

P-ISSN 2734-9748 • E-ISSN 2815-6471

VMOST Journal of Social Sciences and Humanities

APRIL 2026 • VOLUME 68 NUMBER 1

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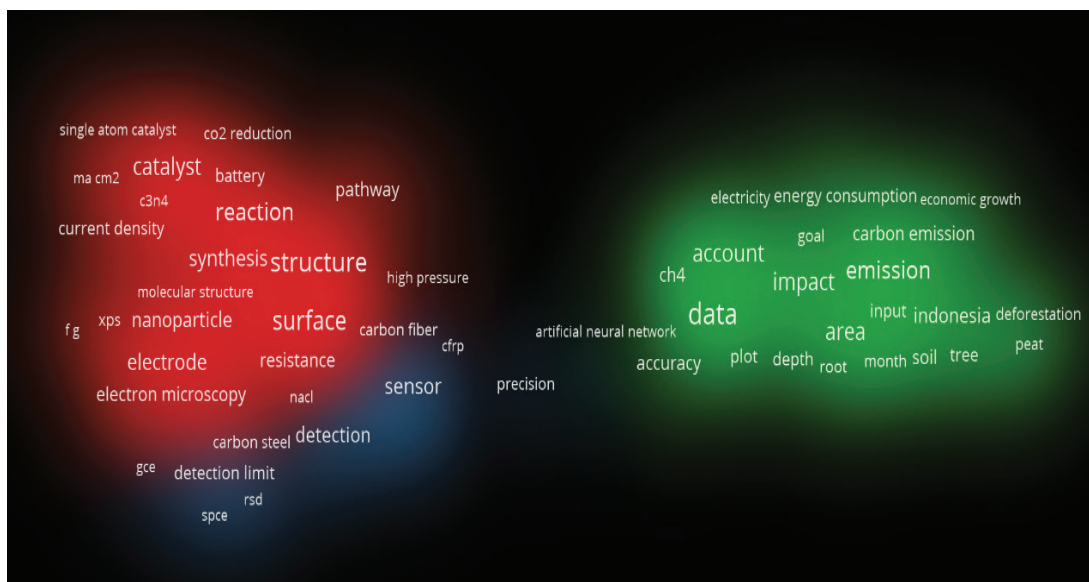
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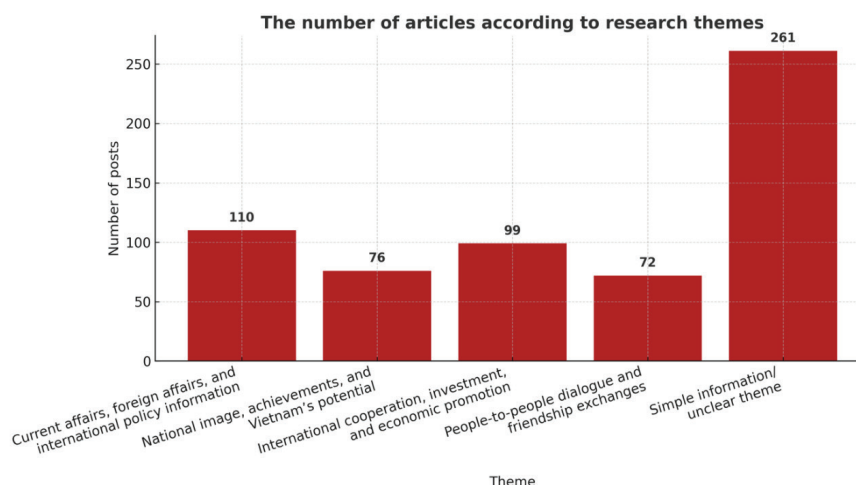
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Exploring peer collaboration's impact on EFL students' language skills and emotional adjustment

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Received 25 April 2025; revised 28 May 2025; accepted 8 July 2025

Abstract:

This article examines the extent to which collaborative presentation tasks enhance psychological resilience among students in an English as a foreign language (EFL) learning environment. Employing a mixed-methods framework that integrates statistical data with experiential insights, it synthesises performance outcomes and learner reflections to investigate how collaborative learning structures influence public speaking efficacy and emotional resilience. Measurable improvements were observed across teamwork, short-form, and long-form presentations, accompanied by a notable post-intervention increase in resilience (Cohen's $d=0.72$). Qualitative findings highlighted the psychological and relational benefits of peer collaboration, with key themes including reduced anxiety, greater confidence, and strengthened peer affiliation. The convergence of statistical outcomes and thematic analysis underscores the pedagogical value of collaborative learning as a dual pathway for developing linguistic competence and emotional fortitude within high-pressure speaking contexts.

Keywords: collaboration, language learners, psychological well-being, resilience, teamwork.

Classification numbers: 1.3, 3.3

1. Introduction

Public speaking is a well-documented source of anxiety among language learners, particularly in EFL contexts, where restricted linguistic resources, limited familiarity with target-language discourse norms, and fear of critical evaluation intensify communicative pressure. These affective challenges are further magnified by contemporary language pedagogy's increasing emphasis on oral proficiency and the ability to communicate effectively in authentic, real-world situations [1]. EFL learners are expected to deliver spoken performances that are not only linguistically accurate but also emotionally composed, requiring both language competence and emotional resilience.

Resilience, understood as learners' capacity for positive adaptation and sustained effort in the face of adversity [2, 3] provides a meaningful lens through which to examine the affective dimensions of oral performance in language learning. While resilience has been widely examined in educational and psychological research, its application to second language acquisition—particularly in speaking-intensive environments—remains underexplored. Existing literature largely focuses on the experience of anxiety, offering limited insight into

how learners gradually develop coping strategies and emotional adaptability.

Task-based language teaching (TBLT) has gained prominence as a pedagogical response to these challenges, emphasising interaction and real-world meaning-making through task-oriented engagement [4]. Oral presentations, especially when delivered collaboratively, align closely with TBLT principles as they simultaneously foster linguistic proficiency and learner engagement. Instructional tools such as rubrics, planning frameworks, and peer feedback forms serve as scaffolding mechanisms, helping learners to manage their performance and cultivate self-regulation and autonomy [5].

In addition, integrating teamwork into oral activities introduces a valuable interpersonal dimension, promoting communication, cooperation, and mutual accountability. Through shared decision-making and peer interaction, collaborative learning supports the development of learner autonomy, defined by D. Little (1991) [6] as the ability to take responsibility for one's own learning. When students engage in co-preparation and co-presentation, they assume responsibility not only for their individual contributions but also for the overall success of the

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group. This collective responsibility strengthens both self-confidence and emotional security, encouraging learners to take risks and manage performance-related anxiety.

Although collaborative oral tasks are theoretically associated with resilience-building, empirical studies examining their impact over time-particularly in underrepresented EFL contexts such as Vietnam-remain limited. While prior research has highlighted the anxiety-reducing benefits of collaboration [7] and the motivational gains associated with group work [8], few studies have employed longitudinal, mixed-methods designs to systematically investigate these effects.

This study addresses these gaps by exploring how teamwork-oriented oral presentation tasks influence both the linguistic development and emotional resilience of EFL learners in a Vietnamese university setting. Grounded in sociocultural theory, the study emphasises the importance of peer collaboration and instructional scaffolding within the Zone of Proximal Development [9]. Collaborative oral tasks, supported by structured materials and peer feedback, engage learners in co-constructing knowledge, negotiating meaning, and reflecting on their performance. The study specifically examines how such supportive learning conditions shape students' ability to regulate anxiety, persist through communicative challenges, and build confidence across multiple speaking sessions.

To achieve these aims, a mixed-methods design was employed, combining quantitative data from resilience scales and presentation assessments with qualitative insights derived from learner interviews and reflections. This approach provides a comprehensive understanding of how pedagogical strategies influence both the cognitive and affective dimensions of language learning. The study is guided by the following research questions:

To what extent do teamwork-based presentation tasks improve students' public speaking resilience in an EFL classroom context?

What are students' perceptions of the emotional and academic influence of collaboration on their confidence, anxiety, and resilience across presentation sessions?

2. Literature review

2.1. Emotional resilience in second language speaking

Resilience-broadly defined as the ability to recover from adversity and sustain positive adaptation in the face of challenges-has gained increasing prominence in the field of language education [2, 3]. Within the context of

second language acquisition (SLA), resilience is reflected in learners' capacity to persist through communicative breakdowns, regulate language-related anxiety, and navigate the emotional demands of oral performance [10, 11].

T.A. Nguyen (2025) [12] conducted a qualitative case study examining English-speaking anxiety among Vietnamese pre-service teachers during classroom oral interactions. The study identified fear of negative evaluation, limited linguistic competence, and public scrutiny as key sources of anxiety. Importantly, it highlighted the role of coping mechanisms such as positive self-talk, thorough preparation, and-most notably-peer collaboration in fostering communicative confidence. T.A. Nguyen (2025) [12] emphasised that a supportive classroom environment, particularly one that promotes teamwork, enhanced learners' emotional regulation and sense of control. These findings reinforce the pedagogical value of structured group speaking tasks in enabling EFL learners to confront and manage anxiety more effectively.

G.H. Khajavy, et al. (2018) [1] advanced the application of positive psychology in language learning by emphasising the value of emotionally supportive classrooms in reducing anxiety and enhancing learners' willingness to communicate-two variables closely associated with the development of resilience. They argued that positive emotions such as enjoyment and pride can broaden learners' behavioural repertoires and strengthen their persistence during oral tasks. Complementing this perspective, P.D. MacIntyre, et al. (2001) [13] introduced the concept of Willingness to Communicate (WTC), demonstrating that communicative confidence and perceived social support significantly predict learners' readiness to engage in authentic interaction. Collectively, these findings underscore the importance of peer-mediated affective scaffolding in cultivating resilience in speaking performance.

2.2. Collaborative learning and task-based speaking

Team-based learning strategies grounded in TBLT offer meaningful opportunities for learners to build resilience within authentic communicative contexts. TBLT prioritises the completion of real-world tasks to foster fluency and accuracy through purposeful and meaningful language use [4]. Within this framework, speaking activities such as presentations and group projects function not only as tools for linguistic development but also as catalysts for affective growth, supporting learners' confidence, persistence, and emotional adaptability.

N. Storch (2005) [14] found that peer collaboration in ESL writing significantly improved grammatical accuracy and task completion. Although her research focused on written production, it highlights the broader cognitive and affective benefits of interactive learning, including mutual scaffolding and shared responsibility. Similarly, J. Philp, et al. (2016) [15] conceptualised engagement in collaborative tasks as a multidimensional construct - encompassing emotional, cognitive, and behavioural dimensions - that collectively foster both language development and learner resilience.

C. Lambert, et al. (2017) [16] reported that task repetition significantly improved speech fluency and reduced disfluencies in second language production. These cognitive gains were accompanied by increased performance confidence, indicating that repetition functions not only as linguistic practice but also as a form of emotional training. Their findings align with the present study's use of repeated team-based presentations as a means of fostering both communicative competence and self-efficacy.

Instructional materials - such as rubrics, peer feedback forms, and planning aids - serve as essential scaffolding tools that support learners' performance and self-regulation [5, 17]. Moreover, social interdependence theory developed by D.W. Johnson, et al. (2009) [8] emphasises that structured collaboration enhances both academic achievement and emotional well-being by fostering promotive interaction, wherein learners actively support one another's success [8].

2.3. Empirical insights into collaboration and speaking outcomes

A growing body of empirical research highlights the emotional and academic benefits of structured teamwork in EFL speaking contexts. A.A. Alzubi, et al. (2024) [18] reported significant improvements in fluency and interactional competence among Saudi EFL learners following a collaborative learning intervention. Similarly, T.M.X. Vo, et al. (2021) [19] observed notable gains in oral performance and speaking confidence among Vietnamese students engaged in team-based tasks. M.L. Terres, et al. (2021) [20] further demonstrated that collaborative planning contributed to more coherent and effectively delivered oral presentations. M.H.A. Khresheh, et al. (2025) [21] found that incorporating peer assessment into team presentations enhanced learners' self-efficacy while simultaneously reducing anxiety. Likewise, D.A. Mahdi (2024) [22] demonstrated that group-based language enhancement programme (LEP) activities significantly improved EFL students' oral communication

skills and social engagement. Collectively, these findings underscore the positive impact of peer collaboration on both linguistic development and emotional well-being.

Despite the expanding body of evidence, methodological limitations remain. A significant number of studies rely solely on either quantitative performance data or qualitative self-reports, resulting in a fragmented understanding of learner development. This highlights the need for integrated mixed-methods approaches that can capture both measurable improvements in performance and the nuanced progression of learners' emotional resilience over time.

While the theoretical and empirical literature increasingly supports the integration of collaborative oral tasks in EFL instruction, few studies have systematically examined how structured teamwork contributes to the development of speaking resilience over time. Although a number of researchers have reported positive outcomes related to fluency, self-efficacy, and reduced anxiety through collaboration [7, 19, 21, 22], most of these studies focus on short-term effects or rely on a single methodological lens. Furthermore, while studies by T.Q. Lap, et al. (2025) [23] and K.B. Hoang (2021) [24] have explored resilience in Vietnamese EFL contexts, they primarily adopt theoretical or exploratory approaches without systematically evaluating how pedagogical strategies-such as repeated team-based presentations-may actively foster resilience in classroom practice.

This study addresses these gaps by examining how teamwork-based oral presentation tasks influence both the linguistic development and emotional adaptability of EFL learners over an eight-week instructional period. Using a mixed-methods design, it explores the impact of repeated collaborative presentations supported by instructional scaffolds - such as rubrics - offering a more comprehensive understanding of resilience-building processes in classroom-based settings.

3. Methodology

The research was conducted at Hong Bang International University, a private multidisciplinary institution in Vietnam, where English is designated as a mandatory subject for all undergraduate students. The institution promotes communicative English proficiency across its programmes; however, the adoption of collaborative and presentation-based methods varies among language courses. Accordingly, the course functioned as a pilot initiative for embedding structured collaborative practices within English instruction, offering an opportunity to examine their role in fostering student resilience.

3.1. Student recruitment and group structuring

At the beginning of the semester, 198 first-year students participated in A1-level English communication classes for non-English majors, each comprising approximately 30-40 students. The research was conducted over the course of 15 sessions (in eight weeks), beginning with the initial week (two sessions) dedicated to modelling the learning environment, familiarising students with class regulations, expectations, and grading approaches, and forming teams based on students' preferences. As a foundation for the study, students underwent training in teamwork through discussions led by their lecturer. Essential elements of this training included effective collaboration, task coordination, workload allocation, and the selection of a team leader, either by mutual agreement or through a democratic process. Students were also taught conflict management strategies and were permitted to revise their group composition or switch teams if necessary. Once this preliminary stage concluded, team compositions were finalised and remained consistent for the rest of the course. This preparatory training helped students develop a more positive perception of teamwork and improved both individual well-being and collective performance [25].

3.2. Grading models and voluntary participation

To support varied learning preferences, students were offered two grading systems. The traditional model comprised 40% from in-class performance (10% attendance, 30% listening test) and 60% from the final speaking test. The alternative teamwork-based model included 40% based on the team's average session scores, 30% from short presentations across sessions (1.5-2 minutes), and 30% from extended presentations delivered every two sessions (5-6 minutes). To respect learner autonomy, students were permitted to opt out of the teamwork model and follow the individual pathway. After the first week, 43 teams were formed, each comprising three to five students. Throughout the semester, some students chose to withdraw from the teamwork model due to differing learning styles, personal preferences, or challenges in team dynamics.

3.3. Final participant cohort and instructional environment

Several changes occurred over the following weeks. Some participants withdrew from the teamwork model and reverted to the traditional grading system. Disbanded teams led to transfers, with some groups expanding to five or six members. Ultimately, 47 students fully withdrew

from the teamwork model. At the conclusion of the study, 151 students remained engaged in the teamwork-based learning model, forming the final cohort. These students regularly participated in group-oriented speaking tasks, received peer feedback, and were assessed according to rubrics covering teamwork, short oral tasks, and extended presentations. The final cohort comprised 59 males and 92 females, aged between 18 and 24. All participants were Vietnamese, sharing similar sociocultural and academic backgrounds. Their English proficiency was assessed at the A1 level of the Common European Framework of Reference for Languages (CEFR), based on a university-administered standardised placement test conducted at the beginning of the academic year. Participants represented diverse academic majors: logistics (24), law (36), finance and banking (27), digital marketing (14), multimedia (22), tourism and hospitality management (16), and business administration (12). This academic heterogeneity introduced a broad spectrum of perspectives, group interaction patterns, and communicative styles during teamwork-based activities.

The course was delivered by an experienced English lecturer with a background in TESOL and training in classroom-based research. All sessions were conducted in English, with the first language used only for essential clarifications. The lecturer embedded reflective practices and targeted interventions to support students' emotional growth in parallel with their linguistic development. The majority of students (151 out of 198) found the teamwork approach valuable, despite some initial uncertainty. The voluntary nature of participation meant that those who remained in the model were genuinely invested in collaborative learning, thereby enhancing the study's capacity to assess its impact on resilience, speaking confidence, and teamwork behaviours.

3.4. Research design

Building on the framework outlined by J. Reeve, et al. (2014) [26], this study employed a quasi-experimental longitudinal design to examine how teamwork influences students' resilience and speaking confidence. Data were collected using rubric-based assessment to ensure reliability and objectivity [17, 27], recorded semi-structured interviews to facilitate qualitative exploration [28, 29], and a self-perception survey to capture students' attitudes and experiences while mitigating potential self-reporting biases [30]. This design enabled the study to track changes in students' performance and self-perceived resilience across different stages of the course.

3.5. Assessment methods and data gathering

Three scoring rubrics, a self-perception survey, and qualitative interviews were employed for data collection, as described below.

3.5.1. Evaluating performance with rubric-based criteria

Students' performance within the teamwork model was assessed through three structured rubrics corresponding to teamwork, short presentations, and extended presentations.

Teamwork rubric: This rubric was applied weekly over 12 sessions to evaluate students' engagement, cooperative behaviour, and contribution within group activities. Assessment criteria included equal participation, supportive peer interaction, turn-taking, and participation in lesson-based language practice. Scores were informed by a combination of instructor observations and peer feedback.

Small presentation rubric: Students delivered 1.5-2 minute presentations in each session, with all members contributing to a unified topic. The rubric assessed thematic coherence, timing, fluency, and presentation competencies such as visual engagement, posture, and voice modulation, rather than pronunciation and grammatical accuracy. Consistent with W. Cheng, et al. (2005) [31], the rubric prioritised fluency and delivery over linguistic correctness, encouraging students to develop comfort and confidence in speaking.

Big presentation rubric: Group presentations were conducted biweekly, every second session. The rubric measured both collective organisation and individual delivery. Key evaluation dimensions included content accuracy and recall, distribution of speaking roles, effectiveness of visual materials (e.g., PowerPoint design), collaborative support during delivery, speaking fluency, and adherence to the 5-6-minute time frame. This aligns with P. MacIntyre, et al. (2012) [32], who highlighted that repeated presentation practice over an extended period fosters confidence and reduces anxiety.

Each rubric was distributed to students in advance to guide their preparation and performance. Post-task feedback was provided to facilitate reflection and improvement.

3.5.2. Survey on resilience in speaking

There are two surveys:

First instrument (10-item scale): Adapted from the self-perceived communication competence scale [33], this was used to establish a baseline measure of students'

perceived communicative efficacy. It was administered at the commencement of the course and served as an initial benchmark for tracking progress.

Second instrument (15-item adapted resilience scale):

This principal instrument was devised and psychometrically validated for the current research. It was adapted from three foundational instruments: the Connor-Davidson resilience scale (CD-RISC) and the classroom life instrument [34]. The resilience questionnaire was piloted with a sample of 105 learners, and minor modifications were made. All items were tailored to reflect the dynamics of teamwork-based public speaking and to measure students' confidence, emotional support, and progress in resilience. The scale consisted of three sections with five items in each subscale: (1) Speaking confidence after teamwork, focusing on students' comfort and clarity when speaking with the assistance of their group; (2) Support from teammates, measured students' emotional perception and practical support from their members during presentations; and (3) Resilience and confidence growth, captured students' reflections on how teamwork contributed to their ability to recover from mistakes and facilitate long-term confidence in public speaking. Participants rated each item on a 5-point Likert scale, from 1 (strongly disagree) to 5 (strongly agree). The instrument underwent content validity and tested through a pilot with a small sample to ensure appropriateness and clarity. To measure the reliability of the instrument, Cronbach's alpha values were calculated for the overall scale.

3.5.3. Semi-structured interviews

All participants took part in semi-structured interviews to share qualitative reflections on their experiences with teamwork and resilience in speaking activities. This method enabled participants to articulate individual perspectives in greater depth [35]. The interview protocol was reviewed by two field experts and piloted with a small student group before formal data collection.

Interview data were analysed using V. Braun, et al. (2006) [36] six-phase thematic analysis model: familiarisation, initial coding, theme identification, theme review, theme definition, and reporting. A combined deductive-inductive approach was adopted, beginning with codes derived from the study's conceptual framework and expanding through iterative, data-driven readings. All responses were independently coded by two researchers. Divergent codes identified in the first round were collaboratively reviewed and resolved, ensuring consistency. This joint resolution enhanced the trustworthiness and coherence of theme identification.

