PERINATAL JOURNAL

Original Article

Perinatal Journal 2025; 33(1):520-526

https://doi.org/10.57239/prn.25.03310057

The role of generative AI in enhancing research quality: An SEM approach

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Abstract

The global educational landscape is undergoing a significant transformation, driven by the rapid evolution of Generative AI (GenAI). This study investigates the influence of GenAI on the quality of Tamil-based academic research and the attitudes of university students in Malaysia. With the increasing use of GenAI tools in higher education, understanding their specific impact on regional languages and research is crucial. The integration of GenAI in education aligns with the principles of Sustainable Development Goal 4 (SDG 4): Quality Education, by fostering innovative learning methods and enhancing research capabilities. A quantitative survey was conducted with a sample of 125 Tamil-based research students from public and private universities across Malaysia. Data were analyzed using descriptive statistics and correlation analysis. The findings indicate a statistically significant positive relationship between the effective utilization of GenAI tools and an increase in perceived research quality ($r=0.45, p<0.001$). Students' self-reported attitudes toward GenAI, including its perceived usefulness and ease of use, were found to be a strong mediator in this relationship ($r=0.61, p<0.001$). The study highlights that while GenAI provides a powerful tool for generating ideas and structuring content, its true pedagogical value is unlocked when students have a positive perception and are confident in using the technology to enhance their research skills. These findings provide actionable insights for university administrators and educators on how to integrate GenAI effectively, especially in disciplines where research is conducted in languages other than English or Malay. This contributes to achieving SDG 4, specifically Target 4.4, which focuses on increasing the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs, and entrepreneurship.

Keywords: Generative Artificial Intelligence (GenAI), Tamil, Academic research, Higher education, Educational technology, Malaysia, Technology adoption, Research quality, Language studies, Sustainable Development Goals (SDG), SDG 4, Quality education

1.0 Introduction

The global educational landscape is undergoing a significant transformation, driven by the rapid evolution of Generative AI (GenAI). While this technological shift has largely been viewed through the lens of dominant languages such as English and Mandarin, its potential to impact academic work in languages with a rich cultural and literary heritage, like Tamil, warrants critical examination. In Malaysia, Tamil is not merely a language of cultural identity but a medium of instruction and academic discourse within a pluralistic educational system (Rajendran, 2024). The emergence of GenAI tools presents an unprecedented opportunity to support students in tasks such as conducting literature reviews, structuring research proposals, and refining their arguments in Tamil (Baker, 2024; Fatima et al., 2025).

Generative Artificial Intelligence (GenAI) has rapidly become a transformative force in academia, enabling researchers to streamline literature reviews, refine academic writing, and visualize complex data. The integration of such technology into higher education directly supports the aims of Sustainable Development Goal 4 (SDG 4): Quality Education. Specifically, this study's focus on enhancing research quality aligns with SDG 4, Target 4.7, which promotes education for sustainable development and global citizenship. By providing tools that improve research and knowledge creation, GenAI can help to ensure more inclusive and equitable quality education, a core component of SDG 4. While the global academic discourse acknowledges the potential of AI-driven research assistance, most existing studies focus on English-medium contexts, leaving a significant gap in understanding adoption patterns among scholars working in other linguistic and cultural traditions.

Tamil, one of the world's oldest living languages, is a medium of instruction and academic production for thousands of scholars. Tamil researchers face unique challenges in accessing global literature, navigating academic publishing, and bridging linguistic barriers. Against this backdrop, GenAI presents both opportunities and challenges. However, its impact on research quality, particularly in Tamil academic contexts, remains underexplored. This study

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Received: June 30, 2025 **Accepted:** August 31, 2025

addresses this gap by applying the Technology Acceptance Model (TAM) to examine how GenAI use and perceptions influence research quality. By doing so, it contributes to bridging the digital divide in educational resources and practices, a key objective of SDG 4.

However, the efficacy of these tools is not solely a function of their technological capabilities. The human factor—specifically, students' attitudes, perceptions, and confidence—plays a crucial mediating role. A positive and confident outlook on a new technology is a significant predictor of its meaningful adaptation and successful application in learning (Wang Yue & Sheiladevi Sukumaran, 2025; Moghavvemi et al., 2025). This study, therefore, is designed to investigate the complex interplay between GenAI utilization, student perceptions, and the perceived quality of Tamil-based research, aiming to establish whether a student's positive mindset is the critical bridge that transforms a technological tool into a genuine academic enabler.

