles echoed in current educational technology literature. Building on this foundation, the second phase utilized the Fuzzy Delphi Method (FDM) and Interpretive Structural Modeling (ISM) to validate and structure the TACC Digital Content Model. Evaluations by 15 experts produced high fuzzy consensus scores (0.887–0.953), confirming

the conceptual validity and relevance of four core domains: TACC-AS, TACC-IS, TACC-MC, and TACC-CGCS. ISM further clarified internal dependencies, offering a systems-level view of the model's implementation pathway. This theory-informed, stakeholder-driven process emphasizes the importance of aligning technological innovation with both pedagogical theory and practitioner insight. The final phase assessed usability through the Modified Nominal Group Technique with 21 Digital Career Counselor Ambassadors, where all components surpassed the usability benchmark of 70%, scoring between 78.9% and 81.0%. These results affirm the model's practical viability and field-level acceptance, confirming that the TACC model is both theoretically grounded and operationally scalable. Its ability to embed AI-supported tools and digital systems into current counseling practices highlights its potential for broader adoption, aligning with ET&S's commitment to impactful, learner-centered educational technologies.

Conclusion

This study presents the successful development, validation, and evaluation of the Technology-Assisted Career Counseling (TACC) Digital Content Model, a structured and scalable framework designed to transform school-based career guidance through the integration of educational technology. Grounded in the Design and Development Research (DDR) methodology, the model was developed through a systematic three-phase process comprising needs analysis, expert validation, and practitioner-based usability testing, each providing empirical support for its relevance within Malaysia's evolving educational landscape. Validation using the Fuzzy Delphi Method (FDM) and Interpretive Structural Modeling (ISM) confirmed strong expert consensus on the model's four core components; TACC-AS, TACC-IS, TACC-MC, and TACC-CGCS, while usability evaluation among field practitioners demonstrated high acceptance and operational readiness. These findings align with ET&S's emphasis on evidence-based, practical applications of advanced technology that support pedagogical innovation, empower educators, and foster learner autonomy. By bridging national policy with real classroom practice, the TACC model supports the objectives of Malaysia's Digital Education Policy (2023) and reflects global trends in competency-based, digitally enhanced education. Through the integration of AI-driven assessments and digital career systems, the model advances inclusive, personalized, and future-ready career counseling, offering a replicable and research-driven framework for wider educational contexts.

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Conflict of Interest Statement

This research was conducted independently, and no financial or non-financial interests influenced the study design, data collection, analysis, or the conclusions presented in this manuscript.

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