3.6. Data analysis

A mixed-methods framework was employed to analyse the data, integrating statistical techniques for quantitative insights with thematic analysis for qualitative interpretation. SPSS version 27, with repeated measures ANOVA, was used to track changes in students' resilience and speaking confidence over time, enabling the study to determine whether engagement in teamwork-based presentations resulted in significant improvements across multiple sessions. In addition to the main analyses, paired-sample t-tests were conducted to assess whether there were statistically significant differences in resilience scores before and after the course. Thematic analysis was applied to qualitative interview data to identify recurring patterns and insights regarding students' experiences of teamwork, their confidence progression, and their resilience in public speaking. The triangulation of qualitative and quantitative findings provided a more comprehensive and nuanced understanding of the results.

4. Results

4.1. Pilot scale results

The adapted scale underwent expert evaluation for content validity by two TESOL specialists and was administered in a pilot study involving 105 first-year non-English majors (38 males, 67 females; aged 18-22). Reliability testing revealed excellent internal consistency, as indicated by a Cronbach's alpha of 0.971, with corrected item-total correlations ranging from 0.631 to 0.914. Although the removal of item R4 marginally improved reliability to 0.972, the item was retained to preserve theoretical coherence. To assess construct validity, an Exploratory Factor Analysis (EFA) was conducted to identify underlying factor structures. The Kaiser-Meyer-Olkin (KMO) measure confirmed excellent sampling adequacy (KMO=0.932), while Bartlett's test of sphericity ($\chi^2(105)=1832.103$, $p<0.001$) indicated the dataset's suitability for factor extraction. A single dominant factor emerged with an eigenvalue of 10.730, accounting for 71.531% of the total variance. The scree plot further supported the retention of a single factor, showing a pronounced elbow after the first component. Item communalities ranged from 0.441 to 0.862, and all items demonstrated strong loadings on the single extracted component (0.664 to 0.928), validating the unidimensional nature of the scale. Overall, the findings confirm the adapted scale as a reliable and theoretically grounded instrument for assessing public speaking resilience in collaborative EFL environments.

4.2. Descriptive statistics

Descriptive statistics were calculated to examine patterns in student performance across teamwork participation, speaking tasks, and pre- and post-course resilience levels. The average teamwork score across 12 sessions was $M=8.40$, $SD=1.10$, indicating a high level of group collaboration and contribution. Students' average score for short presentations (1.5-2 minutes) across 12 sessions was $M=7.11$, $SD=0.92$, reflecting increasing confidence in short-duration, collaborative speaking performances. While short presentation scores remained relatively consistent, longer presentations (5-6 minutes) proved more challenging, with a lower mean score ($M=6.36$, $SD=1.81$), suggesting that students experienced greater difficulty maintaining confidence over extended speaking tasks. The 15-item resilience scale yielded a pre-course mean of 3.69 ($SD=0.65$) and a post-course mean of 4.27 ($SD=0.78$), indicating that students reported stronger self-perceived speaking resilience following the intervention. To gain more detailed insight into students' perceptions, descriptive statistics were computed for the three subscales of the post-resilience scale. The Speaking Confidence after Teamwork subscale produced a mean score of $M=4.20$, $SD=0.78$, indicating strong student confidence when accompanied by their team. With the highest mean score ($M=4.34$, $SD=0.83$), the Support from Teammates subscale illustrates students' strong perception of emotional and motivational support from peers. Students' awareness of progress in recovering from public speaking difficulties through presentations was observed with a high mean score ($M=4.26$, $SD=0.85$).

4.3. Reliability analysis

Cronbach's alpha coefficients were calculated to evaluate the internal consistency of the resilience scale. The full 15-item scale demonstrated excellent reliability ($\alpha=0.970$). Each subscale also showed strong internal consistency: Speaking Confidence after Teamwork ($\alpha=0.847$), Support from Teammates ($\alpha=0.951$), and Resilience and Confidence Growth ($\alpha=0.944$). The results indicate that each subscale reliably captured its intended dimension of students' resilience in speaking supported by teamwork.

4.4. Repeated measures ANOVA

4.4.1. Teamwork

Changes in teamwork scores across 12 sessions were examined using repeated measures ANOVA. Mauchly's Test of Sphericity indicated a violation, $\chi^2(65)=363.34$, $p<0.001$, requiring the use of the Greenhouse-Geisser

correction ($\epsilon=0.710$). The analysis showed that teamwork scores varied significantly over time, $F(7.81, 1171.93)=4.45$, $p<0.001$, partial $\eta^2=0.029$, representing a small but meaningful time effect. The mean teamwork score began at 8.11 in session 1, dipped slightly between sessions 2 and 4 ($M=7.75-8.07$), and then progressively improved from session 5 onwards. By session 12, the mean teamwork score had risen to 8.83, indicating peak collaborative performance. This pattern reflects a steady enhancement of students' teamwork and mutual support as the course progressed.

4.4.2. Short presentations

To evaluate changes in students' performance on short presentations across 12 sessions, a repeated measures ANOVA was conducted. Mauchly's Test of Sphericity was significant, $\chi^2(65)=593.70$, $p<0.001$, prompting the use of the Greenhouse-Geisser correction ($\epsilon=0.641$). The analysis showed that short presentation scores varied substantially over time, $F(7.05, 1057.78)=96.61$, $p<0.001$, partial $\eta^2=0.392$. Mean scores increased consistently across sessions, beginning at 3.27 in session 1 and reaching 8.84 by session 12. This trend illustrates significant and sustained improvement in short-form public speaking over the course of the semester.

4.4.3. Extended presentations

Mauchly's Test of Sphericity was also significant for extended (long-form) presentations, $\chi^2(65)=123.58$, $p<0.001$, leading to the use of the Greenhouse-Geisser estimate ($\epsilon=0.780$). The repeated measures ANOVA revealed a strong effect of time on extended presentation performance, $F(3.12, 468.05)=324.33$, $p<0.001$, partial $\eta^2=0.684$, indicating a large effect size. A steep upward trend was observed in performance, with the mean score rising from 2.50 in session 1 to 9.03 in session 5. Exploratory correlational and regression analyses did not reveal meaningful relationships between resilience scores and students' performance measures. These results are not discussed further, given their limited relevance to the core research questions.

4.5. Paired samples t-test for resilience

A paired-samples t-test was conducted to assess changes in students' perceived resilience over time, comparing scores before and after the course. Results showed that resilience and speaking confidence scores improved significantly, from pre-course ($M=3.69$, $SD=0.65$) to post-course ($M=4.27$, $SD=0.78$), $t(150)=-8.74$, $p<0.001$. The effect size was medium to large, *Cohen's d*=0.72, 95% CI [0.53, 0.89]. These results suggest a substantial enhancement in students' perceived resilience in public speaking following participation in the semester-long teamwork presentation

model. With *Cohen's d* approaching a large effect, the findings highlight the potential impact of collaborative learning environments on fostering resilience and confidence in public speaking. The repeated-measures ANOVA results are summarised in Table 1.

Figure 1 illustrates changes in the three performance measures across assessment sessions.

Table 1. Results of repeated - measures ANOVA for teamwork, short presentations, and extended presentations.

Measure	df	F	p	Partial η^2
Teamwork	7.81, 1171.93	4.45	<0.001	0.029
Short presentations	7.05, 1057.78	96.61	<0.001	0.392
Extended presentations	3.12, 468.05	324.33	<0.001	0.684

Source: Author's calculations.

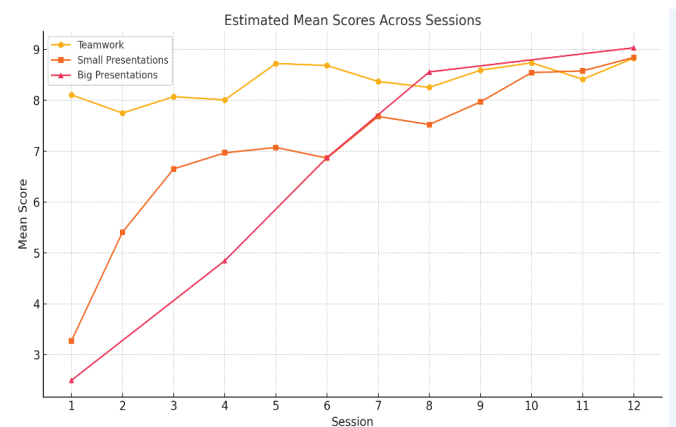


Fig. 1. Estimated mean scores for teamwork, short presentations, and extended presentations across assessment sessions. Source: Author's calculations.

4.6. Interview

4.6.1. Question 1: Difficulties faced during group presentations

Students most commonly cited lack of confidence (66.2%) and difficulties with fluency (37.1%) as their primary problems when reflecting on group presentations. These themes emerged from original Vietnamese codes such as “run” (nervous), “sợ” (afraid), “vấp” (stumble), and “tự ti” (insecure or lacking confidence). For instance, one student shared, “I was very nervous and scared. I felt insecure when speaking in front of a crowd”. Another explained, “At first, I didn't understand the task clearly. I felt nervous, shy, and kept stumbling”. A notable proportion of students also expressed anxiety about speaking in front of an audience (31.8%), and nearly an equal number (31.1%) highlighted difficulties adjusting to the course structure and learning style. One student explained, “I was afraid of the audience, afraid I would forget what to say, and that people wouldn't understand me”.

Less frequently mentioned challenges included team communication issues (17.2%) and language anxiety (9.3%), often linked to lack of experience: “I wasn’t used to group work yet. We didn’t work well together, and I often forgot my part”. In contrast, some felt overly confident or unaffected by the task (6.0%). A small percentage of students also pointed out having to deal with unprepared group members (2.6%), confusion or misalignment with group (0.7%), and poorly organised workload distribution (1.3%). Overall, most students reported challenges with self-assurance and verbal performance, while external factors related to team dynamics and organisation affected a smaller proportion.

4.6.2. Question 2: Support from group while presenting

When asked about the support they received from teammates during presentations, the most commonly cited benefit was emotional encouragement, reported by 68.2% of students. This was reflected in phrases like “together,” “remind,” and “support,” which formed the basis for the theme Peer Encouragement. As one student described: “If someone forgot, we would pass the mic to another teammate”. Another shared: “When I forgot what to say, my teammate next to me continued for me”. Others noted how practice and preparation helped alleviate anxiety: “My teammates helped me practice before the presentation, which made me feel more confident”.

Additionally, 27.2% of students mentioned encouragement through positive talk: “My teammates encouraged me before presenting, which helped calm me down”. About 18.5% mentioned that they appreciated their peers’ assistance when experiencing memory lapses during a presentation, such as one stating, “When I forgot what to say, my teammate next to me continued for me”. A fair and supportive group environment was highlighted by 15.2% of students: “Everyone took turns fairly, and no one judged anyone”. Approximately 8.6% pointed to the role of well-prepared members in their experience. Less frequently cited forms of support consisted of receiving limited feedback (2.6%), having unengaged peers (2.0%), or felt indifferent about whether they were presenting alone or in a group (2.0%). One said, “Some group members didn’t care and didn’t help prepare”. Only a small subset of students reported more negative experiences, including encouragement was unnecessary (1.3%), a personal preference for solo work (2.0%), or peer feedback was overly critical (0.7%). Only 2.0% of participants offered no particular comments or opinions about support from their team members. Overall, the findings highlight that most students benefited from emotional support in teamwork, gaining comfort and reduced anxiety, though a minority reported limited or negative experiences.

4.6.3. Question 3: Improvements and resilience gained through group presentations

More than half of the students (53.0%) identified improvements in English language skills, including vocabulary use, pronunciation, and fluency. Additionally, 36.4% reported increased confidence, citing reduced anxiety and greater ease in public speaking. Enhanced teamwork awareness was noted by 38.4% of participants, while 19.9% mentioned better time management. These themes were derived from codes such as “tự tin hơn (more confident),” “nói tốt hơn” (more fluent), and “quản lý thời gian” (time management). One student noted: “I spoke more fluently. My time management and English improved, and I stopped stumbling”. Another reflected: “I became more confident, remembered my parts better, and improved my ability to present in front of others”. Beyond communication and collaboration, 18.5% of them highlighted gains in self-reflection and independence (18.5%), as well as better memory and concentration (9.9%). Students also described overcoming fears: “Doing it many times helped me get used to it and improve my mindset, skills, and English”. Even those who initially struggled expressed resilience: “My teammates guided me on how to present, which helped me become more confident when speaking in public”. While most students confirmed growth, a small percentage of students felt they experienced limited or no gains (6.0%) or had mixed or unclear in terms of group influence (6.6%). The patterns of responses demonstrate substantial gains in communication and collaborative abilities for most students, despite some viewing the group setting to be less impactful on their personal growth.

4.6.4. Question 4: Final decision on learning model in classroom

When asked about presentation preferences, the majority of students (90.8%) preferred team presentations, compared with 7.2% who favoured individual work and 2.0% who expressed no preference. As one student shared: “I prefer group work because someone can support me if I forget something”. Others appreciated the balance of effort: “If the group has responsible members, I feel more comfortable presenting”. Among those who preferred presenting alone, the rationale often stemmed from disillusionment with disengaged peers and the disproportionate burden of work, which caused diminished motivation and a reluctance to participate in collaborative efforts. Those who preferred working alone (7.2%) cited negative group experiences such as unequal workload or unprepared teammates: “I prefer working alone because my previous group didn’t prepare their parts”. As a result, these complications precipitated a withdrawal from

active participation and generated a general sense of dissatisfaction with the group presentation format. Nevertheless, several students noted that their initial preference for solo work was conditional; given the opportunity to collaborate with more accountable and proactive peers, they would be more inclined to favour group presentations over individual ones.

5. Discussion

The findings reinforce the value of team-based presentations in strengthening students' confidence and resilience in public speaking. Across the course, statistically significant gains were observed in teamwork, short presentations, extended presentations, and overall resilience. With an effect size of 0.72, the results highlight the substantial positive impact of collaborative presentations on students' ability to manage speaking-related stress. These outcomes reflect the principles of Vygotsky's sociocultural theory [9], which asserts that peer interaction and support are essential for learning and growth, particularly within the learner's zone of proximal development. In this study, the enhanced confidence and resilience achieved among students are consistent with this view, with teamwork functioning as both emotional and intellectual scaffolding during high-pressure speaking activities. Students not only engaged actively in teamwork but also learned by observing peers and emulating their strategies and improvements.

Previous research has also demonstrated the advantages of collaborative learning in promoting academic achievement and adjustment. D.W. Johnson, et al. (2009) [8] argue that positive interdependence and individual accountability contribute to improved performance and psychological well-being. In the context of second language learning, S. Fatimah (2019) [7] and S. Mercer (2011) [35] found that peer collaboration mitigates anxiety and fosters greater self-assurance in speaking. The present results echo these findings, suggesting that sustained involvement in group tasks cultivates not only communicative ease but also relational confidence. Notably, this study did not reveal significant correlations between the measured performance variables and changes in resilience scores. This absence of correlation underscores an important point: while performance metrics reflect progress, such improvements may not directly translate into learners' perceptions of resilience. Instead, resilience appears to emerge from a complex interplay of internal and external influences. As defined by K.M. Connor, et al. (2003) [2], resilience encompasses emotional regulation, adaptability, and self-efficacy, dimensions less visible in task-based assessments. The qualitative data further illuminated

students' emotional journeys during the learning process. Many participants directly attributed their increased confidence to peer support, motivational feedback, and the shared responsibility of team presentations. A key insight from this study is that teamwork offers students both a psychologically safe environment and a structure of mutual accountability. These findings align with Z. Dornyei, et al. (2015) [37] view that emotional factors - such as interpersonal bonds, anxiety regulation, and learner motivation - are critical for success in language classrooms.

In summary, this research contributes to the literature by demonstrating that teamwork-oriented learning environments foster both communicative competence and emotional development. By integrating quantitative and qualitative findings, it offers a comprehensive account of how structured group activities can shape students' engagement with public speaking. Framing these results within sociocultural and language learning theories reinforces the view that collaborative learning is as empowering emotionally as it is effective academically.

Although participation in the teamwork model was voluntary, 47 students (23.7%) discontinued and withdrew during the early phase of the programme. Several of these students attended the initial teamwork sessions; however, peer feedback and classroom observations indicated frequent absences and limited engagement in group activities, which ultimately undermined their teams' effectiveness. When consulted by the lecturer, some students expressed a preference for individual work in order to avoid compromising their classmates' scores through inconsistent participation. Others attributed their disengagement to doubts about their teams' ability to collaborate productively. Challenges such as weak intra-group communication, unclear task allocation, and a lack of collective accountability were cited as contributing factors to the poor outcomes observed in their first three presentations. As a result, certain groups voluntarily disbanded, with members requesting a transfer to the traditional individual grading model. Although the instructor attempted to facilitate team reassignment, several students - disillusioned with the group format - chose to continue the course independently. These experiences underscore the practical challenges of implementing teamwork-based instruction, particularly when disparities in accountability and motivation exist among learners. The findings suggest that while teamwork has clear potential to enhance resilience and speaking confidence, it must be supported by structured guidance, thoughtful team formation, and ongoing monitoring to ensure balanced participation.

6. Conclusions, implications and limitations

The findings of this study yield several pedagogical insights for EFL instruction, particularly in contexts that prioritise the cultivation of speaking competences through group presentation formats.

Firstly, the recurring reports of low confidence and difficulties with fluency signal a critical need for targeted scaffolding at the foundational stage of presentation-focused instructional design. Educators are encouraged to incorporate language modelling, structured vocabulary enrichment tasks, and non-evaluative oral practice opportunities to support incremental growth in speaking confidence. Planned rehearsal routines, supplemented by constructive peer feedback, can play a pivotal role in reducing the apprehension commonly associated with oral performance.

Secondly, the emergence of emotional support as a dominant theme highlights the importance of creating educational spaces that foster psychological safety and peer collaboration. As students often attribute diminished nervousness and heightened confidence to collaborative dynamics, educators are advised to implement structured teamwork instruction, cultivate an ethos of reciprocity, and clarify intra-group responsibilities to reduce performance pressure.

Thirdly, the implementation of group presentation tasks not only promoted linguistic development but also fostered key attributes such as adaptability, mnemonic capability, and reflective thinking. These outcomes underscore the multifaceted benefits of cooperative oral tasks in advancing both communicative competence and critical psychological skills, including interpersonal collaboration, affective regulation, and self-efficacy.

Fourthly, while the majority of students expressed a preference for group work, a subset favoured individual presentations, often citing unequal workload distribution and inconsistent peer engagement. This suggests the need for educators to oversee group processes more closely and to embed reflective assessment practices that allow learners to raise concerns about collaboration. To strengthen group cohesion and equity, instructors might consider strategic student pairing, reinforcing collective responsibility through clearly defined roles, and formalising group agreements.

To better equip practitioners with practical tools, this study proposes several targeted strategies for classroom implementation. Beginning the academic term with intentional community-building activities - such as guided peer interviews, shared goal articulation, and cooperative game-based tasks - can establish trust within student teams. To prevent interpersonal

challenges, educators may integrate conflict - resolution training through structured role - plays or guided peer discussions. Establishing collaborative contracts and rotating group roles (e.g., speaker, timekeeper, organiser) can encourage shared responsibility while reducing dominance or disengagement. The use of rubrics that assess both individual and collective contributions - augmented by structured opportunities for peer and self-assessment - can enhance equity and learner accountability. Consistent formative assessment and scheduled instructor consultations throughout the course can further support the cultivation of resilience and the progressive development of communicative abilities.

Despite the relevance of these findings, the study has limitations that must be acknowledged. The intervention's duration of only three months constrains the extent to which lasting impacts on students' confidence and resilience can be determined. Longitudinal investigations are needed to assess whether such improvements persist over time. In addition, disparities in teaching styles among lecturers may have introduced inconsistencies in student experiences, suggesting that the adoption of standardised instructional protocols would strengthen data reliability and enable more meaningful cross-contextual comparisons. Finally, as this study concentrated solely on oral communication, future research should examine the effects of teamwork on resilience in other language modalities - particularly reading and writing - and in more culturally and pedagogically diverse environments. Such expansion would enrich the current body of knowledge by providing a more nuanced and holistic understanding of collaborative learning processes in EFL contexts.

CRedit author statement

Thi Tuyet Hanh Nguyen: Reviewing, Formal analysis, Editing, Data analysis, Abstract; Thi Huong Tran: Writing, Proofreading, Data analysis.

COMPETING INTERESTS

The authors declare that there is no conflict of interest regarding the publication of this article.