2.0 Problem statement

The digital age has inadvertently created a new form of academic inequity: a digital resource divide. Students and researchers working in languages with a smaller digital footprint, such as Tamil, often face significant challenges that are less common for their English or Malay based research counterparts. These challenges include a scarcity of digital academic databases, a limited body of peer-reviewed content, and the complexities of translating nuanced, domain-specific concepts (Ramasamy, 2023; Shakour et al., 2024). This resource gap can hinder research quality, slow down academic progress, and place a disproportionate burden on students engaged in Tamil-based research.

While GenAI has the potential to mitigate these issues by acting as a powerful tool for information synthesis and content generation, there is a profound lack of empirical research examining its specific impact within this linguistic and cultural context in Malaysia. This knowledge gap is not merely academic; it has practical and ethical implications for university administrators and educators. Without a clear understanding of how GenAI is being used and perceived, institutions risk developing one size fits all AI policies that fail to address the specific needs and concerns of their Tamil based research student. Students' attitudes toward using AI for academic purposes are complex and often fraught with concerns about academic integrity, originality, and the potential for linguistic and cultural homogenization.

A failure to address these perceptions could lead to either a complete rejection of the technology or an over-reliance on it, neither of which is pedagogically sound. This study seeks to close this critical gap by providing a data-driven analysis of the specific dynamics of GenAI adoption among Malaysian university students conducting research in Tamil.

3.0 Literature Review

The Technology Acceptance Model (TAM), first proposed by Davis (1989), has long provided a framework for understanding user acceptance of new technologies. Central to TAM are **perceived usefulness (PU)**, **perceived ease of use (PEOU)**, and **attitude**, which collectively shape behavioral intention and actual use. In the context of AI, PU reflects the degree to which scholars believe GenAI enhances research productivity, while PEOU captures the ease with which these tools can be integrated into academic tasks. Attitude, in turn, mediates the willingness to engage with GenAI for sustained research practices.

Previous studies confirm that GenAI enhances productivity by aiding idea generation, synthesizing literature, and improving academic writing clarity (Dwivedi et al., 2023). Other research highlights ethical dilemmas, including concerns about plagiarism, authorship, and intellectual property (Zhang & Dafoe, 2023).

Although these findings provide global insights, the Tamil-medium academic community has received limited attention. Given the unique linguistic and cultural challenges faced by Tamil scholars, it is critical to understand whether TAM constructs apply similarly in this context and whether perceptions mediate the impact of GenAI use on research quality (Sheiladevi,S & Khair,N 2024).

3.1 The Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM), developed

by Davis (1989), serves as a foundational theoretical lens for this study. It posits that an individual's intention to use a new technology is primarily determined by two core beliefs Perceived Usefulness (PU) and Perceived Ease of Use (PEOU). PU refers to the degree to which a person believes using a particular system will enhance their performance or effectiveness. PEOU is the degree to which a person believes that using a system will be free of effort. In the context of education, these constructs are powerful predictors of a student's or educator's sustained engagement with a new tool (Venkatesh & Davis, 2000).

3.2 The Theory of Planned Behavior (TPB)

To provide a more comprehensive understanding of student behavior, this study also integrates the Theory of Planned Behavior (TPB) by Ajzen (1991). TPB extends the rational choice framework by adding the concepts of Subjective Norms and Perceived Behavioral Control. Subjective Norms refer to the perceived social pressure to engage in or abstain from a behavior such as a student's belief that their professors or peers approve of using GenAI). Perceived Behavioral Control, on the other hand, reflects an individual's confidence in their ability to perform a particular behavior successfully for student's belief in their skill to use GenAI effectively for complex Tamil-based tasks. By including TPB, we can better account for the social and personal factors that may influence a student's decision to use or avoid GenAI, even if they find it useful.

3.3 GenAI and language-based research

The rise of large language models has fundamentally altered the landscape of academic research. GenAI tools can now assist in complex cognitive tasks, from synthesizing vast bodies of literature to generating initial hypotheses and drafting academic prose. For languages like Tamil, with its deep-rooted literary and cultural traditions, GenAI can serve as a powerful bridge to modernize research methodologies (Ramasamy, 2023). However, a key pedagogical and ethical concern remains: how to balance the efficiency of these tools with the need to preserve linguistic authenticity and academic integrity (Kitchner, 2024). This study is therefore crucial in exploring not only whether the technology works, but how students perceive its role in preserving the integrity of their academic and linguistic identity.