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University students' attitudes towards AI-enabled learning enjoyment: Evidence from the Philippines

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Received 4 June 2025; revised 14 June 2025; accepted 6 January 2026

Abstract:

As artificial intelligence (AI) tools increasingly shape higher education, understanding their impact on students' motivation and learning experiences is essential. This study investigated university students' attitudes towards AI and its role in enhancing learning enjoyment. A total of 220 university students from Regions XI and XII in the Philippines participated in the study during the second quarter of 2025, using an instrument based on the Technology Acceptance Model (TAM) and Self-determination Theory (SDT). Data were analysed using descriptive statistics and factor analysis. The measurement model showed satisfactory reliability (Cronbach's $\alpha=0.759$ to 0.914). Using Principal Axis Factoring with Promax rotation, strong factor loadings ($\lambda=0.414$ to 0.946) emerged, along with acceptable model fit indices (CFI= 0.916 , TLI= 0.901 , RMSEA= 0.0873 , SRMR= 0.086). While students generally reported positive experiences with AI tools, concerns regarding creativity loss, over-reliance, and occasional confusion were also noted. These findings suggest that AI integration should balance technical benefits with pedagogical considerations to support both academic performance and student well-being. Limitations include the cross-sectional design and focus on university-level participants, suggesting the need for longitudinal and multi-context studies.

Keywords: AI in education, educational technology, intrinsic motivation, learning engagement, student perceptions.

Classification numbers: 1.3, 3.4

1. Introduction

The integration of AI into educational settings has become a major area of inquiry, as digital technologies increasingly shape higher education worldwide [1]. As AI continues to advance, its capacity to transform learning environments is being actively explored by educators, policymakers, and researchers. AI-driven technologies offer adaptive learning systems, real-time analytics, personalised tutoring, and automated feedback, thus redefining pedagogical strategies and enhancing instructional delivery [2, 3]. AI tools such as intelligent tutoring systems, automated essay graders, and learning analytics dashboards are increasingly adopted to optimise learning efficiency, assessment accuracy, and administrative convenience [4-6].

While these developments reflect AI's potential for improving academic performance, much of the existing research remains focused on cognitive or performance-related outcomes, such as academic achievement,

knowledge acquisition, and task efficiency [7, 8]. Comparatively fewer studies have investigated AI's role in shaping students' affective experiences and motivational engagement - particularly whether AI can foster greater learning enjoyment [6, 9, 10]. This gap is significant, as emotional engagement is strongly linked to intrinsic motivation, persistence, and deeper learning outcomes [11, 12].

In this study, we conceptualise learning enjoyment not merely as a transient emotional reaction, but as an affective-motivational construct closely aligned with intrinsic motivation, which plays a critical role in sustaining students' interest, curiosity, and commitment to learning [13, 14]. Learning enjoyment reflects the psychological satisfaction derived from engaging with educational tasks, combining both positive emotional experiences and enduring motivational qualities that contribute to deeper learning processes [15]. Thus, investigating how AI influences learning enjoyment offers important insights into students' sustained engagement and long-

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term academic development, rather than merely short-term satisfaction or convenience.

The theoretical foundation of this study integrates the TAM [16] and SDT [13]. While TAM emphasises perceived ease of use and perceived usefulness as drivers of technology adoption [17, 18], SDT emphasises intrinsic motivation driven by autonomy, competence, and relatedness [19-21]. The integration of TAM and SDT allows for a more comprehensive analysis of both the functional and emotional dimensions of AI adoption in higher education [5, 22, 23].

Moreover, as higher education institutions in regions such as the Philippines increasingly adopt AI-powered learning tools [24, 25], it becomes essential to examine not only their technical benefits but also their potential influence on students' affective learning experiences. This study aims to contribute to this emerging discourse by empirically investigating how AI tools affect students' learning enjoyment, using a combined TAM and SDT framework to analyse student attitudes, perceived usefulness, intrinsic motivation, and concerns related to AI use.

2. Methodology

This study employed a descriptive, cross-sectional quantitative design to investigate university students' attitudes towards AI and its role in enhancing learning enjoyment. Grounded in the TAM [16] and SDT [13], the study examined how perceived usefulness, intrinsic motivation, and related constructs influence students' affective engagement with AI tools.

2.1. Sampling procedure and participants

The target population consisted of university students in Regions XI and XII of the Philippines, where the adoption of AI-enabled learning technologies has gradually expanded across public and private institutions. To enhance representativeness, a stratified random sampling technique was employed. Participating institutions were first stratified according to academic discipline (e.g., education, engineering, business, and computer studies) to ensure diversity in academic backgrounds and exposure to AI tools. From these strata, student participants were randomly selected using institutional class lists and electronic enrolment databases provided by the university registrars, ensuring proportional representation across fields of study.

A total of 220 students voluntarily participated in the study during the second quarter of 2025. Participants represented a variety of undergraduate year levels (first year to senior year), with academic majors spanning education (27%), business (22%), information technology/computer science (20%), engineering

(18%), and other programmes (13%). The mean age of respondents was 20.8 years ($SD=1.9$), with a balanced distribution of male (51%) and female (49%) participants. All respondents reported prior exposure to AI tools used in academic settings, including - but not limited to - automated language models, virtual tutors, plagiarism detection systems, personalised learning platforms, and AI-supported research tools.

Recruitment was conducted through institutional email invitations, university bulletin announcements, and instructor referrals during the second quarter of 2025. Participation was voluntary and anonymous, with informed consent obtained prior to data collection. Ethical considerations and protocols adhered to the guidelines set forth by the Philippine Health Research Ethics Board (PHREB).

2.2. Instrumentation and scale development

The survey instrument was developed based on an extensive literature review of students' perceptions and attitudes towards AI [5, 10, 22]. Key constructs reflected performance expectancy, facilitating conditions, ease of use, intrinsic motivation, and enjoyment, drawing from TAM and SDT frameworks [22, 23, 26]. The initial item pool underwent expert validation involving five specialists in educational technology, AI, and psychometric assessment to ensure content validity and construct alignment.

The final instrument consisted of Likert-type items rated on a five-point scale (1=strongly disagree to 5=strongly agree). The scale was pilot-tested prior to full administration to confirm clarity and respondent understanding.

2.3. Data collection and analysis procedures

Data were collected through an online survey distributed via Google Forms over a four-week period. The online format ensured accessibility across multiple campuses and minimised logistical barriers. Descriptive statistics, exploratory factor analysis, and reliability testing were conducted using Jamovi Software 2.0.

Internal consistency reliability was assessed using Cronbach's alpha, yielding values between 0.709 and 0.937 across all subscales [27]. Principal Axis Factoring with a rotation method of Promax with Kaiser Normalization was used. These methods were chosen because an underlying theoretical structure is being hypothesised, and the structure's dimensions or indicators were assumed to be intercorrelated. Construct validity was confirmed via factor analysis. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.948 [28], while Bartlett's Test of Sphericity was significant ($\chi^2=3623$, $df=210$, $p<.001$), confirming suitability for

factor analysis [29, 30] (Table 1). Factor loadings ranged from 0.414 to 0.946 [31, 32], supporting the stability of the measurement model.

To further assess model adequacy, confirmatory factor analysis and model fit indices were computed, including Chi-square ($\chi^2=479$, $df=179$, $p<.001$), CFI=0.916, TLI=0.901, RMSEA=0.0873, and SRMR=0.086, as shown in Table 5, indicating an acceptable model fit [33, 34].

Table 1. KMO and Bartlett's test results.

Bartlett's Test of Sphericity		
χ^2	df	p-value
3623	210	<.001
KMO Measure of Sampling Adequacy (MSA)		0.948

3. Results and discussion

In Table 2, Cronbach's alpha coefficients for all scales indicate a strong level of internal consistency, with values ranging from 0.759 to 0.914. This range reflects good to excellent reliability across the constructs assessed [27]. The scale assessing Concerns or Negative Perceptions recorded the lowest reliability ($\alpha=0.759$); however, despite being the least reliable among the scales, it remains within an acceptable threshold for exploratory research. These reliability coefficients imply that the instruments employed in the study are generally sound and yield dependable measurements of the constructs under examination.

Table 2. Scale reliability statistics.

Scale reliability statistics	Cronbach's α
Perceived enjoyment scale	0.892
Perceived usefulness in learning enjoyment scale	0.906
Social enjoyment in AI-enabled learning scale	0.908
Confidence and control in AI-enabled learning scale	0.914
Concerns or negative perceptions scale	0.759

In Table 3, it is observed that the factor loadings for the majority of items surpass the threshold of 0.7, which is indicative of strong convergent validity. High factor loadings imply that the items are effectively represented by their corresponding factors [35]. The overall factor structure demonstrates that the items maintain a robust connection with their designated constructs, thereby affirming the validity of the measurement model.

Table 4 highlights the ease of understanding and application of the various aspects influencing students' impressions of AI. These factors, including reported happiness, perceived utility, social enjoyment, and

Table 3. Standardised factor loadings from the confirmatory factor analysis.

Factor	Indicator	Estimate	SE	Z	p
Perceived enjoyment	AI tools make studying more fun compared to traditional methods.	0.681	0.0535	12.73	<.001
	Using AI tools in learning makes the experience more enjoyable.	0.733	0.0530	13.83	<.001
	I feel excited when learning with the help of AI-based applications.	0.759	0.0527	14.42	<.001
	Learning with AI motivates me to engage more with course materials.	0.846	0.0564	14.98	<.001
	AI tools provide a more entertaining approach to solving academic problems.	0.702	0.0562	12.49	<.001
Perceived usefulness in learning enjoyment	AI tools help simplify complex topics, making learning more enjoyable.	0.701	0.0553	12.68	<.001
	The use of AI in my studies improves my overall satisfaction with learning.	0.851	0.0550	15.49	<.001
	AI applications help me stay interested in the subject matter.	0.920	0.0586	15.71	<.001
	The interactive features of AI tools make learning less stressful and more enjoyable.	0.711	0.0507	14.02	<.001
	AI tools help me stay focused and entertained during study sessions.	0.809	0.0560	14.45	<.001
Social enjoyment in AI-enabled learning	Collaborating with peers using AI tools enhances my learning enjoyment.	0.781	0.0505	15.48	<.001
	AI tools make group projects more engaging and productive.	0.848	0.0555	15.28	<.001
	Sharing AI-assisted outputs with classmates is an enjoyable experience.	0.835	0.0560	14.92	<.001
	AI applications encourage meaningful discussions with peers during learning activities.	0.814	0.0534	15.25	<.001
Confidence and control in AI-enabled learning	I feel confident and capable when I use AI tools for learning tasks.	0.813	0.0539	15.10	<.001
	AI tools give me more control over my learning process, which I find enjoyable.	0.910	0.0541	16.82	<.001
	I enjoy exploring AI tools because they allow me to learn at my own pace.	0.837	0.0546	15.32	<.001
	Learning with AI gives me a sense of accomplishment and joy.	0.866	0.0577	14.99	<.001
Concerns or negative perceptions	I sometimes find AI tools confusing, which reduces my enjoyment of learning.	0.256	0.0907	2.82	0.005
	I am interested in the development of AI.	0.792	0.0888	8.92	<.001
	Over-reliance on AI tools takes away the creative enjoyment of learning.	0.454	0.0848	5.35	<.001

confidence in AI-enabled learning, are clearly and significantly correlated, according to the data. For instance, a high correlation of 0.875 suggests a particularly strong link between students' enjoyment of AI and their perceptions of its value in education. This indicates that if students enjoy AI-based learning, they are more likely to perceive it as beneficial [35].

However, the correlations between AI-related concerns or unfavourable impressions and other characteristics are marginally weaker, with values ranging from 0.599 to 0.875. This suggests that although unfavourable views are statistically significant, their impact on general attitudes towards AI is smaller than that of the more positive elements [16]. The majority of the components show robust and substantial associations, and the overall factor structure is clear and easy to interpret, allowing academics and educators to use the findings more effectively. As a result, focusing on promoting positive perceptions of AI may help improve students' educational experiences.

The following table includes several statistical measures used to assess the adequacy of the factor analysis concerning respondents' perceptions of AI related to learning enjoyment. These metrics include the chi-square statistic, the Comparative Fit Index (CFI), the Tucker-Lewis Index (TLI), the Root Mean Square Error of Approximation (RMSEA), and the Standardized Root Mean Square Residual (SRMR). Each of these indices provides important information regarding the overall fit and efficiency of the model.

The chi-square statistic for the model is $\chi^2(179)=479$, $p<.001$, indicating statistical significance. While a large chi-square value typically suggests poor model fit, it is important to note that this statistic is highly sensitive to sample size. In larger samples, the chi-square test often yields significant results even when the model fits the data adequately [36]. Under these considerations, this significant chi-square finding should be interpreted cautiously, as it may reflect the relationship between sample size and the chi-square statistic rather than a substantial discrepancy between the observed and expected covariance matrices.

The CFI is 0.916, and the TLI is 0.901, with both exceeding the commonly accepted minimum threshold of 0.90. These results indicate an overall marginal model fit. Both indices compare the proposed model against a baseline model and suggest that the model adequately explains the relationships among the observed variables [33]. The values of the CFI and TLI therefore support the appropriateness of the model structure for the data.

The RMSEA is estimated at 0.0873, with a 90% confidence interval ranging from 0.0779 to 0.0968. This

Table 4. Latent factor correlation matrix.

Factor	Indicator	Estimate	SE	Z	p
Student attitudes towards AI in terms of perceived enjoyment	Student attitudes towards AI in terms of perceived enjoyment	1.00			
	Student attitudes towards AI in terms of perceived usefulness in learning enjoyment	0.875	0.0245	35.76	<.001
	Student attitudes towards AI in terms of social enjoyment in AI-enabled learning	0.865	0.0257	33.68	<.001
	Student attitudes towards AI in terms of confidence and control in AI-enabled learning	0.802	0.0319	25.13	<.001
	Student attitudes towards AI in terms of concerns or negative perceptions	0.607	0.0691	8.79	<.001
Student attitudes towards AI in terms of perceived usefulness in learning enjoyment	Student attitudes towards AI in terms of perceived usefulness in learning enjoyment	1.000			
	Student attitudes towards AI in terms of social enjoyment in learning enjoyment	0.843	0.0272	31.01	<.001
	Student attitudes towards AI in terms of confidence and control in AI-enabled learning	0.854	0.0254	33.63	<.001
	Student attitudes towards AI in terms of concerns or negative perceptions	0.633	0.0709	8.93	<.001
Student attitudes towards AI in terms of social enjoyment in AI-enabled learning	Student attitudes towards AI in terms of social enjoyment in AI-enabled learning	1.000			
	Student attitudes towards AI in terms of confidence and control in AI-enabled learning	0.843	0.0253	34.12	<.001
	Student attitudes towards AI in terms of concerns or negative perceptions	0.612	0.0678	9.03	<.001
Student attitudes towards AI in terms of confidence and control in AI-enabled learning	Student attitudes towards AI in terms of confidence and control in AI-enabled learning	1.000			
	Student attitudes towards AI in terms of concerns or negative perceptions	0.599	0.0674	8.89	<.001
Student attitudes towards AI in terms of concerns or negative perceptions	Student attitudes towards AI in terms of concerns or negative perceptions	1.000			

value is slightly above the generally accepted threshold of 0.08, indicating a moderate fit. Although the RMSEA suggests that the model does not perfectly represent the population covariance structure, it remains close to the acceptable limit, implying that the model can still be regarded as reasonably fitting. Moreover, the lower bound of the confidence interval falls below 0.08, suggesting that the model fit may be considered marginally acceptable.

The SRMR is reported as 0.086, which marginally exceeds the recommended threshold of 0.08 adopted by L. Hu, et al. (1999) [33]. This indicates that the model is close to achieving an acceptable fit but may benefit from minor refinements. The SRMR reflects the standardised difference between observed and predicted correlations. Although values above 0.08 suggest a suboptimal fit, an SRMR of 0.086 still indicates a reasonably good model fit, and further adjustments could improve congruence with the observed data.

The model fit statistics indicated a satisfactory fit. CFI and TLI were good indicators that the model fitted the data well, although RMSEA and SRMR were slightly above the commonly recommended cut-offs, indicating marginal model fit [34]. The values being somewhat higher for RMSEA and SRMR suggest that further refinements of the models of certain elements or items whose low factor loadings could be contributing to the marginal fit.

Table 5. Confirmatory factor analysis model-fit indices.

Test for exact fit					
χ^2	df	p			
479	179	<.001			
Comparative Fit Index	Tucker-Lewis Index	Root Mean Square Error of Approximation	Standardised Root Mean Square Residual	Lower	Upper
0.916	0.901	0.0873	0.086	0.0779	0.0968

RMSEA 90% CI.

3.1. Level of students' attitudes towards artificial intelligence

Tables 6-10 presented below illustrate the average scores concerning respondents' perceptions of AI in relation to learning enjoyment, derived from the analysis of 220 completed responses. In general, respondents demonstrate a moderately favourable attitude towards the integration of AI in educational contexts, reflected by an average score of Mean=3.60 (SD=0.671). This finding suggests that respondents predominantly regard AI as a beneficial resource for improving learning enjoyment, albeit with some degree of variability in individual opinions.

Analysing the data in more detail, the subscale measuring Perceived Usefulness in Learning Enjoyment achieved the highest score, with a mean of 3.67 (SD=0.838). This indicates that respondents perceive AI

as especially advantageous in enhancing their enjoyment of the learning process [6]. Such a finding underscores a favourable view of AI's ability to enrich the educational experience. Nonetheless, the higher standard deviation points to a wider range of opinions among respondents, suggesting that the perceived benefits of AI vary significantly among individuals [37].

Conversely, the Concerns or Negative Perceptions subscale, which has a mean score of 3.55 (SD=0.760), indicates a relatively elevated level of apprehension regarding the use of AI in educational settings. While the score remains moderately positive, it underscores that certain respondents exhibit a more cautious or sceptical stance towards the integration of AI in education. The moderate standard deviation observed in this subscale further implies a diversity of opinions concerning the possible disadvantages or challenges linked to the application of AI in learning environments [38].

Overall, the findings indicate a predominantly favourable perspective on the application of AI in educational settings, although there is notable variability in respondents' attitudes, particularly with respect to its perceived utility and associated concerns. This suggests that while the majority view AI as advantageous, there are considerable apprehensions that must be addressed to facilitate wider acceptance.

Table 6. Student attitudes towards AI in terms of perceived enjoyment.

Statements	N	Mean	SD
AI tools make studying more fun compared to traditional methods.	220	3.86	0.906
Using AI tools in learning makes the experience more enjoyable.	220	3.65	0.921
I feel excited when learning with the help of AI-based applications.	220	3.56	0.932
Learning with AI motivates me to engage more with course materials.	220	3.55	1.012
AI tools provide a more entertaining approach to solving academic problems.	220	3.74	0.951
Grand Mean	220	3.67	0.790

Table 6 further indicates that respondents display a favourable attitude towards the enjoyment associated with AI, with mean scores ranging from 3.55 to 3.86. This finding implies a generally positive perception of the enjoyable features of AI, as evidenced by the relatively low variability in respondents' responses (Grand Mean=3.64, SD=0.790).

Furthermore, consistent with the research by A.R. Malik, et al. (2023) [8] on AI in education, students show a positive disposition towards the incorporation of AI into their academic endeavours. The results reveal a strong recognition among respondents of the potential advantages offered by AI tools. Based on the feedback received, AI is regarded as a valuable asset that provides significant benefits, thereby enhancing students' educational experiences.

Table 7. Student attitudes towardss AI in terms of perceived usefulness in learning enjoyment.

Statements	N	Mean	SD
AI tools help simplify complex topics, making learning more enjoyable.	220	3.89	0.942
The use of AI in my studies improves my overall satisfaction with learning.	220	3.63	1.001
AI applications help me stay interested in the subject matter.	220	3.56	1.073
The interactive features of AI tools make learning less stressful and more enjoyable.	220	3.82	0.893
AI tools help me stay focused and entertained during study sessions.	220	3.46	0.955
Grand Mean	220	3.67	0.838

In Table 7, the data indicate a favourable tendency among respondents to acknowledge the perceived benefits of AI in enhancing the enjoyment of learning. This is demonstrated by their expressed intentions to increase interest, motivation, and engagement in the educational process, with mean scores ranging from 3.46 to 3.89. Respondents not only recognise the significance of AI but also exhibit a proactive approach to incorporating AI tools to enhance their learning experiences, thereby making the learning process more enjoyable and engaging (Grand Mean=3.67, SD=0.838).

This favourable tendency is consistent with the findings of N.N. Ayoub, et al. (2024) [39], which emphasise a distinctly positive attitude towardss the integration of AI as a valuable resource for improving learning enjoyment. In addition, further research highlights the role of AI in enhancing learning experiences by rendering them more engaging and enjoyable [3, 40]. The positive responses from respondents - encompassing perceptions of usefulness, ease of use, and overall satisfaction - collectively indicate a promising future for AI tools in enriching students' educational journeys.

Table 8. Student attitudes towardss AI in terms of social enjoyment in AI-enabled learning.

Statements	N	Mean	SD
Collaborating with peers using AI tools enhances my learning enjoyment.	220	3.50	0.919
AI tools make group projects more engaging and productive.	220	3.66	1.005
Sharing AI-assisted outputs with classmates is an enjoyable experience.	220	3.54	1.004
AI applications encourage meaningful discussions with peers during learning activities	220	3.43	0.965
Grand Mean	220	3.53	0.862

In Table 8, the data indicate a favourable disposition among respondents regarding the social enjoyment associated with AI-enabled learning, with mean scores ranging from 3.43 to 3.67. This suggests that students generally perceive AI-enabled learning as socially engaging and enjoyable. The relatively low variability in

responses further implies a uniform understanding of AI's capacity to improve social interaction within educational settings (Grand Mean=3.53, SD=0.862).