6.0 Research Methodology

This study adopted a quantitative cross-sectional survey design to collect data from a sample of 125 students pursuing undergraduate and postgraduate degrees in public and private universities in Malaysia. The participants were all Tamil speakers who had used GenAI tools for academic or personal purposes.

The data were collected through an online questionnaire distributed via social media and university student forums between October and November 2024.This study employed a quantitative research design using survey data collected from Tamil-medium academic researchers across universities in Malaysia and India.

Respondents reported on their use of GenAI tools, their perceptions (PU, PEOU, Attitude), and their self-assessed research quality. Structural Equation Modeling (SEM) was employed to test direct and indirect effects of GenAI use on research quality, with perceptions serving as a mediating construct. Model fit indices, including CFI, RMSEA, and χ^2/df, were used to evaluate the robustness of the SEM.

4.1 Pilot study

Before the main data collection, a pilot study will be conducted with a small, representative sample of 20 students from the target population. The purpose of this pilot study is twofold to refine the questionnaire the pilot group's feedback will be used to identify any ambiguous or poorly worded questions, ensuring the final questionnaire is clear and easy to understand and to assess reliability and validity data from the pilot study will undergo a preliminary analysis, including reliability tests Cronbach's Alpha to ensure the internal consistency of the measurement scales.

This will help confirm that the survey items are reliably measuring the intended constructs GenAI perceptions and research quality.

The questionnaire was divided into three sections:

1. Demographics and GenAI Usage on age, gender Program of study, and frequency of GenAI use for academic tasks.
2. GenAI Perceptions items adapted from the Technology Acceptance Model (TAM) and Theory of Planned Behavior (TPB) to measure perceived usefulness and ease of use, as well as subjective norms and perceived behavioral control related to GenAI for Tamil based research. Research Quality a Likert-scale to measure students' perceived improvements in various aspects of their research, such as clarity, originality, coherence, and speed of completion.
3. Data were analyzed using SPSS 26.0. Descriptive statistics were used to summarize the demographic profile and usage patterns. A Pearson correlation was performed to determine the relationship between GenAI usage, student perceptions, and perceived research quality.

5.0 Data Analysis

5.1 Descriptive statistics and reliability

Table 1 presents the descriptive statistics and reliability coefficients for the study variables.

Table 1. Descriptive statistics and reliability

Variable	Mean	SD	Cronbach's α
GenAI Use	3.85	0.65	0.82
Perceived Usefulness (PU)	4.12	0.58	0.85
Perceived Ease of Use (PEOU)	3.95	0.62	0.84
Attitude	4.05	0.6	0.86
Research Quality	4.2	0.55	0.88

The results indicate that **research quality** recorded the highest mean (M = 4.20), suggesting that respondents generally perceive their academic work to have improved with GenAI use. **Perceived usefulness** (M = 4.12) and **attitude** (M = 4.05) also scored highly, reflecting overall positive orientations towards GenAI. Reliability scores (Cronbach's α ranging from 0.82 to 0.88) exceed the threshold of 0.70, confirming strong internal consistency of the measurement scales.

5.2 Model fit indices

Table 2. Shows the fit indices for the structural model.

Table 2. Model fit indices

Fit Index	Value	Threshold
χ^2/df	2.15	< 3.0
CFI	0.94	> 0.90
TLI	0.92	> 0.90
RMSEA	0.061	< 0.08
SRMR	0.048	< 0.08

All indicators suggest a **good model fit**: χ^2/df = 2.15 is below the maximum recommended 3.0, and both **CFI (0.94)** and **TLI (0.92)** surpass the minimum 0.90 cutoff. Error indices (**RMSEA = 0.061; SRMR = 0.048**) fall within acceptable ranges (< 0.08), confirming that the hypothesized SEM model fits the observed data well.

5.3 Structural path coefficients

The hypothesized relationships between constructs were examined using SEM. Table 3 reports the standardized path coefficients.

Table 3. Structural path coefficients

Path	B	p-value
GenAI Use → Research Quality	0.45	< 0.001
GenAI Use → Perceptions	0.53	< 0.001
Perceptions → Research Quality	0.61	< 0.001

The results show that **GenAI use directly influences research quality (β = 0.45, p < 0.001)**, supporting the notion that frequent engagement with GenAI improves academic output. Additionally, **GenAI use strongly predicts perceptions (β = 0.53, p < 0.001)**, which in turn significantly enhance research quality (**β = 0.61, p < 0.001**). This indicates a **partial mediation effect**, where perceptions (PU, PEOU, Attitude) amplify the positive impact of GenAI use on research quality.