Notably, research conducted by Z. Xu (2024) [40] and P. Kaledio, et al. (2024) [3] supports these findings, demonstrating that AI-enabled learning tools can significantly enhance students' educational experiences. These tools are crucial in promoting social interaction, boosting engagement, and facilitating collaboration among students, thereby creating a more vibrant and enjoyable learning atmosphere. This alignment of participant perceptions underscores the potential of AI to enrich the social dimensions of learning and highlights its significance as an effective instrument for improving student engagement and interaction.

Table 9. Student attitudes towardss AI in terms of confidence and control in AI-enabled learning.

Statements	N	Mean	SD
I feel confident and capable when I use AI tools for learning tasks.	220	3.50	0.972
AI tools give me more control over my learning process, which I find enjoyable.	220	3.49	1.018
I enjoy exploring AI tools because they allow me to learn at my own pace.	220	3.62	0.992
Learning with AI gives me a sense of accomplishment and joy.	220	3.45	1.039
Grand Mean	220	3.51	0.896

In Table 9, the data reveal that respondents exhibit a favourable disposition regarding their confidence and sense of control in AI-assisted learning, with mean scores ranging between 3.45 and 3.62. This suggests that students predominantly feel empowered and assured when utilising AI tools in their educational activities. Additionally, the limited variation in responses implies a relatively uniform belief in AI's capacity to enhance students' sense of control and self-confidence in their learning experiences (Grand Mean=3.51, SD=0.896).

Research conducted by N.D. Bation, et al.(2024) [22] supports these results by emphasising that students' confidence and perceived control in AI-enabled learning environments play a critical role in shaping their overall attitudes towardss AI. The findings indicate that students are more likely to engage favourably with AI technologies when they feel comfortable using them and believe that they retain control over their learning processes. Moreover, higher levels of self-efficacy are associated with a stronger sense of ownership over educational activities. As AI tools have the potential to strengthen students' agency and efficacy in the learning process, the alignment between the study's findings and prior research underscores the importance of fostering confidence and control in AI-enabled learning environments.

Table 10. Student attitudes towards AI in terms of concerns or negative perceptions.

Statements	N	Mean	SD
I sometimes find AI tools confusing, which reduces my enjoyment of learning.	220	3.11	1.094
I am interested in the development of AI.	220	3.82	0.995
Over-reliance on AI tools takes away the creative enjoyment of learning.	220	3.70	1.038
Grand Mean	220	3.55	0.760

Based on the data presented in Table 10, the results attest that there is a degree of fear or negative perception towards AI, with mean scores ranging between 3.11 and 3.82. Thus, although many respondents express some level of caution or scepticism regarding AI, the overall sentiment remains relatively balanced. The low variation in responses reflects a general equilibrium in respondents' levels of concern, indicating that students tend to feel either mildly worried or largely neutral about the role of AI in education (Grand Mean=3.55, SD=0.76).

Most respondents adopt a neutral stance towards AI, which supports this balanced perspective. A. Smolansky, et al. (2023) [41] explain that such average scores suggest that some students may have concerns about how AI could affect education, but these concerns are not particularly strong. The responses are relatively homogeneous, with most students expressing similar views, as reflected by the standard deviation of 0.760. This pattern suggests that students are cautious or somewhat uncertain, yet not polarised in their opinions, and are likely to approach AI in education with careful optimism rather than outright rejection [42].

Despite generally positive attitudes towards AI, participants reported meaningful concerns about over-reliance on AI tools (M=3.70) and the over-reliance and loss of creative enjoyment (M=3.70). Such concerns align with growing debates in the literature suggesting that excessive automation may undermine critical thinking, originality, and learner autonomy if not carefully managed [41, 42]. Students' confusion when using AI tools (M=3.11) also indicates usability challenges that could create frustration or disengagement if interfaces are not designed to support intuitive learning experiences. These concerns suggest that, while AI can enhance learning enjoyment, poorly designed systems or excessive dependence may paradoxically reduce students' creative ownership of learning, potentially limiting long-term skill development.

3.2. Group differences (independent samples t-test)

Gender-based comparisons indicated minor differences, with male students reporting slightly higher learning enjoyment scores than female students

(M_{male}=3.71, SD=0.72; M_{female}=3.48, SD=0.59). However, the observed effect sizes in Table 11 (Cohen's d=-0.336; r=0.237) and significance levels suggest that these differences are small and may not hold substantial practical significance [43, 44] (Table 12). Accordingly, these gender differences should be interpreted with caution.

Table 11. Gender differences in overall AI-attitude scores.

	Statistic	df	p	Mean difference	SE difference	Effect size
Grand Mean	Student's t	-2.49	218	0.014	-0.223	Cohen's d -0.336
	Mann-Whitney U	4614	0.002	-0.258		Rank biserial correlation 0.237

$$H_a: \mu_{\text{Female}} \neq \mu_{\text{Male}}$$

Table 12. Group descriptions.

	Group	N	Mean	Median	SD	SE
Grand Mean	Female	107	3.48	3.45	0.592	0.0572
	Male	113	3.71	3.72	0.723	0.0680

3.3. Theoretical implications

This study also contributes to the existing body of knowledge on the use of artificial intelligence in educational settings by combining two major models: the TAM [16] and SDT [13]. The theoretical implications of this research are manifold, with one of the main contributions being the further development of existing theories of technology use, as well as an enhanced understanding of how intrinsic motivation affects learners' perceptions of AI-based instructional tools [15].

This study reaffirms the significance of students' attitudes towards AI as a crucial factor influencing their intention to utilise AI technologies, in accordance with TAM. The findings indicate that students are more inclined to adopt AI tools when they perceive them as both beneficial and user-friendly [17]. This observation highlights the continuing importance of TAM and SDT as key determinants of technology adoption, particularly in the context of AI [18]. By validating the relevance of TAM within higher education environments, this research strengthens the model's capacity to predict students' behavioural intentions regarding the adoption of innovative educational technologies [45]. However, the findings also highlight the need for a deeper understanding of these behavioural attitudes and their influence on the actual use of AI applications. In this regard, both TAM and SDT present inherent limitations in fully explaining students' AI learning behaviour. TAM primarily emphasises perceived usefulness and ease of use but does not sufficiently account for broader contextual and social influences such as peer interaction, instructor support, institutional conditions,

and technological infrastructure, which are critical in AI-enabled learning environments. It also assumes relatively rational decision-making and may overlook emotional, ethical, and critical responses to AI use. Meanwhile, SDT offers insights into intrinsic motivation through autonomy, competence, and relatedness but does not adequately address technology-specific issues such as the reliability, accuracy, and transparency of AI systems, nor learners' trust in algorithmic outputs. Additionally, SDT may not fully capture the tension between enhanced autonomy and potential over-reliance on AI, which could undermine creativity and deep learning, suggesting the need for integrating additional perspectives that consider social, technological, and trust-related factors.

Incorporating SDT into the analytical framework highlights the psychological factors associated with the transition towards the use of artificial intelligence and thus comprehensively shows how the students are engaged. It is very well possible that students' motivation to use AI tools may be fostered by these tools' capacity to satisfy psychological needs for autonomy, competence, and relatedness. AI systems that support personalised learning pathways can enhance autonomy, provide timely feedback to strengthen competence, and facilitate interaction to promote social connectedness, thereby encouraging learners to become more intrinsically motivated to engage with technology [19]. This is particularly significant in academic contexts, where motivation is closely linked to sustained engagement and academic success. However, while SDT offers valuable insights into motivational processes, it does not fully account for technology-specific concerns inherent in AI use. In particular, SDT cannot adequately explain issues related to the reliability and accuracy of AI-generated information, the quality and biases of underlying algorithms, or students' trust in AI outputs. These factors may significantly influence learners' willingness to engage with AI tools beyond motivational considerations alone. Thus, while focusing on motivational aspects of AI adoption is appropriate, it is not sufficient on its own, and a more comprehensive framework is needed to capture both psychological and technological dimensions of AI use.

The integration of TAM and SDT further reinforces the argument that perceptions of AI in education extend beyond ease of use and perceived usefulness [20]. It also accounts for how effectively AI technologies respond to students' fundamental psychological needs. This integrated theoretical framework offers a more nuanced understanding of AI adoption, highlighting the complex interactions between cognitive perceptions and underlying motivational processes.

4. Conclusions

This study examined the attitudes of university students towards AI and how these attitudes shape their perceptions and, consequently, influence AI adoption in education. By integrating TAM and SDT, the study presents a meaningful framework for understanding the factors driving AI adoption. The findings reveal that students' perceptions of the usefulness and ease of use of AI are significant determinants of their willingness to adopt it. The study also indicates that intrinsic motivation - specifically autonomy, competence, and relatedness - plays a role in AI adoption, as inferred from SDT. However, it is important to acknowledge that TAM does not fully account for the influence of external and contextual factors such as peer interaction, instructor support, and technological conditions (e.g., access to devices and internet connectivity), which may significantly shape students' engagement with AI in educational settings. These facilitating conditions suggest that AI adoption not is solely an individual cognitive evaluation but is also socially and institutionally mediated. Furthermore, while most students reported positive experiences with AI, they also expressed negative perceptions regarding certain attributes of AI, warranting further investigation. It was found that male students generally exhibited more positive attitudes towards AI, indicating gender differences in how individuals interact with AI tools. The results further suggest that improvements to the measurement model are needed, as reflected by the mediocre RMSEA value and weak item loadings.

In effect, the study contends that AI adoption in higher education is influenced by both functional benefits and emotional appeal. In this regard, institutions should place greater emphasis on developing AI tools that nurture autonomy, competence, and relatedness, rather than focusing solely on technical aspects of use. Future studies should examine how these factors influence learning outcomes as AI technologies continue to evolve.

5. Recommendations

The findings of this study indicate that the integration of AI into higher education should address not only technological capacity but also students' psychological engagement. Institutions may design AI-enhanced learning environments that actively support intrinsic motivation by fostering autonomy, competence, and relatedness through personalised pacing, adaptive feedback, and collaborative learning experiences. However, given the reported concerns regarding over-reliance on AI and diminished creativity, educators should deliberately integrate AI as a complement to, rather than a replacement for, active, critical, and creative learning tasks.

To mitigate potential drawbacks, faculty development programmes may be implemented to equip instructors with the pedagogical skills needed to integrate AI tools thoughtfully into instructional design. These programmes may include strategies for balancing automation with opportunities for student-led inquiry, problem-solving, and creative production, ensuring that students remain cognitively engaged rather than passively dependent on AI-generated outputs.

At the policy level, institutions may develop clear ethical guidelines for AI use, addressing issues such as data privacy, algorithmic transparency, and responsible reliance on AI-generated content. Students should also receive training in digital literacy and critical engagement with AI, enabling them to evaluate AI outputs, understand algorithmic limitations, and make informed decisions when using AI-supported platforms. Integrating AI literacy modules into general education curricula may help foster responsible and reflective AI use early in students' academic journeys.

Finally, given the variability in attitudes across academic disciplines and the minor gender-based differences identified in this study, future research may employ multi-group analyses to explore how different learner profiles experience AI integration. Tailoring AI-supported pedagogical approaches to specific student needs may further enhance learning enjoyment and academic outcomes while addressing diverse expectations in higher education contexts.

6. Limitations and future research

This study has several limitations that should be considered when interpreting the findings.

First, although grounded in TAM and SDT, the study did not examine additional factors such as social influence, trust in AI, or prior AI experience, which may further shape students' attitudes and usage behaviours. Moreover, the cross-sectional design captures perceptions at a single point in time; future longitudinal studies are needed to examine how students' motivations and attitudes evolve with increased exposure to AI tools.

Second, the sample was limited to university students from selected regions of the Philippines, which restricts the generalisability of the findings across educational levels, disciplines, and cultural contexts. Broader and more diverse samples would allow for a more comprehensive understanding of how AI adoption varies across learner populations and institutional environments. Additionally, institutional and technological factors - such as internet access, device availability, and organisational support - were not directly measured, despite their potential influence on students' engagement with AI-based learning systems.

Finally, although the measurement model demonstrated acceptable fit, the slightly elevated RMSEA (0.0873) and SRMR (0.086) values suggest minor model misfit, potentially attributable to weaker item loadings within the Concerns or Negative Perceptions subscale. Refining these items and exploring alternative modelling strategies, such as item parcelling, may improve measurement precision in future research.

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COMPETING INTERESTS

The authors declare that there is no conflict of interest regarding the publication of this article.

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Psychological safety and turnover intentions in public organisations in Hanoi, Vietnam: The indirect role of employee voice

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Received 4 February 2025; revised 8 April 2025; accepted 29 August 2025

Abstract:

This study aims to empirically investigate the relationships between psychological safety, employee voice, and turnover intention based on social exchange and voice-exit theories. Additionally, the study identified the fully mediating mechanism of employee voice in the link between psychological safety and turnover intention. The study employed self-reported survey techniques to collect individual-level data from public organisations in education, healthcare, and public administration in Vietnam. Partial least squares structural equation modelling (PLS-SEM) in SmartPLS 4.0 was used to test the proposed hypotheses with a sample of 227 observations from public employees. Findings revealed a direct positive effect of psychological safety on employee voice and a negative effect on turnover intention. Moreover, the results confirm that employee voice fully mediates the relationship between psychological safety and turnover intention. This study not only provides empirical evidence but also sheds light on how psychological safety influences the process of turnover intention in the public sector. Additionally, this study highlighted several intriguing data points that should provide managers with worthwhile options to improve psychological safety for public employees and offer them a voice to mitigate turnover intention.

Keywords: employee voice, psychological safety, public organisations, turnover intention.

Classification numbers: 1.4, 2.2, 7

1. Introduction

One recent problem, which has sparked the interest of researchers, particularly in public organisations, is employee job turnover. In Vietnam, the departure of skilled and talented workers in the public sector is becoming increasingly apparent [1]. It is noted that the majority of public servants leave government agencies to work for private enterprises [2]. According to Q.D. Ngo (2023), public employees who quit their jobs were mainly education and training officials (54.2%) and health workers (26.5%). The statistics in this study also showed that the proportion of university and master's graduates leaving the organisation accounted for 48.65 and 15.7%, respectively [3]. Any organisation's performance, development, and sustainability may be seriously threatened by employee turnover [1]. In addition to creating chaos and disrupting service delivery, turnover entails significant costs, including severance pay and replacement expenses, which include recruiting, onboarding, and training new staff [2]. Even though employee mobility in the labour market is unavoidable, the loss of many public civil servants

can have serious repercussions, including decreased performance and a scarcity of trained workers in the public sector [3]. This can have a significant impact on the public's quality of service delivery. This issue requires further investigation, and the development of effective interventions.

Most studies focus on identifying the reasons or causes of turnover of public employees in Vietnam [4-6]. However, it is more important to figure out how to reduce employees' intention to leave in the public sector, thereby decreasing actual turnover. For the nation's administrative and economic reforms to be effective, it is imperative that turnover intention be recognised and addressed. The long process of rehiring and retraining staff, as well as its detrimental effects on public sector organisations, makes high turnover intention a serious problem for organisations [7]. Retaining experienced staff and maintaining the continuity of public service delivery requires addressing turnover intention.

Moreover, previous studies on how to mitigate employee turnover intention in the public sector in Vietnam focused on two main factors, including

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personal factors (work motivation, personality) [2, 8, 9] and organisational factors (organisational support, organisational justice, talent management practices, perceived person-environment fit, ethical leadership) [1, 2, 8, 9]. The determinants of mitigating employee turnover intention have been examined in public organisations thus far; however, psychological safety has been overlooked as a possible organisational predictor of employee turnover intention in previous studies. In essence, establishing a psychologically safe workplace may reduce perceived and actual interpersonal risks to prevent public servants from developing turnover intention [10].

Psychological safety refers to a mental condition in which workers feel comfortable expressing their inner selves without fear of unfavourable reactions or jeopardising their reputation, status, or employment [11]. The ability of an organisation to involve its employees in meaningful and ongoing learning to improve practices and lower turnover intentions is directly related to these perceptions.

Furthermore, this study explores how psychological safety serves as a predictor of turnover intention, considering the mediating role of employee voice in explaining this relationship. The results of this study could expand existing empirical literature by providing a better understanding of the role that psychological safety may play in employee turnover intention. Psychological safety in the workplace has been associated with communication outcomes, such as increased error reporting and interpersonal communication [12], as well as enhanced information sharing among team members [13]. It has also been demonstrated that psychological safety in dyadic interactions increases employee voice behaviour [14]. Employee voice refers to the extent to which people are willing to communicate concerns, issues, worries, and grievances, take a problem-solving approach, and offer input about the workplace's decision-making process is known as employee voice [14].

Most studies show positive individual-level outcomes of employee voice, such as improving employee commitment [15], employee satisfaction [16], and employee well-being [17]. However, fewer studies demonstrate that employee voice can help to limit consequences, such as conflict [18], workplace bullying [16], and turnover intention [19]. Furthermore, Y. Song, et al. (2022) [20] suggested that further research is necessary to clarify the relationship between employee voice and its ability to prevent negative consequences, such as turnover intention, and to gain a deeper understanding of the mechanisms underlying employee voice behaviour. Therefore, this study

aims to investigate the direct and indirect effects of employee voice behaviour in the association between psychological safety and employees' intention to leave in public organisations in Vietnam.

This study significantly makes several theoretical contributions. Firstly, it addresses a knowledge gap by investigating the relationship between psychological safety and public employees' intention to leave. While previous studies have focused on organisational factors (organisational support, organisational justice, talent management practices, perceived person-environment fit, ethical leadership), the specific link between psychological safety in the work environment and intention to leave remains understudied in the context of the public sector in Vietnam [1, 2, 8, 9]. Therefore, the study examines how turnover intention and psychological safety may be directly related. We hypothesise that workers with higher levels of psychological safety are less likely to experience unfavourable outcomes, such as intention to leave. Secondly, there is a significant gap in the research, as few studies have examined the relationship between employee voice behaviour, psychological safety, and intention to leave public organisations. This study suggests that fostering psychological safety in the workplace will successfully foster employees' voice, building on social exchange theory and voice-exit theory [21, 22]. Employees who have a greater desire to stay with the organisation are less likely to intend to leave and more inclined to participate in discretionary activities, such as voicing their thoughts [22]. Previous studies indicate that employees use cognitive processing to weigh the advantages and disadvantages of using their voice when deciding whether to engage in speech behaviour in any given circumstance [16, 23]. We suggest that employee voice behaviour could be a key factor in bridging the gap between turnover intention and psychological safety. Thus, we propose that employee voice mediates the relationship between psychological safety and intention to leave. Finally, there are clear theoretical and practical implications for understanding the relationship between psychological safety and turnover intention, as well as explaining the mechanism underlying these relationships by investigating the mediating function of employee voice. To effectively manage the high cost of employee turnover in public organisations, this study aids in identifying predictors to mitigate turnover intention among public workers. This study adds to the existing body of knowledge by investigating these dimensions and their interactions in an Asian context, thereby making the findings more applicable to non-Western contexts by increasing their generalisability beyond Western settings.

2. Theoretical framework and hypothesis development

2.1. Social exchange theory

Social exchange theory, proposed by P. Blau (1964) [21], suggests that relationships evolve over time and are predicated on individuals weighing the advantages and disadvantages of any social interactions before deciding whether to maintain them. Individuals must obtain a positive cost-benefit analysis to sustain any social relationship. The norm of reciprocity has received considerable attention from researchers in retaining any social relationship [24, 25]. When an individual receives a benefit from a social interaction, they are generally expected to provide another benefit in return to continue the relationship. If this is not achieved, the disadvantaged person may take action to reduce adverse effects and restore a favourable cost-benefit balance. For instance, workers may decide to leave the organisation to acquire a positive cost-benefit balance if they are dissatisfied with their jobs. Employees will then emotionally commit to their employers if they feel psychologically safe in their workplace. Therefore, social exchange theory explains the association between psychological safety and employee turnover intention in public organisations.

Over time, the norm of reciprocity leads social exchange to be characterised by trust and emotional engagement [26]. Based on this norm of reciprocity, social exchange theorists have claimed that employees who feel comfortable at work are more likely to make constructive, change-oriented proposals in return for the favourable treatment they have received in their work interactions [26]. Additionally, the reciprocity norm of social exchange serves as a foundation for the conceptualisation of employee voice. When employees are in exchange relationships marked by trust, respect, and satisfaction, they are more inclined to speak up about their concerns and make constructive statements [27]. By and large, social exchange theory suggests that the use of voice is largely other-directed. In other words, one acts in a way that benefits the other party since doing so benefits them in return [24]. Thus, social exchange theory supports investigating the relationship between psychological safety and employee voice, as well as the underlying mechanism through which psychological safety influences employee turnover intention via the role of employee voice.