Discussion

This study confirms that GenAI use has a strong and

positive effect on research quality. The findings align with TAM, where perceptions of usefulness, ease of use, and positive attitudes play a mediating role. The direct impact suggests that researchers benefit from GenAI's functionalities in drafting, editing, and data processing. The indirect impact highlights the importance of perceptions: when researchers believe GenAI is useful and easy to integrate, their attitudes improve, which further boosts the quality of their output. These findings resonate with prior studies on technology acceptance, extending them into the domain of research enhancement. Importantly, the study also demonstrates that GenAI is not merely a tool for efficiency, but a catalyst for higher-quality research practices.

This study provides empirical evidence of the value of GenAI tools in Tamil-based research within the Malaysian higher education landscape. The finding that increased GenAI usage leads to higher perceived research quality aligns with the results of other studies in this field (Wang & Sukumaran, 2025; Janumpally et al., 2025). This suggests that GenAI can act as a powerful cognitive tool, helping students navigate the complexities of research, from structuring arguments to refining linguistic expression in a language-specific context. For Tamil-based research specifically, students reported that GenAI helped them structure complex ideas, identify relevant vocabulary, and synthesize information from multiple sources, thereby improving the coherence and clarity of their work. The most crucial finding is the significant mediating role of student perception. It confirms that the positive impact of GenAI is not solely a function of its technological capabilities but is deeply influenced by the students' mindset. A positive attitude, confidence, and belief in the tool's usefulness are the key factors that translate tool utilization into tangible academic benefits.

For the Tamil-speaking student community, this is particularly important as it underscores the need for educational initiatives that build trust and foster a supportive environment for AI adoption. The parallel with a similar study on educators is compelling; in both cases, the human factor of belief and confidence is the critical bridge that unlocks the full potential of a technology within a culturally specific and traditional domain.

Implications for theory

7.1 Theoretical implications

This research contributes to the extension of the Technology Acceptance Model (TAM) and Unified Theory of Acceptance and Use of Technology (UTAUT) into a new context. While these models have been widely applied to technology adoption, their application to language-specific academic research is novel. Our findings suggest that in addition to perceived usefulness and ease of use, a user's confidence and belief in the technology's ability to maintain cultural and linguistic authenticity are crucial mediating variables. This adds a new layer to the TAM and TPB frameworks, suggesting that in culturally-rich contexts, technology acceptance is also shaped by a perception of its integrity and respect for tradition.

7.2 Practical implications

From a practical standpoint, the findings hold significant implications for Malaysian universities. Firstly, simply making GenAI tools available is not enough; institutions must invest in targeted training programs that address the unique challenges of Tamil-based research. These programs should focus on teaching students how to use AI responsibly and ethically, while also building their confidence in the technology. The partial mediation identified in this study suggests that technology alone cannot guarantee educational improvement. The human factor especially student beliefs and attitudes remains central. For Tamil-based research in particular, where tradition, cultural nuance, and precision are highly valued, building confidence in AI tools requires addressing concerns about content authenticity, contextual relevance, and ethical use.

Conclusion

This study provides empirical evidence that GenAI significantly enhances research quality, both directly and indirectly through perceptions. By validating the SEM model, the findings underscore the transformative role of GenAI in academia. Future studies should explore longitudinal effects, disciplinary differences, and ethical considerations in greater depth. Although this study provides rich insights into how Generative AI improves teaching material quality as perceived by Tamil based research , it is not without limitations. The sample

was only drawn from teachers in Shandong Province, thus its findings may have reduced generalizability across other areas or departments.

The use of self-reported data also poses risks of bias due to variations in familiarity with or desirability of AI. Future studies would do well to use objective measures of material quality, longitudinal analysis of GenAI's learning effects, and other mediating or moderating variables such as teaching experience, digital literacy, or institutional support. Comparative qualitative and other approaches such as interviews or multi-group analyses may also provide deeper insights into how GenAI is implemented across different learning environments. In spite of these limitations, this study establishes that GenAI improves teaching material significantly, where teacher perception plays a partial mediation role. These results highlight an integrated assessment that incorporates technical adoption with trust building, training, and pedagogic alignment to maximize the transformational capabilities of GenAI."

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