2.2. Voice-exit theory

A.O. Hirschman (1974) [22] developed the voice-exit theory, which provides a framework for understanding how people react to problems or dissatisfaction within an organisation. People usually

have two basic options when they encounter problems, namely “voice” and “exit”. Resigning from a position or ceasing the use of a product or service are examples of the “exit” option, which entails physically leaving the organisation. On the other hand, using the “voice” option means speaking up within the organisation about issues, complaints, or viewpoints in the hope of bringing about constructive changes through comments, recommendations, or active involvement in organisational procedures. People use a strategic decision-making process in which they balance the perceived value of exercising their “voice” within the organisation against the possibility of “exit”. Recent research found that employees who are likely to voice concerns are more loyal to the organisation and less likely to exit or leave [19, 26]. Thus, the voice-exit theory is applied in this study to explain the impact mechanism underlying the relationship between employee voice and turnover intention in public organisations in the Vietnamese context.

2.3. Hypothesis development

2.3.1. Psychological safety and turnover intention

The concept of psychological safety was proposed fifty years ago, and since the early 1990s, psychology researchers have renewed their interest in it [11]. The term refers to an individual's belief that the workplace is safe for taking interpersonal risks, speaking up with ideas, sharing opinions, and acting independently on key decisions. Accordingly, reducing real and perceived interpersonal risks requires establishing a psychologically secure workplace. T.D. Nguyen, et al. (2023) [1] found that psychological safety significantly impacted turnover intention, alongside the influence of other established predictors. The significance of organisational factors that affect employee well-being is highlighted by research examining the connection between psychological safety and turnover intention in the public sector. Motivated by a sense of public service, public employees might value a psychologically comfortable workplace that supports their dedication to organisational objectives. Psychological safety promotes commitment and trust and may serve as a deterrent to turnover intention in public sector organisations [28]. There is a correlation between a supportive organisational culture that includes psychological safety and a decreased intention to leave [29]. Psychological safety and the apparent job security that comes with working in the public sector may interact to affect the intention to leave. Psychological safety might act as a protective barrier against the detrimental consequences of job uncertainty, which may ultimately lead to a decreased

intention to leave the public sector [1]. The impact of policies and regulations must be considered when examining the relationship between psychological safety and turnover intention in the public sector. The policies that govern how the public sector functions may influence employee perceptions and the workplace. Exploring how these policies interact with psychological safety to shape turnover intention is crucial for a comprehensive understanding of the underlying dynamics. This leads to the following hypothesis:

Hypothesis 1 (H1): Psychological safety is negatively associated with turnover intention.

2.3.2. Psychological safety and employee voice

This cost-benefit analysis is significantly shaped by psychological safety. A. Edmondson (1999) [30] described psychological safety as a person's confidence and self-protection, ensuring that they will not be humiliated, rejected, or punished for speaking up. Employees who are afraid or insecure may adopt a defensive posture and refrain from sharing their thoughts and concerns because doing so is perceived as risky and unpredictable. On the other hand, a sense of security motivates workers to overcome these reservations and express their opinions. Workers tend to express their thoughts when they believe doing so will be safe and likely to have a beneficial effect [14]. Employee voice - a set of individual discretionary behaviours to articulate their ideas, opinions, and suggestions in the workplace - can stimulate organisational innovation by challenging the status quo and improving organisational processes [31].

Most research on voice behaviour has been grounded in Social Exchange theory [21] in general and the norm of reciprocity in particular [24]. This perspective suggests that individuals who experience their work environments as positive are likely to reciprocate by using voice more frequently or intensely. Employees are still likely to reciprocate with it for at least two reasons. First, voice behaviour is self-initiated; the employee does not need to wait to be asked to perform it, and they can readily engage in it when their felt obligations to reciprocate increase. Second, because voice is easily "heard" by others, it can quickly gratify employees' needs to reciprocate.

M.M. Elsaied (2019) [32] discovered that when participants believed their leaders were open to their suggestions and fostered an inspiring atmosphere, they felt psychologically comfortable and were more likely to voice their opinions. Therefore, the study hypothesises:

Hypothesis 2 (H2): Psychological safety is positively associated with employee voice.

2.3.3. Employee voice and turnover intention

When given the opportunity to voice their opinions, workers are less likely to quit their jobs. E.W. Morrison (2023) [33] noted that employees feel like valued contributors when they can express their thoughts in an organisation because their opinions are considered in decision-making processes. Employees are more inclined to reciprocate when they feel that their organisations value them, which lowers their intention to leave [15]. Employees who understand that their voice may drive organisational improvements, such as resolving conflict and offering solutions, are less likely to leave [19]. As a result, workers' expression of voice may reduce their desire to quit. Additionally, voice gives workers a greater sense of control over their immediate surroundings and cultivates the idea that they have the power to influence occurrences at work [34]. By speaking up, workers feel that their opinions are valued and that they have the power to affect organisational outcomes. Conversely, experts suggest that workers may experience collective indifference and disengagement when they believe they have little control over the destiny of their organisation, which could increase their intention to quit. As anticipated, C. Schuster, et al. (2022) [35] concluded that appropriate use of voice methods lowers job search activities and desire to quit among public employees, and Y. Choi, et al. (2016) [36] indicated a negative link between speech mechanisms and teacher turnover. The following hypothesis results from these arguments:

Hypothesis 3 (H3): Employee voice is negatively related to turnover intention.

2.3.4. Mediating role of employee voice: Psychological safety and turnover intention

This study clarifies the psychological processes involved in the connection between organisational success, employee voice, and psychological safety. Psychological safety increases workers' sense of control over their immediate workplace [34]. Employees feel more in control and less apprehensive, which frequently leads to turnover intention when they are empowered to express their ideas and influence their workplace. This study sheds light on how employees' perceptions of control are influenced by the psychological safety-voice dynamic, which in turn affects their intentions to leave. Additionally, it supports the notion that voice processes may counteract turnover intentions. Individuals are less inclined to consider quitting an organisation if they believe they can influence decisions through available

voice channels. In order to reduce turnover intentions, this study emphasises the importance of employee voice as a tool for giving people a sense of control and influence over their workplace.

Studies tailored to the public sector setting can enhance the mediation process [1, 36]. The connection between psychological safety, employee voice, and turnover intention may be considerably more complex in public service organisations, where the mission and sense of purpose are crucial. The degree to which psychological safety permits employee voice may impact public service motivation, a motivating factor for those working in the public sector [36]. In light of the social exchange theory, when workers feel free to express their views in a way that aligns with the organisation's mission, they believe that doing so can result in improvements or positive changes, which can lead to internal discussions and possible organisational adjustments [19]. This motivation might serve as a deterrent to plans to leave. The current study might be viewed as an attempt to use employee voice in the public sector to examine the indirect relationship between psychological safety and turnover intention. Employee voice is anticipated to play a mediating role in the relationship between employee voice and intention to leave in this study. Therefore, the following hypothesis is proposed:

Hypothesis 4 (H4): Employee voice mediates the relationship between psychological safety and turnover intention.

2.3.5. Proposed research model

The aim of this proposed study is to develop a research model that examines the complex connections between employee voice, psychological safety, and turnover intentions in the Vietnamese public sector. Fig. 1 depicts the proposed research model.

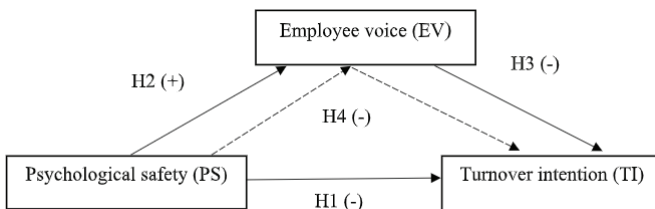


Fig. 1. Proposed research model. Source: Authors' construction.

3. Research methodology

3.1. Sampling and data collection

The study adopted survey techniques to gather individual-level data from a diverse range of public organisations in Vietnam. According to statistics from the Ministry of Home Affairs, the public sectors

with the highest rate of job turnover are education, healthcare, and public administration [3]. Thus, public organisations in the study come from education, healthcare, and public administration sectors located in Hanoi, Vietnam, which were strategically chosen to ensure representativeness of the sample size and reflect the research problem. The study's focus on employee perspectives, particularly examining employee voice, psychological safety, and turnover intention within these public organisations, underscores its significance in understanding organisational behaviour in the Vietnamese public sector.

To test the model, self-reported survey questionnaires were utilised to gather data through purposive sampling. The research team contacted representatives of the human resource departments of public organisations to explain the purpose of the study and solicit their support. The questionnaires were sent to emails of employees in public organisations through a list provided by the human resource department. To avoid bias in the research, all questionnaires were anonymised, and the confidentiality of information was ensured. The survey questionnaire was divided into two primary sections. The first part involved descriptive statistics on demographic factors (including gender, educational level, tenure with the current organisation, and departments). The second part focused on employee perspectives, particularly examining employee voice, psychological safety, and turnover intention within these public organisations, underscoring its significance in understanding organisational behaviour in the Vietnamese public sector. Because the scales in the study were based on English-written studies, the survey questionnaire was translated into Vietnamese with the advice of human resource experts to send to Vietnamese participants. After two months of survey data collection, a total of 280 responses were collected, of which 227 valid samples were retained following preliminary screening.

An analysis of the demographic factors of the collected samples (Table 1) suggested a balanced distribution across genders, with 52.4% female respondents, 45.4% male, and a minimal proportion identifying with other genders. Moreover, the educational background of the respondents predominantly comprised individuals with university degrees (93.4%), highlighting the importance of higher education in key organisational roles. Regarding tenure within the current organisation, a significant proportion (42.7%) reported affiliations ranging from one to three years, emphasising the stability and commitment levels among employees. In terms of fields, respondents worked in the education sector (45.8%), followed

Table 1. Participants' demographic statistics.

Category		Percent
Gender	Female	52.4%
	Male	45.4%
	Other	2.2%
Education level	College	6.6%
	University	93.4%
Tenure with current organisation	<1 year	26%
	1-3 years	42.7%
	3-7 years	31.3%
Organisations	Education	45.8%
	Healthcare	22.0%
	Public administration	32.2%
Departments	Human resources	7.5%
	Accounting-Finance	8.8%
	Administrative-Secretariat	13.2%
	Organisation-Administration	7.5%
	Project management	6.6%
	Law	7.9%
	Communication	17.2%
	Information technology	8.8%
	Foreign affairs-International	9.3%
	Others	13.2%

by public administration (32.2%) and healthcare (22.0%). Further examination of working departments revealed the distribution of employees across various functional areas, with Communication (17.2%) and Administrative-Secretariat (13.2%) emerging as prominent areas of employment (Table 1). These findings shed light on the organisational structure and workforce composition within the sampled public sector organisations, providing valuable insights for future research and policy-making endeavours.

3.2. Measurements

A five-point Likert scale response format, ranging from 1 (strongly disagree) to 5 (strongly agree), was used to measure each construct. *Psychological safety* (PS) was measured using a scale of seven items, adapted from A. Edmondson (1999) [30]. Next, the scale to measure *Employee voice* (EV) was developed by J. Liang, et al. (2012) [37]. It was modelled as a reflective-reflective construct made up of 10 lower-order reflective constructs, including five items for promotive voice (PMV) and five items for prohibitive voice (PBV). Finally, *Turnover intention* (TI) of employees in the organisation was measured using a scale adapted from J. Kim (2015) [38], which contained three items.

3.3. Data analysis

This study utilised PLS path modelling with the support of SmartPLS 4.0 based on the sample and model's properties, particularly mediation analysis. PLS path modelling is widely used in management and human resource management studies [39]. Moreover, the dependent variable in this study was predicted using the partial least squares structural equation model (PLS-SEM) for various reasons. Initially, the research framework was intricate, encompassing numerous higher-order constructs. This method simultaneously identifies a set of the generated model's equations and establishes the association between the constructs. This study employed a two-step analytic approach, which involves an initial evaluation of the measurement model and, subsequently, an assessment of the structural model to test the proposed hypotheses [40]. Additionally, G. Dash, et al. (2021) suggested that for a composite-based model, PLS-SEM should be considered for developing and analysing the structural relationship [41].

3.4. Common method variance

This study employed two methods to investigate common method bias (CMB). Firstly, Harman's single-factor test was used, indicating that a single factor only explained 38.5% of the variation (below the 50% threshold) [42]. The second technique to check for CMB is to test the variance inflation factor (VIF), which has been proposed and extensively utilised in previous literature as a comprehensive collinearity test [40]. The inner VIF values of all studied constructs, ranging from 2.018 (EV) to 2.712 (PS), fell below the threshold of 3 (Table 3), indicating no significant multicollinearity issues in this study. These results demonstrated that the data are free from CMB.

4. Empirical findings

4.1. Measurement model assessment

The research model included one higher-order reflective construct (employee voice). Accordingly, the first-order (lower-order) measurement model was evaluated first, followed by the second-order (higher-order) constructs.

4.1.1. First-order measurement model assessment

This study utilised assessment criteria to examine the measurement model of first-order constructs, which were measured reflectively. The first-order measurement model displays the results of evaluating internal consistency, construct reliability, and validity. Reflective indicator loadings exceeding 0.7 were retained to ensure sufficient convergent validity in the PLS model. Any item with a factor loading ≤ 0.7 was

deleted [40]. Two items of Promotive voice (PMV), namely PMV1 and PMV2, two items of Prohibitive voice (PBV), namely PBV1 and PBV2, and two items of Psychological Safety (PS), namely PS1 and PS2, were deleted due to low factor loading (see Table 2).

Table 2. First-order construct validity and reliability (round 1).

Code	Construct (Items)	Loading	Cronbach's alpha	Composite reliability (CR)	Average variance extracted (AVE)
EV	Employee voice				
PMV	Promotive voice		0.748	0.827	0.500
PMV1		0.570*			
PMV2		0.482*			
PMV3		0.848			
PMV4		0.783			
PMV5		0.779			
PBV	Prohibitive voice		0.752	0.834	0.510
PBV1		0.562*			
PBV2		0.514*			
PBV3		0.798			
PBV4		0.834			
PBV5		0.800			
PS	Psychological safety		0.841	0.881	0.526
PS1		0.483*			
PS2		0.444*			
PS3		0.775			
PS4		0.855			
PS5		0.785			
PS6		0.826			
PS7		0.790			
TI	Turnover intention		0.860	0.915	0.782
TI1		0.912			
TI2		0.877			
TI3		0.863			

*: Deleted (outer loading <0.7). Source: Authors' own work.

After removing items with a low factor loading less than 0.7, the factor loadings of the remaining items ranged from 0.777 to 0.911, which exceeded the cut-off point of 0.70 [40] (see Table 3). Convergent validity was further supported by the Average Variance Extracted (AVE) values, which show the proportion of variance accounted for by factors. All latent variables in the assessed model showed acceptable convergent reliability, with AVE values greater than 0.5 [43]. All Cronbach's Alpha values of first-order constructs were greater than 0.7, ranging from 0.806 (PV) to 0.880 (PS) (Table 3). Indicator reliability was evaluated using composite reliability (CR), where a value greater than 0.7 denotes sufficient internal consistency of constructs [40].

Table 3. First-order construct validity and reliability (round 2).

Code	Construct (Items)	Loading	Cronbach's alpha	Composite reliability (CR)	Average variance extracted (AVE)
EV	Employee voice				
PMV	Promotive voice		0.806	0.886	0.721
PMV3		0.878			
PMV4		0.846			
PMV5		0.822			
PBV	Prohibitive voice		0.828	0.897	0.745
PBV3		0.854			
PBV4		0.890			
PBV5		0.844			
PS	Psychological safety		0.880	0.913	0.677
PS3		0.798			
PS4		0.882			
PS5		0.803			
PS6		0.849			
PS7		0.777			
TI	Turnover intention		0.860	0.915	0.782
TI1		0.911			
TI2		0.877			
TI3		0.864			

Source: Authors' own work.

4.1.2. Second-order measurement model assessment

The second-order measurement model was created using a two-step procedure. Latent variable scores were first calculated using the first-order model, which were then used to construct a subsequent

Table 4. Final measurement - model reliability and validity.

	Outer loadings	Cronbach's alpha	Composite reliability (CR)	Average variance extracted (AVE)	Inner VIF
Turnover intention (TI)		0.860	0.915	0.782	N/A
TI1	0.911				
TI2	0.877				
TI3	0.864				
Psychological safety (PS)		0.880	0.913	0.677	2.712
PS3	0.798				
PS4	0.882				
PS5	0.803				
PS6	0.849				
PS7	0.777				
Employee voice (EV)		0.904	0.954	0.913	2.018
Promotive voice (PMV)	0.954				
Prohibitive voice (PBV)	0.956				

Source: Authors' own work.

model. The scores for these latent variables were then applied as weights to the corresponding single items of the second-order constructs. Table 4 shows that all constructs achieved CR values exceeding 0.7, AVE values surpassing the threshold of 0.5, and Cronbach's alpha coefficients greater than 0.7. Furthermore, all item factor loadings exceeded the suggested cut-off point of 0.7 [40]. Convergent validity was therefore verified for the entire sample.

The discriminant validity was tested by analysing the AVE's square root [40]. To assess the discriminant validity for second-order constructs, it is attained if the exogenous variance is higher than the average value with other variables [40, 43]. The square root of the AVEs is shown by the diagonal values in bold font in Table 5 below, while the correlations of the research variables are represented by the off-diagonals. The square root of the AVE of the constructs is higher than the correlations of every other construct.

Table 5. Discriminant validity of the second-order constructs - Fornell-Larcker criterion.

	EV	PS	TI
Employee voice (EV)	0.955		
Psychological safety (PS)	0.951	0.823	
Turnover intention (TI)	-0.666	-0.697	0.884

Source: Authors' own work.

4.2. Structural model assessment and hypothesis testing

4.2.1. Measuring Coefficients (R^2 , f^2 , Q^2)

The importance of significant correlations and the predictive power of measurements - which establish the goodness-of-fit in PLS - were also evaluated using a variety of measures. As shown in Table 5, adjusted R^2 values range from 0.482 to 0.904, which means that 90.4% of the variance in employee voice (EV) and 48.2% in turnover intention (TI) is explained by the independent variables (psychological safety - PS). Q^2 values generated through the blindfolding procedure range from 0.374 to 0.6, well above zero, and therefore confirm the predictive relevance of all path models. The results validated the predictive significance of the model, with Q^2 values of both EV ($Q^2=0.6$) and TI ($Q^2=0.374$) exceeding zero. Additionally, the effect size (f^2) is categorised as weak (0.02), moderate (0.15), and substantial (0.35). If the f^2 value is <0.02 , there is no significant effect. The effect sizes of PS in relation to EV ($f^2=9.430$) were significant and substantial, while the effect size of PS in relation to TI was very weak ($f^2=0.000$). The effect size of EV on TI was small ($f^2=0.083$) (Table 6).

Table 6. Measuring Coefficients (R^2 , f^2 , Q^2).

	R^2	R^2 adjusted	f^2	Remark	Q^2	Remark
Employee voice (EV)	0.904	0.904	PS → EV 9.430	Substantial	EV 0.600	High predictive accuracy
Turnover intention (TI)	0.486	0.482	PS → TI 0.000	Weak	TI 0.374	Moderate predictive accuracy
			EV → TI 0.083	Small		

Source: Authors' own work.

4.2.2. Hypothesis testing

This study employed the technique with 5,000 bootstrap resamples to test the proposed hypotheses. The first hypothesis (H1) concerned the direct relationship between PS and TI. The findings indicated that PS has a significant negative relationship with TI ($\beta = -0.666$; $p < 0.001$; 95% CI (-0.732, -0.588)), thereby supporting H1. The findings (Table 7) reveal that the path coefficient from PS to EV is also significant and positive ($\beta = 0.951$, $p < 0.001$; 95% CI (0.935, 0.964)). Thus, H2 is empirically supported. Additionally, EV was shown to be a significant predictor of TI, negatively related to TI, supporting H3 ($\beta = -0.668$, $p < 0.001$; 95% CI (-0.958, -0.365)) (Table 7).

Next, the indirect effect was analysed to test the mediating effect of EV in the negative relationship between PS and TI. The results presented in Table 6 confirmed that the indirect negative effect of PS ($\beta = -0.635$; $p < 0.001$; 95% CI (-0.913, -0.348)) was significant. Moreover, when EV was added simultaneously with PS as a predictor of TI, the direct effect from PS to TI ($\beta = -0.030$; $p = 0.844 > 0.05$) was not significant, indicating that full mediation of EV occurred. Therefore, H4 was supported. Fig. 2 summarised our findings of tested hypotheses.

Table 7. Results of structural model.

Hypothesis		Path	SD	T	P	95% CI		Remark
		Coeff.		-value	-values	LLCI	ULCI	
Total effect								
H1	c. PS → TI	-0.666	0.036	18.267	<0.001	-0.732	-0.588	Accepted
H2	a. PS→ EV	0.951	0.007	130.923	<0.001	0.935	0.964	Accepted
H3	b. EV→ TI	-0.668	0.152	4.402	<0.001	-0.958	-0.365	Accepted
Direct effect								
H4	c'. PS→ TI	-0.030	0.154	0.197	0.844	-0.331	0.266	Accepted, fully mediating
Indirect effect								
	PS→EV→ TI	-0.635	0.145	4.395	<0.001	-0.913	-0.348	

Source: Authors' own work.

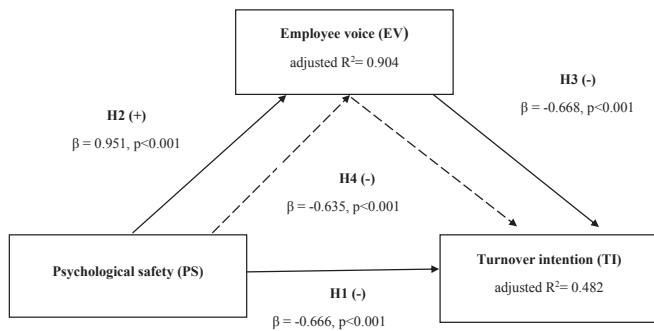


Fig. 2. Results of structural model test. Mediation model of psychological safety on turnover intention. Source: Authors' own work.

5. Discussion

5.1. Psychological safety and turnover intention

Psychological safety negatively impacts public employees' intention to leave (H1). The findings confirmed Social Exchange theory and earlier research, as expected. Employees who work in a psychologically safe environment believe that their colleagues will not reject them for being who they are or what they think, respect each other's abilities, care about each other as individuals, have good intentions towards one another, can engage in constructive conflict or confrontation, and feel comfortable trying new things and taking chances [30]. In terms of behaviour, psychological safety encourages workers to express their problems, communicate honestly, and seek more feedback, all of which reduce the likelihood that they will resign [11, 17]. Therefore, psychological safety may be seen as a mechanism that reduces stress in workers, which in turn mitigates job discontent and, ultimately, turnover intentions [1].

5.2. Psychological safety and employee voice

The results of the study also support the second research hypothesis (H2), which posits that psychological safety enhances employees' voices. The outcome was anticipated as employees expressed their confidence, sense of security, and fearless trust [30]. Psychological safety is becoming increasingly important to organisational success in a public environment, given the requirements for employees to share information and exchange ideas with other team and organisational members in the attainment of shared goals [11].

When employees are in exchange relationships marked by happiness, respect, and trust, they are more likely to use voice behaviour [27]. This finding confirms the norm of reciprocity in social exchange theory. Individuals are more likely to act in pro-organisational ways that align with such perceptions when they have positive social interactions with their employers. Employees then primarily utilise voice to control the quality of their social interactions with others.

5.3. Employee voice and turnover intention

The third hypothesis that employee voice has a detrimental effect on employees' intention to leave is supported by the results of the current study. Employee voice has the capacity to reduce the intention to leave among public workers. Employee voice is a positive behaviour that is advantageous for the growth and advancement of the organisation [26]. Employees feel valued, equitable, and part of the organisation when they have a voice [19], because they can participate in the decision-making process that resolves an issue [44]. Conversely, employees who lack a voice experience feelings of alienation, discontent, and abandonment from the organisation. This indicates that when workers feel safe, encouraged, and are given opportunities to grow, they are more likely to desire to remain with the organisation.

5.4. Mediating role of employee voice: psychological safety and turnover intention

Examining the mediating role of employee voice in the relationship between psychological safety and turnover intention in the public sector was one of the primary goals and inquiries of this study. Interestingly, the results demonstrated that employee voice had a full mediating role in the association between psychological safety and intention to leave. Thus, the relationship between psychological safety and intention to leave can be explained through employee voice. The results demonstrated that the level of employee voice among public employees could regulate the relationship between psychological safety and intention to leave.

Employee voice can help reduce unfavourable consequences for employers. Based on social exchange theory, psychological safety encourages employees to speak up, which leads to employees adopting favourable views and deciding to remain with the organisation [10]. The ability of employee voice to open the "black box" between psychological safety and work outcomes, including turnover intention, is noteworthy. Lower turnover intention is ensured by the presence of employee voice. This is a significant discovery because it demonstrates that employee voice serves as a means for employees to stay attached to and loyal to the organisation, in addition to being a behaviour that benefits the firm. This finding builds upon and enhances earlier research by Y. Ge (2020) [14], M.M. Elsaied (2019) [32], and J. Liang, et al. (2012) [37]. This finding underscores the importance of fostering a safe work environment that encourages open communication and employee voice in policymaking processes. Overall, this study fills a gap in the existing

literature by exploring the influence of psychological safety on employees' intention to leave, with employee voice as a mediating role.

6. Contribution and implications

6.1. Theoretical contribution

This study adds significantly to the theoretical body of public literature, particularly regarding the critical role psychological safety plays in reducing public employees' intentions to leave. Furthermore, this finding extends the comprehensive understanding of the mechanism of psychological safety on turnover intention related to employee voice through the lens of social exchange theory and voice-exit theory. Available empirical evidence supports the theoretical viewpoints. The study provides complex insights into the role of employee voice in organisational behaviour by analysing the intricate dynamics within the Vietnamese public sector. The voice-exit theory states that when employees believe their workplace is becoming less beneficial to them or of lower quality, they have two options: they can leave the relationship, or they can speak up to improve the situation by communicating their grievance, complaint, or change proposal. Disagreements can be resolved, and a culture of voice in the workplace is substantially associated with lower turnover intentions. Our study employed psychological safety as a predictor to promote employee voice. These employees are therefore more inclined to stay, which increases the likelihood that organisations will avoid unfavourable outcomes. Understanding the dynamics of psychological safety and employee voice and their relationship to turnover intention through the lens of social exchange and voice-exit theory is particularly crucial in the context of Vietnam's public sector, which is undergoing administrative, cultural, and economic changes. Advancing theoretical knowledge of psychological safety, our review of the literature has important practical implications for organisations.

6.2. Practical implications

The findings of the current study significantly advance practical development by offering recommendations and direction to public managers on how to create suitable working conditions for their employees. Psychological safety is advantageous since it encourages employees to share ideas to be innovative and provide feedback for ongoing development. This might therefore be translated into establishing a setting that improves psychological safety and reduces employees' perceptions of their intention to leave. Public organisation leaders ought to explicitly prioritise psychological safety. They must successfully provide psychologically safe environments for their personnel.

This can be achieved by fostering an atmosphere in which employees feel free to voice their opinions and raise concerns without worrying about facing repercussions. Leaders should also respect their employees' opinions and use them to make the workplace a positive environment. They must set standards for dealing with failure. These procedures provide their organisations' employees with a safe working environment. Managers will be able to improve the effectiveness and efficiency of public sector organisations and businesses in a context of rapid and competitive change by doing this, which will foster a positive organisational culture that promotes employee participation and contribution and reduces talent departure.

Our analyses show that the indirect effect of psychological safety on turnover intention through employee voice is fully mediated. Thus, our study clarified the psychological mechanisms by showing that promoting employee voice can also reduce employees' intention to leave. Implementing a variety of formal and informal voice procedures to resolve conflicts and, more generally, to encourage individual decision-making in public organisations can help create a healthy culture. We conclude that when organisations give workers a voice in resolving issues at work, they are less likely to desire to leave. As a result, these employees are more likely to stay, and the organisation will avoid the negative effects of unresolved disagreement. To improve understanding, trust, and cooperation, as well as the organisation's ability to make better decisions and innovate, leaders in public organisations must establish channels of communication, feedback, and dialogue between managers and staff, as well as between departments and units.

7. Limitations and future research

It is important to consider the study's limitations. Firstly, the study only examined the Vietnamese public sector, so the results might not be highly generalisable. It is necessary to extrapolate these findings to other industries or global contexts. Secondly, the study's cross-sectional design makes it more difficult to determine the causal links between psychological safety, employee voice, and intention to leave. Another potential drawback is social desirability bias, which could compromise the reliability of self-reported data by influencing participants' responses. Additionally, relying solely on employee self-reports could lead to common method bias, which might compromise the study's validity.

This domain can be better understood in several ways for future research. Comparative studies could examine how different industries in Vietnam or other nations differ in how employee voice affects psychological safety and intention to leave. The drawbacks of the cross-sectional

design are addressed by longitudinal research, which allows for tracking changes over time in employee voice, psychological safety, and turnover intention. A further understanding of the mechanism might be obtained by examining the moderating or mediating factors that might influence these interactions. Furthermore, the conclusions might be strengthened by incorporating data from multiple sources, such as organisational records or supervisor ratings. Overall, a more comprehensive and in-depth understanding of the phenomenon could be achieved by addressing these constraints and adhering to these suggested research directions.

8. Conclusions

The findings of the current study have significantly contributed to the use of voice-exit and social exchange theories as a strategy to reduce employees' intentions to leave public organisations. More specifically, this study examined how employee voice mediated the relationship between psychological safety and the inclination to leave in a public setting. Turnover intention is negatively impacted by psychological safety. The results of the study also show that employee voice has a negative correlation with turnover intention. Conversely, employee voice fully mediates the relationship between turnover intention and psychological safety. This indicates that the presence of employee voice ensures a reduction in the intention to leave. This implies that employee voice has the power to modify the influence of the relationship between psychological safety and turnover intention. Staff voice must therefore be given greater consideration to help ensure staff retention. All employees can be supported, inspired, cared for, treated fairly, and engaged by employee voice, which ultimately reduces employees' desire to quit by fostering a psychologically safe workplace. Additionally, the study advanced the theory by deepening our understanding of the importance of psychological safety and employee voice in organisational contexts. The authors made recommendations for ways to increase psychological safety, encourage employee input, and reduce the intention to leave.

CRedit author statement

Thi Hoai Nhung Duong: Conceptualisation, Methodology, Formal analysis, Writing - Reviewing and Editing; Hai Yen Le: Investigation, Writing - Original draft preparation, Validation.

COMPETING INTERESTS

The authors declare that there is no conflict of interest regarding the publication of this article.

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Factors influencing students' intention to choose creative majors in higher education

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Received 8 April 2025; revised 21 May 2025; accepted 25 August 2025

Abstract:

Choosing a major is a crucial decision that shapes students' career paths and personal growth. While extensive research has examined major selection in business and science, technology, engineering, mathematics (STEM) fields, studies on creative disciplines remain limited. This study investigates the factors that influence students' intention to pursue creative majors, including arts, design, communication, and fashion, across universities in Hanoi, Vietnam. A mixed-methods approach was employed, combining qualitative thematic analysis (n=21) using NVivo with quantitative analysis (n=307) conducted through PLS-SEM in SmartPLS 4.0. The results indicate that attitude towards creative majors is a significant predictor of students' intentions, primarily shaped by job prospects, personal interest, and self-efficacy. In contrast, media publicity and subjective norms, including the influence of family, peers, teachers, and counsellors, did not have a direct significant impact on students' intentions. Gender differences were observed, with female students demonstrating greater personal interest in creative majors and male students displaying higher self-efficacy. However, these differences did not significantly affect their intention to pursue creative fields. Additionally, higher English proficiency was found to positively influence all key constructs in the model, including self-efficacy, personal interest, job prospects, attitude, and ultimately the intention to pursue creative majors. These findings provide valuable insights for universities to enhance their academic programmes, career counselling services, and recruitment strategies, thereby ensuring stronger support for students pursuing creative disciplines.

Keywords: creative majors, higher education, intention to choose majors, students, universities in Hanoi.

Classification numbers: 1.4, 3.4, 4.1

1. Introduction

Higher education plays a critical role in Vietnam's socio-economic development, equipping students with the skills and knowledge necessary for innovation and global competitiveness. Over the past two decades, Vietnam has significantly expanded access to higher education, with tertiary enrolments increasing from 0.9 million in 2000 to 2.3 million in 2016, raising the gross enrolment rate (GER) from 9 to 28% [1]. Despite this growth, Vietnam's GER remains lower than that of many regional countries, highlighting the ongoing challenge of expanding opportunities for higher education participation. The increasing number of universities, from 214 in 2013 to 242 in 2022 [1, 2], demonstrates a national commitment to improving access to tertiary education. However, this expansion has intensified competition among institutions, necessitating a stronger focus on student recruitment, curriculum relevance, and career-oriented education [3, 4].

Within this evolving educational landscape, creative industries have emerged as a crucial economic sector. The global creative economy generates approximately \$2.3 trillion in annual revenue, accounting for 3.1% of global GDP [5]. The rapid growth of creative goods and services, evident in exports reaching a record high of \$1.4 trillion in 2022, underscores the increasing demand for creative skills worldwide. Vietnam mirrors this trend, with its creative industries experiencing substantial growth over the past decade. Revenue from "creative, arts, and entertainment activities" has increased from over \$25 million in 2012 to more than \$125 million in 2024, reflecting rising consumer demand, technological advancements, and a growing middle class [6]. In recognition of this potential, Vietnam has integrated creativity into its national development strategy, with initiatives such as the "Innovation and creativity in teaching and learning" policy [7] and the United Nations Educational, Scientific and Cultural Organisation (UNESCO)'s designation of Hanoi as a "Creative City" [8].

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Creative majors, including arts, design, media, and communication, play a vital role in fostering this creative economy, a rapidly expanding sector that contributes significantly to both global and national economic growth. According to the United Nations Conference on Trade and Development (UNCTAD) (2010) [9], creative industries span four main sectors: heritage (cultural traditions, crafts), arts (visual and performing arts), media (publishing, film, television), and functional creations (design, digital media, advertising). These industries are largely driven by intellectual property, artistic expertise, and innovation [10]. Higher education institutions thus serve as essential environments for creative talent, preparing students to thrive in these dynamic, skill-intensive fields [11].

Despite the growing demand and policy support, recent fluctuations in student interest reflect underlying tensions. In 2021, journalism (311.65%) and arts (210.7%) ranked among the top five most sought-after majors [12]. By 2022, journalism, multimedia communication, and public relations reached record-high admission scores [13] and remained top choices in 2023 [14]. However, in 2024, creative majors declined from the list of top registered fields [15], suggesting renewed uncertainty regarding their appeal and perceived value.

While extensive research exists on students' choice of academic majors, the focus has largely centred on business, science, technology, engineering, and mathematics (STEM), and specialised fields such as agriculture and physics. Far less attention has been paid to the decision-making processes behind selecting creative majors, despite their growing relevance in the 21st-century economy. This gap in the literature limits our understanding of what motivates students to pursue careers in creative fields, or what deters them.

Investigating these factors is essential for several reasons. Firstly, it informs the development of targeted educational policies that support students with creative aspirations. Secondly, it enhances career counselling and student guidance programmes by addressing common misconceptions about job prospects in creative industries. Finally, a deeper understanding of students' motivations can help universities refine their programmes to attract and retain talent in creative fields, contributing to the long-term sustainability of Vietnam's creative economy.

Research objective: This study aims to explore the key factors that influence undergraduate students' intention to choose creative majors, with particular emphasis on personal interest, job prospects, self-efficacy, subjective norms, and media and publicity.

Research question: What are the primary factors influencing students' intention to pursue creative majors at the undergraduate level?

2. Theoretical framework

2.1. The Theory of Reasoned Action in academic decision-making

To understand the determinants of students' intention to choose creative majors, this study applies the Theory of Reasoned Action (TRA), developed by M. Fishbein, et al. (1975) [16]. TRA posits that behavioural intention is the strongest predictor of actual behaviour and is shaped by two key factors: attitude towards the behaviour, which refers to how positively or negatively an individual evaluates a specific action based on expected outcomes such as career satisfaction, economic prospects, and personal fulfilment [17]; and subjective norms, which reflect perceived social pressure or encouragement from influential figures such as family, peers, and educators [16].

TRA has been extensively applied in educational research to explore factors influencing students' academic and career choices. Numerous studies have examined how attitudes and subjective norms impact students' selection of various academic disciplines. W. Zhang (2007) [18] utilised TRA to investigate the factors affecting female students' decisions to pursue a major in computer information systems (CIS), highlighting the role of social influences and personal attitudes in shaping their academic choices. Similarly, W.L. Kuechler, et al. (2009) [19] examined the decline in students choosing information systems as a major, demonstrating how changing perceptions and societal influences impacted students' intentions. S. Sathapornvajana, et al. (2012) [20] applied TRA to study Thai students' motivations for enrolling in information technology (IT) programmes, emphasising cultural and social dimensions in academic decision-making. A. Kumar, et al. (2013) [21] explored the factors influencing college students' choices of business majors, further affirming the relevance of TRA in understanding educational preferences.

2.2. Hypotheses development

Each year, adolescents navigate the complex process of selecting a major, which involves exploring options, evaluating personal interests and abilities, and making informed decisions [22]. This choice plays a crucial role in shaping their academic experience, career trajectories, and long-term financial stability [23]. Scholarly interest in major selection has increased steadily, with research publications in Scopus-indexed journals peaking in 2021 [24]. This study focuses on factors that have been extensively examined in previous literature and are recognised as critical determinants of students' academic choices.

2.3. Personal interest

Personal interest is a key determinant in students' academic decision-making, reflecting their attraction

to specific topics and enjoyment of the subject [25, 26]. Closely linked to academic motivation, personal interest plays a crucial role in engagement and persistence in higher education [27]. Research consistently highlights personal interest as a decisive factor in major selection. L.N. Calkins, et al. (2006) [28] found that students opting out of economics prioritised subject interest, while K. MacLeod, et al. (2016) [29] identified personal interest as the most critical determinant for physics majors. M.Y.Y. Goh, et al. (2021) [30] further reinforced that intrinsic motivators outweigh extrinsic factors in career decisions. The TRA also supports the role of personal interest in shaping attitudes toward academic fields. W. Zhang (2007) [18] and W.L. Kuechler, et al. (2009) [19] demonstrated that genuine interest strongly influences students' attitudes towards a major, while E. Awadallah, et al. (2021) [31] confirmed that personal interest directly shapes attitudes towards a field.

H1: Personal interest positively influences a student's attitude to choose creative majors.

2.4. Job prospects

The availability of job opportunities and career advancement potential significantly influence students' choice of major. Research indicates that students balance career stability, growth potential, and personal interest when making academic decisions [18]. W.L. Kuechler, et al. (2009) [19] found that job availability influenced students' attitudes towards Information Systems (IS) majors, while A. Kumar, et al. (2013) [21] identified job prospects as one of the strongest predictors of business major selection. Similarly, L.C. Tang, et al. [32] observed that accounting students placed high importance on career stability and long-term growth potential. Further supporting these findings, K. Stair, et al. (2016) [33] emphasised that clear career pathways impact students' decisions, while students across disciplines prioritise stable employment opportunities [34]. These studies indicate that job prospects are a crucial factor in major selection, though their impact may vary based on individual perceptions and industry expectations.

H2: Job prospects positively influence a student's attitude to choose creative majors.

2.5. Self-efficacy

Self-efficacy, or an individual's belief in their ability to succeed, plays a significant role in academic and career decision-making [35]. In creative fields where career paths can be uncertain and highly competitive, self-efficacy is particularly crucial. Research suggests that self-efficacy influences students' persistence in their chosen fields. G. Harder, et al. (2015) [36] found that business students' self-efficacy shaped their confidence in their major choice, while individuals with higher self-efficacy are more likely to pursue academic and career paths aligned with their perceived competencies [37].

H3: Self-efficacy positively influences a student's attitude to choose creative majors.

2.6. Attitude towards a major

Attitude towards a major is a key predictor of students' intention to pursue a particular field of study. Research applying TRA and the Theory of Planned Behaviour (TPB) consistently demonstrates that positive perceptions of a major strongly influence decision-making. A. Kumar, et al. (2013) [21] found that attitude towards a business major was the strongest predictor of major selection, while W. Zhang (2007) [18] emphasised that students who perceived Information Systems (IS) as offering strong career prospects and high earning potential were more likely to choose the field. Similarly, L.C. Tang, et al. (2016) [32] found that attitudes towards accounting were positively correlated with major selection, while personal interest in IS was more influential than job security or salary expectations [19].

H4: Attitude towards the intended creative majors positively influences a student's intention to choose creative majors.

2.7. Subjective norms: Influence of family, peers, and educators

Family, peers, teachers, and counsellors play an important role in shaping students' academic choices. While subjective norm is widely recognised as a factor in major selection, its influence varies by discipline and context. Q. Liang, et al. (2023) [38] found that wealthier students often choose humanities, while lower-income students prefer financially stable fields. L.C. Tang, et al. (2016) [32] highlighted the role of family and teachers in choosing accounting, and A. Kumar, et al. (2013) [21] noted stronger family influence on female business students, with peers and professors being more influential for males. TRA-based studies also confirm the significant impact of subjective norm, especially from family and instructors [19, 31]. However, other research suggests limited influence; for instance, IT students tend to decide independently [20], and business students report minimal input from parents or advisors [39].

H5: Family & peers, teachers & counsellors influence a student's intention to choose creative majors.

2.8. Media and publicity

Media and publicity serve as key sources of information that shape students' academic decisions. Research suggests that students rely on digital platforms, social media, and university marketing when selecting a major. It is found that students consider the internet a crucial tool for researching educational opportunities [40], while A. Hoag, et al. (2017) [41] demonstrated that media exposure positively predicted the choice of journalism as a major.

H6: Media and publicity positively influence a student's intention to choose creative majors.

2.9. Control variables: Gender and English proficiency

Gender has been widely studied in relation to educational and career decisions. Research suggests that gender differences impact major selection and persistence [42]. A.D. Kugler, et al. (2021) [43] found that women are more likely to switch majors due to negative feedback, while A.L. Mullen (2014) [44] highlighted gender-based selection patterns across disciplines.

English proficiency is another important factor, particularly in Vietnam, where many higher education programmes require English certification. L.D. Doan, et al. (2021) [45] found that higher English proficiency is associated with greater self-efficacy and confidence in academic skills and major selection, highlighting the important role of language ability in shaping students' academic and career decisions [46, 47].

Based on the hypotheses, this study proposes the following framework model as seen in Fig. 1.

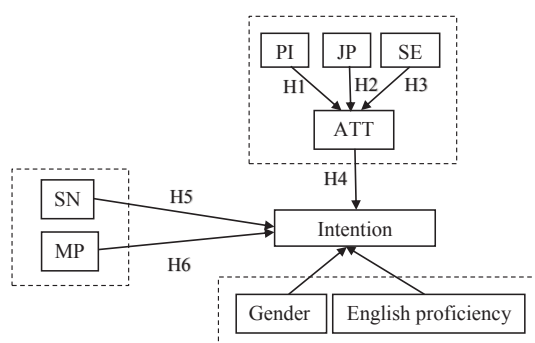


Fig. 1. Hypothesised structural model. PI: Personal interest, JP: Job prospects, SE: Self-efficacy, ATT: Attitude toward a major, SN: Subjective norms, MP: Media and publicity. Source: Authors' construction.

3. Methodology

This study employs a mixed-methods approach, combining qualitative and quantitative research. The qualitative phase explores students' motivations and decision-making processes, while the quantitative phase empirically tests hypothesised relationships using survey data. This approach provides both contextual insights and statistical validation.

The qualitative research involved in-depth interviews with 21 participants, focusing on their decision-making process, career perceptions, and external influences such as family, peers, and educators. The semi-structured interviews explored students' motivations, challenges, and the skills required for creative careers. Thematic analysis of V. Braun, et al (2006) [48] was used to analyse qualitative data, with NVivo software facilitating coding and theme identification.

The quantitative phase involved a structured survey measuring personal interest, job prospects, self-efficacy, subjective norms, media and publicity, and attitude towards creative majors. Gender and English proficiency were included as control variables. The questionnaire, adapted from validated scales, comprised 26 items on a five-point Likert scale. A non-probability sampling strategy, combining purposive and snowball sampling, was employed, targeting students in creative majors at universities in Hanoi. A total of 331 responses were collected in 2025, with 307 valid responses retained after screening, exceeding the required sample size based on J.F. Hair's (2017) [49] guidelines.

Data analysis was conducted using SPSS 26.0 for descriptive statistics and PLS-SEM in SmartPLS 4 to assess measurement validity and test the hypothesised relationships [50]. PLS-SEM is appropriate for this study as it supports prediction-oriented research, handles complex models with multiple constructs, and is robust to non-normal data and moderate sample sizes [49]. ANOVA and t-tests were employed to examine the influence of gender and English proficiency on students' intention to choose creative majors [51].

4. Results and discussion

4.1. Qualitative results

The qualitative findings, based on in-depth interviews with 21 students enrolled in creative majors, provide insight into the factors influencing their academic choices. Personal interest was the most frequently cited motivation, with students emphasising their passion for creativity and self-expression. Participants also highlighted the role of self-efficacy, acknowledging that confidence in their creative abilities influenced their commitment to pursuing these fields.

The role of job prospects in decision-making varied among students. Some expressed confidence in securing opportunities in the creative industries, particularly in design, media, and entrepreneurship. Others conveyed concerns about financial stability and industry competitiveness, which sometimes led to hesitation or reconsideration of their major choices. External influences, including family, peers, and educators, played a mixed role: while some students received encouragement, others faced resistance due to concerns over job security.

Another recurring theme was the perceived skill set required for success in creative careers. Many students recognised that creative disciplines demand both talent and technical skills but emphasised that hard work and continuous learning were more critical than innate ability. Some participants also noted the impact of media and publicity, with exposure to successful creative professionals reinforcing their aspirations. However, media influence was not a dominant factor compared to intrinsic motivation and social support.

4.2. Quantitative results

The final sample consisted of 307 valid responses from students pursuing creative majors. The most common field of study was art (32.3%), followed by design (26.7%), communication (22.1%), and fashion (18.9%). In terms of gender, 59.9% identified as male, 38.1% as female, and 2.0% as non-binary.

Regarding English proficiency, students were classified into five levels: beginner (6.8%), intermediate (24.8%), upper-intermediate (39.1%), advanced (15.3%), and fluent (14.0%). The distribution suggests that a significant proportion of students possess upper-intermediate or higher proficiency, which may influence their confidence in pursuing international career opportunities in creative fields.

Table 1. Correlation matrix of key variables.

	ATT	IC	JP	MP	PI	SE	SN
ATT	1.000						
IC	0.488	1.000					
JP	0.611	0.538	1.000				
MP	0.237	0.233	0.209	1.000			
PI	0.460	0.496	0.393	0.231	1.000		
SE	0.515	0.461	0.482	0.258	0.435	1.000	
SN	0.164	0.202	0.153	0.393	0.078	0.136	1.000

Source: Results from SmartPLS 4. ATT: attitude towards creative majors, IC: intention to choose creative majors, JP: job prospects, MP: media and publicity, PI: personal interest, SE: self-efficacy, SN: subjective norm.

To explore the preliminary relationships among the constructs, a Pearson correlation matrix was generated. As shown in Table 1, intention to choose creative majors (IC) was positively correlated with all other variables, most strongly with job prospects ($r=0.538$), personal interest ($r=0.496$), attitude ($r=0.488$), and self-efficacy ($r=0.461$). Attitude (ATT) demonstrated particularly high correlations with job prospects ($r=0.611$) and self-efficacy ($r=0.515$), suggesting that students with favourable career expectations and greater confidence in their creative abilities tend to develop more positive attitudes towards these majors. Meanwhile, media and publicity (MP) and subjective norms (SN) showed relatively weaker correlations with intention ($r=0.233$ and $r=0.202$, respectively), indicating a limited direct association with students' decision-making. These initial results support the model's structure and underscore the importance of internal factors, such as interest, confidence, and perception of opportunities, in influencing intention. Importantly, all correlation coefficients are below 0.85, indicating no multicollinearity concerns among the variables.

4.2.1. Measurement model assessment

To evaluate the reliability and validity of the measurement model, key criteria were assessed, including Cronbach's alpha, composite reliability (CR), outer loadings, and average

variance extracted (AVE), in line with the recommendations of J.F. Hair, et al. (2017) [49]. Internal consistency was confirmed, with Cronbach's alpha values ranging from 0.720 to 0.864, all exceeding the acceptable threshold of 0.7. Similarly, all constructs achieved CR values between 0.843 and 0.906, indicating strong construct reliability.

Convergent validity was assessed using outer loadings and AVE. All item loadings exceeded 0.7, ranging from 0.736 to 0.881, suggesting that the individual items were well-correlated with their respective constructs. In addition,

Table 2. Measurement model assessment.

Construct	Outer loading	Cronbach's alpha (CA)	Composite reliability (CR)	Average variance extracted (AVE)
Attitude towards creative majors (ATT)		0.720	0.843	0.641
ATT1	0.796			
ATT2	0.798			
ATT3	0.808			
Intention to choose creative majors (IC)		0.808	0.886	0.722
IC1	0.860			
IC2	0.840			
IC3	0.850			
Job prospects (JP)		0.830	0.887	0.662
JP1	0.812			
JP2	0.798			
JP3	0.833			
JP4	0.812			
Media and publicity (MP)		0.842	0.893	0.676
MP1	0.819			
MP2	0.813			
MP3	0.849			
MP4	0.807			
Personal interest (PI)		0.859	0.904	0.702
PI1	0.827			
PI2	0.837			
PI3	0.844			
PI4	0.842			
Self-efficacy (SE)		0.844	0.906	0.762
SE1	0.857			
SE2	0.881			
SE3	0.880			
Subjective norms (SN)		0.864	0.900	0.643
SN1	0.736			
SN2	0.801			
SN3	0.812			
SN4	0.826			
SN5	0.829			

Source: Results from SmartPLS 4.

AVE values for all constructs ranged from 0.641 to 0.762, surpassing the minimum requirement of 0.5 and confirming that each construct captured sufficient variance from its indicators.

Overall, the results support the conclusion that the measurement model demonstrates both strong reliability and adequate convergent validity, making it appropriate for subsequent structural analysis (Table 2).

Discriminant validity was assessed using the Fornell-Larcker criterion and the Heterotrait-Monotrait (HTMT) ratio to determine whether the constructs were sufficiently distinct [52]. The Fornell-Larcker criterion requires that the square root of the average variance extracted (AVE) for each construct exceeds its correlations with other constructs. As shown in Table 3, all constructs met this requirement. For example, the square root of AVE for ATT (0.801) was higher than its correlations with IC (0.488) and JP (0.611), while IC (0.850) exceeded its correlations with JP (0.538), MP (0.233), and PI (0.496). These results indicate a clear distinction among the constructs.

The HTMT ratio further confirmed discriminant validity, with all values remaining below the 0.85 threshold (J. Henseler, et al. (2015) [52]). The highest HTMT values, including JP-ATT (0.790), SE-ATT (0.661), and JP-IC (0.655), were within acceptable limits, confirming that the constructs did not exhibit excessive conceptual overlap (Table 3).

Table 3. Results of discriminant validity.

Fornell-Larcker criterion							
	ATT	IC	JP	MP	PI	SE	SN
ATT	0.801						
IC	0.488	0.850					
JP	0.611	0.538	0.814				
MP	0.237	0.233	0.209	0.822			
PI	0.460	0.496	0.393	0.231	0.838		
SE	0.515	0.461	0.482	0.258	0.435	0.873	
SN	0.164	0.202	0.153	0.393	0.078	0.136	0.802
Heterotrait-Monotrait ratio (HTMT)							
	ATT	IC	JP	MP	PI	SE	SN
ATT							
IC	0.636						
JP	0.790	0.655					
MP	0.302	0.275	0.247				
PI	0.579	0.593	0.461	0.269			
SE	0.661	0.554	0.576	0.303	0.509		
SN	0.196	0.228	0.174	0.447	0.090	0.151	

Source: Results from SmartPLS 4. ATT: attitude towards creative majors, IC: intention to choose creative majors, JP: job prospects, MP: media and publicity, PI: personal interest, SE: self-efficacy, SN: subjective norm.

These findings provide strong support for the measurement model, ensuring that the constructs maintain conceptual distinctiveness and thereby allowing for reliable structural model analysis.

4.2.2. Path coefficients and hypothesis testing

The structural model was evaluated for multicollinearity using variance inflation factor (VIF) values, where a VIF below 5.0 indicates the absence of multicollinearity concerns [49]. Results showed that all VIF values ranged between 1.304 and 1.436, confirming that no multicollinearity issues were present. These findings confirm that the predictors are not excessively correlated, allowing for reliable estimation of the structural model.

Bootstrapping with 10,000 subsamples was employed to obtain stable estimates of path coefficients, t-values, and p-values [49]. Relationships were considered significant if p-value < 0.05 and t-value > 1.96.

Table 4. Structural model and hypothesis testing results.

Paths	Path coefficients	t-values	p-values	Inner VIF	f ²	Hypotheses	Decision
PI → ATT	0.194	3.339	0.001	1.304	0.054	H1	Supported
JP → ATT	0.426	6.801	0.000	1.377	0.247	H2	Supported
SE → ATT	0.226	3.708	0.000	1.436	0.066	H3	Supported
ATT → IC	0.452	7.516	0.000	1.066	0.259	H4	Supported
SN → IC	0.093	1.733	0.083	1.190	0.010	H5	Not supported
MP → IC	0.089	1.603	0.109	1.227	0.009	H6	Not supported

Source: Results from SmartPLS 4. ATT: attitude towards creative majors, IC: intention to choose creative majors, JP: job prospects, MP: media and publicity, PI: personal interest, SE: self-efficacy, SN: subjective norm.

As presented in Table 4, several relationships were statistically significant. ATT → IC ($\beta=0.452$, $p=0.000$) and JP → ATT ($\beta=0.426$, $p=0.000$) were strongly supported, confirming that attitude significantly predicts students' intention to choose creative majors, while job prospects strongly shape attitude. These findings align with existing research [31, 21, 38], which similarly emphasises that a positive attitude towards creative fields and favourable job prospects are key determinants in students' decision-making processes.

Similarly, PI → ATT ($\beta=0.194$, $p=0.001$) and SE → ATT ($\beta=0.226$, $p=0.000$) were also significant, highlighting the importance of personal interest and self-efficacy in influencing attitudes. These results are in line with prior studies [31, 21], which found that students with a strong personal interest in their field and high levels of self-efficacy tend to develop more positive attitudes towards their academic choices, subsequently affecting their intention to pursue specific majors.

Conversely, MP → IC ($\beta=0.089$, $p=0.109$) and SN → IC ($\beta=0.093$, $p=0.083$) were not significant, indicating that media and publicity and subjective norms do not directly impact students' intention to pursue creative majors. The low f-square values (0.009 and 0.010, respectively) further support the negligible effect sizes of these relationships. These results are consistent with earlier findings by C.A. Malgwi, et al. (2005) [39], S. Sathapornvajana, et al. (2012) [20], A. Rababah (2016) [53], and A. Hoag, et al. (2017) [41], who suggested that while external factors such as media influence and social expectations may play a role in shaping students' perceptions, they have limited or no significant impact on their final decision to pursue creative majors.

4.2.3. Predictive capability and model fit

The R^2 values indicate the explanatory power of the model, with attitude (ATT) having an R^2 of 0.461, meaning that 46.1% of the variance in students' attitudes towards creative majors is explained by the predictors. Intention to choose (IC) has an R^2 of 0.253, reflecting a moderate level of explanatory power [54]. The Q^2 values, calculated using the blindfolding procedure, were 0.290 for ATT and 0.178 for IC, both above zero, indicating moderate predictive relevance [49].

Table 5. Model fit indices.

Models	SRMR	d_ULS	d_G	Chi-square	NFI
Saturated	0.049	0.851	0.342	630.467	0.834
Estimated	0.071	1.757	0.393	688.030	0.819

Source: Results from SPSS 26.0.

Model fit indices, presented in Table 5, further confirm the adequacy of the structural model. The SRMR value (0.071) falls below the recommended threshold of 0.08, while the NFI value (0.819) exceeds the acceptable level of 0.80, demonstrating a satisfactory model fit [55]. These results indicate that the model possesses strong explanatory power and predictive relevance, thereby reinforcing the robustness of the findings.

4.2.4. Group comparisons by gender

Gender-based analysis was conducted using Levene's test for homogeneity of variances, followed by ANOVA or Welch's test where appropriate (Table 6). Results revealed that female students reported significantly higher personal interest in creative majors ($M=4.34$) compared to males ($M=3.62$), suggesting a stronger emotional or aspirational alignment with creative fields. Conversely, male students demonstrated greater self-efficacy ($M=4.10$ vs. 3.52), indicating higher confidence in their ability to succeed, which is consistent with prior findings on gendered confidence patterns [37].

However, no significant differences were observed in JP, SN, MP, ATT, or IC. This suggests that while gender influences individual traits such as interest and confidence, it does not significantly shape students' overall attitudes or intentions towards pursuing creative majors.

Table 6. Group comparisons by gender.

Factors	Levene's test (Sig.)	Test used	F/Welch statistic	Sig.	Significant difference
PI	0.000*	Welch	33.872	0.000*	Yes (Female > Male)
JP	0.149	ANOVA	0.252	0.778	No
SE	0.349	ANOVA	13.242	0.000*	Yes (Male > Female)
SN	0.724	ANOVA	1.854	0.158	No
MP	0.840	ANOVA	0.090	0.914	No
ATT	0.724	ANOVA	0.561	0.571	No
IC	0.136	ANOVA	1.152	0.317	No

Source: Results from SPSS 26.0. ATT: attitude towards creative majors, IC: intention to choose creative majors, JP: job prospects, MP: media and publicity, PI: personal interest, SE: self-efficacy, SN: subjective norm.

4.2.5. Group comparisons by English proficiency

The relationship between English proficiency and decision-making factors in choosing creative majors was examined using Welch's robust test, due to violations of variance homogeneity across all factors. The analysis revealed that English proficiency significantly affected all measured constructs, underscoring its substantial influence on students' perceptions and intentions.

Table 7. Group comparisons by English proficiency.

Factors	Levene's test (Sig.)	Welch statistic	Sig.	Significant difference
PI	0.000*	12.238	0.000*	Yes
JP	0.000*	28.315	0.000*	Yes
SE	0.000*	14.286	0.000*	Yes
SN	0.000*	4.199	0.004*	Yes
MP	0.000*	4.533	0.002*	Yes
ATT	0.000*	627.404	0.000*	Yes
IC	0.000*	16.514	0.000*	Yes

Source: Results from SPSS 26.0. ATT: attitude towards creative majors, IC: intention to choose creative majors, JP: job prospects, MP: media and publicity, PI: personal interest, SE: self-efficacy, SN: subjective norm.

The results in Table 7 show that higher English proficiency is positively associated with stronger personal interest, better perceived job prospects, and greater confidence in one's abilities. The findings also suggest that English proficiency influences subjective norms and media and publicity.

Importantly, English proficiency contributes to more positive attitudes (ATT) and a stronger intention to pursue creative majors (IC). As shown in Table 7, students with higher English proficiency demonstrated significantly higher scores in these factors, with Welch statistics of 627.404 ($p=0.000$) for ATT and 16.514 ($p=0.000$) for IC,

indicating a strong, statistically significant relationship. These results highlight the overall influence of English proficiency across key decision-making factors, reinforcing its role in shaping students' attitudes and intentions towards creative fields.

5. Conclusions

This study examined the factors influencing students' intention to pursue creative majors, confirming that attitude towards creative majors is the strongest predictor of intention, shaped by personal interest, self-efficacy, and job prospects. While subjective norms and media exposure influence perceptions, they do not directly impact students' career decisions. These findings suggest that intrinsic motivation plays a greater role than external validation in creative career choices.

Gender differences were evident, with female students demonstrating higher personal interest, whereas male students exhibited greater self-efficacy, reflecting potential variations in confidence and career expectations. However, these differences did not affect the overall intention to choose creative majors. Additionally, English proficiency significantly influenced career confidence and attitudes, indicating that language skills enhance students' perceptions of global career opportunities in creative fields.

5.1. Academic contributions

This study extends research on academic major selection by focusing on creative disciplines, an area often overlooked in favour of STEM and business fields. It reinforces the Theory of Reasoned Action [16] by reaffirming that attitude strongly predicts career intention [21, 31]. Unlike prior studies emphasising subjective norms [19, 39], this research suggests that students in creative fields rely more on personal motivation than on social influences.

The study also contributes to discussions on gender differences and language proficiency in creative education. The findings align with previous research on self-efficacy differences across genders [36, 37] and highlight the role of English proficiency in shaping career confidence [46, 53]. By integrating these variables into the study of creative education, this research provides new insights into how students navigate career decisions in an evolving globalised creative industry.

5.2. Practical contributions

The findings emphasise the need for universities to enhance self-efficacy and career preparedness among students pursuing creative majors. Expanding career counselling, industry partnerships, and practical learning

opportunities can help students develop confidence in their career prospects. Integrating portfolio-based assessments and project-driven curricula will further equip students with the skills necessary for success in creative industries.

Concerns about job stability remain a significant factor influencing students' attitudes. To address this, universities should actively promote clear career pathways, alumni success stories, and industry collaborations that provide real-world exposure. Recruitment efforts should also consider gender differences in motivation, emphasising creative freedom for female students and career stability for male students. Strengthening English training programmes and international learning opportunities will better prepare students for global creative careers.

Policymakers should work to improve public perceptions of creative careers through national awareness campaigns and financial incentives, showcasing successful professionals and highlighting the growing economic contributions of creative industries. Expanding scholarships and funding for creative disciplines will improve accessibility, particularly for underprivileged students. Strengthening industry-academic partnerships can bridge the gap between education and employment, providing students with internships and hands-on experience.

Given the strong link between English proficiency and career confidence, policymakers should expand language training initiatives and international learning programmes to enhance students' global career readiness. Supporting cross-border collaborations and global internship programmes will equip students with the linguistic and professional skills needed for success in creative industries.

5.3. Research limitations and future directions

Future research should adopt a longitudinal approach to examine how students' career intentions evolve post-graduation. Expanding the sample across multiple universities and cultural contexts will improve generalisability and capture regional variations. Investigating socioeconomic background as a moderating factor would provide further insights into financial constraints in creative career decision-making.

As digital media increasingly influences career choices, future studies should explore the impact of social media, influencer marketing, and online career resources on students' academic decisions. Understanding these dynamics can help universities and policymakers develop more effective recruitment and career support strategies.

CRediT author statement

Thi Mai Le: Conceptualisation, Guidance, Supervision, Reviewing and Editing; Dieu Linh Dang: Conceptualisation, Writing, Data Collection, Analysing.

COMPETING INTERESTS

The authors declare that there is no conflict of interest regarding the publication of this article.

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Determinants of consumer satisfaction with safe vegetables in modern retail outlets: Evidence from Hanoi, Vietnam

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Received 13 August 2025; revised 9 October 2025; accepted 5 January 2026

Abstract:

Consumer satisfaction with safe vegetables plays a crucial role in shaping consumer behaviour and the performance of supply chain actors in modern retail outlets in Vietnam. However, empirical evidence on the determinants of such satisfaction remains limited. This study aims to identify the main factors influencing consumer satisfaction with safe vegetables in the modern retail context. Using Structural Equation Modelling (SEM) based on a survey of 250 consumers in Hanoi in 2024, with a response rate of 87.6%, the results highlight that brand trust is a key driver of satisfaction with modern vegetable retail systems. In addition, product attributes positively influence satisfaction, while store image indirectly enhances satisfaction through brand trust. These findings suggest that building brand trust, improving brand familiarity, creating appealing store images (i.e. through advertising, attractive decorations, and friendly staff), and enhancing product attributes (i.e. fresh appearance, attractive packaging, and reasonable prices) are essential strategies for strengthening consumer satisfaction with safe vegetables in Vietnam.

Keywords: brand trust, consumer satisfaction, modern retail, safe vegetables, Vietnam.

Classification numbers: 2.1, 2.2

1. Introduction

Consumer concern about food safety has become a central feature of food purchase behaviour in many emerging markets, driven by recurring food-safety incidents, rapid urbanisation, and changing retail structures that increase both exposure and perceived risk [1]. In Vietnam, food safety concerns have attracted great attention from the government, scholars, and the public [2, 3]. Supermarkets and modern retail channels have expanded rapidly in many cities, offering traceability and certification that can reduce information asymmetries for credence attributes such as “safe” or “certified” vegetables, yet adoption of branded safe food remains uneven due to price premiums, limited supply chains, and persistent consumer scepticism [4]. Empirical and review studies indicate that consumers rely on a mix of observable cues (appearance, packaging, price) and institutional signals (labels, certifications, retailer reputation) to infer product safety, with brand and store trust emerging as pivotal mediators between these signals and satisfaction or purchase decisions [5, 6]. Recent consumer-level surveys and policy reports also emphasise the need for integrated approaches, combining supply-side

improvements, credible certification, and consumer education, to strengthen trust and thereby increasing uptake of safe-food products in emerging economies.

In recent years, rapid economic growth and shifting consumption patterns have propelled the expansion of modern retail channels - such as supermarkets, hypermarkets, and convenience stores - in many developing countries, often displacing smaller traditional retailers [7, 8]. In the food and grocery sector, these modern formats are increasingly driven by consumer demands for safety, quality, and convenience, reshaping how food is purchased in emerging markets [5, 9].

In Vietnam, there has been a profound transformation from the traditional food market into modernised retail outlets since the early 2000s [10]. The recent rapid modernisation of the Vietnamese economy in general and the food industry in particular has fostered the striking expansion of food retail systems in major cities such as Hanoi and Ho Chi Minh City. In the early 2000s, there were few supermarkets and other modern retail formats in Vietnam [10, 11]. Over the past two decades, however, the number of supermarkets and other modern

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retail outlets (i.e., convenience stores) has increased tremendously, with over 330 supermarkets and 5,228 convenience stores as of March 2020 [12]. Despite the expansion of modern retail outlets, the market share of food distributed through such outlets compared with traditional markets remains modest [13]. According to a survey by the University of Adelaide (2018) [14], food expenditure in traditional markets accounted for 77-99% of total food expenditure in Vietnam. Consumers in emerging markets such as Vietnam prefer fresh food in traditional wet markets rather than in modernised outlets [2, 3]. Thus, it is vital to improve consumer satisfaction with food products in these modern retail formats to expand the market share of fresh food.

So far, few prior studies have examined the development of the modern retail system (e.g., supermarkets) and compared its performance with traditional markets in distributing food in Vietnam [13, 15]. Recently, F. Evangelista, et al. (2019) [16] have examined consumer store choices for non-food and processed food products between traditional markets and supermarkets in the country. The development of safe food, such as safe vegetables that bear official safety certifications (i.e. hygiene safety certification, Vietnam Good Agricultural Practice - VietGAP, and organic certifications), has received considerable attention from the government and food sector actors [13, 16]. However, the market share of safe vegetables accounts for less than 10% of total vegetable sales, although they are expected to become dominant in modern retail channels under the Vietnamese government's efforts [13, 17]. H.M. Ngo, et al. (2019) [13] estimated that around 80% of safe vegetables were distributed via traditional markets. Barriers to motivating consumers to buy safe vegetables in modern retail formats (supermarkets and convenience stores) have been identified, including high prices and shopping habits favouring traditional markets for fresh produce [13], as well as consumer trust [3, 17]. Meanwhile, other important factors for increasing food sales volume and retailer turnover, such as consumer satisfaction with food products, remain underexplored.

Based on the review of existing literature above, this study is motivated by the following research questions. *First*, what are the key determinants of consumer satisfaction in modern vegetable retail systems in developing countries? *Second*, how do brand trust and brand familiarity affect consumer satisfaction with safe vegetables in modern retail systems? *Third*, how do product attributes and store image jointly influence consumer satisfaction with safe vegetables in modern retail outlets? *Finally*, how can modern retailers enhance consumer satisfaction with safe vegetables to expand their market share?

To the best of our knowledge, very little work has examined consumer satisfaction with safe vegetables in modern retail outlets (i.e. convenience stores and supermarkets) in Vietnam. Limited empirical evidence exists on the determinants of consumer satisfaction within these formats, particularly for safely certified vegetable products. Previous studies have mainly focused on product or store attributes in isolation, overlooking the combined influence of product attributes, brand characteristics, and the store environment on consumer satisfaction [16, 18]. Furthermore, while the Vietnamese government and retail actors have made substantial efforts to promote the distribution of safely certified vegetables through modern outlets, their market share remains disproportionately low compared with traditional markets. This suggests that consumer satisfaction with safe vegetables in modern retail formats has not been sufficiently understood or effectively enhanced. Addressing this gap is crucial not only for academic purposes, by integrating multiple dimensions influencing satisfaction, but also for practical implications, as improving consumer satisfaction can foster repeat purchases, strengthen brand and store loyalty, and ultimately support the sustainable growth of modern retail systems in emerging markets.

Thus, this study focuses on identifying the factors affecting consumer satisfaction with safely certified vegetables (safe vegetables) in modern retail systems (supermarkets and convenience stores). Specifically, we examine the effects of product attributes, store image, brand familiarity, and brand trust on consumer satisfaction with safe vegetables. This study is expected to provide policy and practical recommendations to help modern retailers design and implement appropriate marketing strategies to strengthen consumer satisfaction more effectively.

2. Theoretical framework and the proposed model

Consumer satisfaction has been extensively discussed within several theoretical frameworks that explain how consumers evaluate products and experiences. The Expectation - Disconfirmation Theory (EDT) is one of the most widely applied theories, suggesting that satisfaction results from the comparison between consumers' expectations and their actual perceptions of product or service performance [19, 20]. When perceived performance exceeds expectations, satisfaction increases. In the context of safe food, consumers form expectations about quality, safety assurance, freshness, and the credibility of certification; satisfaction emerges when these expectations are met or exceeded through the actual product and purchasing experience.

The Cognitive - Affective Model further explains that satisfaction arises not only from cognitive evaluations (e.g. perceived quality, safety) but also from affective responses such as trust and familiarity [21, 22].

Meanwhile, Store Image Theory posits that consumers' perceptions of a retail store's environment - such as cleanliness, layout, convenience, and reliability - shape their satisfaction and loyalty [23, 24]. For food products that require safety assurance, a positive store image reinforces perceptions of hygiene, authenticity, and trustworthiness.

Drawing on these theoretical foundations, the present study integrates product attributes, store image, brand trust, and brand familiarity to provide a holistic understanding of consumer satisfaction with safely-certified vegetables in modern retail outlets. This multidimensional approach captures both cognitive evaluations (product and store factors) and affective components (trust and familiarity), offering a comprehensive framework for examining satisfaction in the context of credence-based food products. Together, these theories provide a cohesive foundation for the proposed framework by demonstrating how cognitive evaluations, affective responses, and store-related cues jointly shape consumer satisfaction with safely-certified vegetables.

2.1. Product attributes and store image

Product attributes consist of intrinsic (i.e. colour, freshness, texture, form, and taste) and extrinsic (e.g. price, packaging, certification, and brand) components [18, 26]. These attributes influence consumers' purchase decisions and/or consumer satisfaction [24-26]. Thus, based on the Expectation - Disconfirmation Theory, the direct effects of product attributes on satisfaction are developed in the following hypothesis:

H1. Product attributes positively affect satisfaction.

Meanwhile, the indirect effects of product attributes on satisfaction via brand familiarity and brand trust are drawn from the Cognitive - Affective Model. The impact of food product attributes (i.e., product information, quality, packaging, price, certification, etc.) on consumer trust/brand trust has been found in previous studies [27-29]. Such product attributes, which contain product information and brand characteristics (i.e., brand names), also affect consumers' awareness and familiarity with a brand [27, 29]. These relationships are developed in the following hypotheses:

H2. Product attributes positively influence brand familiarity.

H3. Product attributes positively influence brand trust.

Based on Store Image Theory, store image may have an impact on consumer purchase behaviour and satisfaction [30, 31]. It reflects how a store is defined in consumers' minds by its functional qualities and psychological attributes. We refer to three important dimensions of store image, namely decoration, staff, and advertising [27, 28]. The hypothesis is as follows:

H4. Store image positively affects satisfaction.

The effects of store image on brand trust and/or brand familiarity are also considered [30, 31] based on the Cognitive - Affective Model. Our hypotheses are as follows:

H5. Store image positively influences brand trust.

H6. Store image positively influences brand familiarity.

2.2. Brand familiarity and brand trust

Brand familiarity or brand awareness is consumers' recall or recognition of a given brand that he/she knows or purchased in the past [32]. Meanwhile, brand trust refers to consumers' belief in a given brand's ability to perform its stated function. In this study, consumer trust in a brand of safe food expresses his/her belief that the product safety certified by such a brand is reliable.

The significant roles of brand familiarity and brand trust in consumer satisfaction have been verified in the existing literature [29]. We also hypothesised that better recognition of a brand (brand familiarity) motivates consumer trust in that brand [29].

Based on the Cognitive - Affective Model, our hypotheses are as follows:

H7. Brand familiarity positively affects brand trust.

H8. Brand familiarity positively affects satisfaction.

H9. Brand trust positively influences satisfaction.

2.3. Consumer satisfaction

Fulfilling consumer satisfaction with product and service quality plays an essential role in every business. Consumer satisfaction expresses his/her expectation that a given product is fulfilled after purchasing and consuming the product. It is considered an evaluation of a product against pre-purchase expectations after consumption or use [33].

Consumer satisfaction is a multidimensional construct, which is affected by a range of factors [27]. Based on previous studies, this article considers the following factors as the main determinants of consumer satisfaction.

The proposed model is presented in Fig. 1.

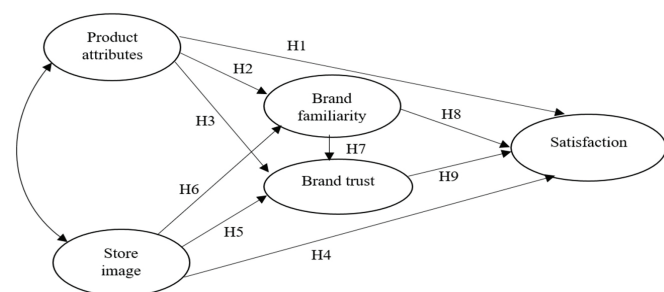


Fig. 1. Factors affecting consumer satisfaction with safe vegetables in modern retail systems.

3. Data collection and analytical methods

3.1. Research area and data collection

This study was conducted in Hanoi, one of the largest cities in Vietnam, with over 8.5 million people in 2023 [34]. Recently, the development of the retailing system in general, and retail outlets for food distribution in particular, has been rapid in Hanoi [13]. This area has also attracted several studies on food safety issues because its residents show much concern about the safety of food, especially vegetable safety [2, 13]. As discussed in the introduction section, the safe vegetable distribution systems in Hanoi face many challenges, mainly due to low consumer trust [17]. Only around 20% of total safe vegetables are distributed through modern retail outlets, with a price premium compared to conventional vegetables [17].

As the survey targeted consumers who purchase branded safe vegetables, conducting interviews at supermarkets and food stores was appropriate. Consumers who pay attention to food brands typically shop at modern retail outlets, whereas those seeking unbranded vegetables tend to purchase from traditional markets [3, 17]. A convenience sampling approach was therefore adopted, reflecting both practical and contextual considerations. Administering the survey at supermarket and store entrances enabled direct access to actual shoppers with recent and relevant purchasing experiences, ensuring that respondents were familiar with the research topic. To minimise potential selection bias, quota controls were applied for two retail formats (supermarkets and food stores) and key socio-demographic characteristics of shoppers (age and education). Prior to the official survey, a pilot test was conducted with twenty consumers to finalise the questionnaire. A total of 340 consumers were invited to participate in the survey, of whom 298 completed the questionnaire, yielding a response rate of 87.6%. After data cleaning (i.e. removing outliers and incomplete responses), a sample of 250 consumers (125 for each outlet: supermarkets and shops) was used for the final analysis. After finishing the survey, a small gift (equivalent to 30,000 VND or approximately 1.5 USD) was given to each consumer as compensation for his/her participation.

The determination of sample size for multiple regression analysis in general, and Structural Equation Modelling (SEM) in particular, often follows established rules of thumb suggesting between five and ten observations per estimated parameter or item. According to J.F. Hair, et al. (2010) [35], a minimum sample size ranging from 100 to 200 is typically adequate for SEM analyses. In this study, we used 17 items, which required between 85 and 170 observations. Therefore, the final

sample of 250 respondents exceeds this threshold and is considered appropriate and sufficient for SEM estimation.

3.2. Measurements

3.2.1. Socio-demographic characteristics of the respondents

A basic description of the respondents' socio-demographic characteristics across retail outlets is reported in Table 1. Overall, the majority of respondents responsible for food shopping were female, which is common in Vietnam [3, 16]. In addition, consumers were generally young and highly educated, reflecting the fact that they lived in urban areas of the city.

Table 1. Socio-demographic characteristics of the respondents.

Characteristics	Sample	Vietnam's urban population*
Age (years old)	37.8	NA
Gender (%)		
Male	28	49.6
Female	72	50.4
Education (years)	14.9	10.9
Family size (people)	3.7	3.7
Children (%)		
Yes	55.6	NA
No	44.4	
Monthly income (%)		
<700 USD	29.6	NA
700-1300 USD	54.8	
>1300 USD	15.6	

NA: not available. * Calculation from General Statistics Office of Vietnam (GSO, 2020) [36]. Source: Author's survey.

3.2.2. Product attributes, store image, brand familiarity, brand trust, and consumer satisfaction

Regarding product attributes and store image, based on previous work [24, 27, 29], we used six items to measure all important aspects of product attributes and store image related to safe vegetables, namely advertising, appearance, package, price, decoration, and staff. These single-item statements were based on a 5-point Likert scale (from 1 = totally unimportant to 5 = totally important).

Brand familiarity, brand trust, and consumer satisfaction were measured by multi-dimensional constructs using 5-point Likert scales, as recommended by several scholars [19, 25, 26]. In this study, we used four items to measure brand familiarity. These items were adapted from previous studies [37, 38]. Meanwhile, three items were used to assess brand trust, as proposed by two recent studies on trust in food products [3, 39]. The details of observed items for product attributes, store image, brand familiarity, brand trust, and consumer satisfaction are presented in Table 2.

Table 2. Descriptions of items.

Constructs	Measurement items	Mean	Standard deviation
Product attributes	Fresh appearance of vegetable is important	3.86	0.72
	Attractive vegetable packaging is important	3.98	0.68
	Reasonable prices of vegetables are important	4.27	0.70
Store image	Advertising signs are important	3.96	0.73
	Shop decorations are important	3.75	0.60
	Friendly staff are important	3.82	0.74
Brand familiarity	I have much understanding of brands of safe vegetables through visiting and buying (BF1)	4.03	0.76
	The staff provided me a lot of information about the products (BF2)	3.60	0.81
	I can differentiate among brands of safe vegetables in the market (BF3)	3.96	0.72
	I am very sure about the certifications of safe vegetables (BF4)	3.93	0.75
Brand trust	I totally trust the safety of safe vegetable brands (BT1)	4.32	0.62
	I believe that the consumption of safe vegetables with brands is really safe for my family's health (BT2)	4.32	0.69
	I feel totally confident when buying safe vegetables with the brands (BT3)	4.31	0.65
Consumer satisfaction	I am totally satisfied with the safe vegetable brands (CS1)	4.22	0.65
	I perceive that the quality and safety of safe vegetable brands meet my expectations (CS2)	4.07	0.67
	I feel satisfied after eating safe vegetables (CS3)	4.17	0.67
	I feel pleasant when eating safe vegetables (CS4)	4.04	0.72

Source: Author's survey.

3.3. Analytical methods

In this study, we used Structural Equation Modelling (SEM) as the main analytical approach. A general SEM consists of two components, namely the measurement model and the structural/path model [31]. Covariance-based Structural Equation Modelling (CB-SEM) was employed in this study due to its suitability for theory testing and confirmation, rather than prediction, as in variance-based SEM [35, 40]. The research aimed to validate the hypothesised relationships among latent constructs influencing Vietnamese consumers' loyalty to safe food, based on the established theoretical framework.

For measurement analysis, the validity and reliability of constructs based on confirmatory factor analysis (CFA) have to meet the following requirements. Factor loadings of all measured items must be at least above 0.4 [40],

while composite reliability (CR) and average variance extracted (AVE), used to test the convergent validity of constructs, should exceed 0.5 [35, 40]. Also, discriminant validity, which verifies the differences among latent constructs, requires the square root of AVE to be higher than the inter-construct correlations [35, 40]. For structural analysis, various indices need to be met to ensure the goodness of fit of the model. The comparative fit index (CFI), Tucker-Lewis index (TLI), and goodness-of-fit index (GFI) should be higher than 0.90. In addition, the root mean square error of approximation (RMSEA) should be less than 0.08 as an acceptable threshold, while a threshold of 0.05 is highly recommended [35].

4. Results

4.1. Measurement validity and reliability based on CFA applied to the whole sample

The validity and reliability of the constructs in the measurement model are reported in Table 3. All the criteria for construct validity and reliability were satisfactory. All factor loadings were higher than 0.4, while the composite reliability values were above 0.8. The average variance extracted also exceeded 0.5. In addition, Table 4 confirmed the differences among latent constructs through higher values of the square root of AVE compared with the correlations among pairs of these constructs. All values of the heterotrait-monotrait ratio

Table 3. Construct validity and reliability.

Constructs	Items	Standardised loadings	Composite reliability (CR)	Average variance extracted (AVE)
Product attributes (PA)	Appearance	0.857	0.812	0.620
	Package	0.723		
	Price	0.777		
Store image (SI)	Advertising	0.685	0.867	0.689
	Decoration	0.915		
	Staff	0.872		
Brand familiarity (BF*)	BF1	0.771	0.828	0.548
	BF2	0.763		
	BF3	0.672		
	BF4	0.750		
Brand trust (BT*)	BT1	0.864	0.917	0.786
	BT2	0.934		
	BT3	0.860		
Consumer Satisfaction (CS*)	CS1	0.797	0.893	0.677
	CS2	0.832		
	CS3	0.860		
	CS4	0.801		

*Specific items (BF1, BF2, BF3, BF4, BT1, BT2, BT3, CS1, CS2, CS3, CS4) were presented in Table 2. Source: Author's survey.

(HTMT) in Table 5 were below 0.9, which established the discriminant validity of the latent constructs. Furthermore, no multicollinearity issues were found, as all variance inflation factor (VIF) values were below the threshold of 5 in Table 4.

Table 4. Discriminant validity based on correlations and AVE.

	1	2	3	4	5	VIF ^a
1. Product attributes	0.726					2.00
2. Store image	0.724*	0.830				1.76
3. Brand familiarity	0.496*	0.598*	0.860			1.53
4. Brand trust	0.581*	0.354*	0.500*	0.941		1.38
5. Consumer satisfaction	0.638*	0.527*	0.547*	0.780*	0.906	

Note: Bold values are the square roots of the average variance extracted (AVE). *: $p < 0.001$. ^aVIF values were obtained after running multiple regression with consumer satisfaction as the dependent variable and four independent variables (product attributes, store image, brand familiarity, and brand trust). Source: Author's survey.

Table 5. Discriminant validity based on heterotrait-monotrait ratio (HTMT).

	1	2	3	4	5
1. Product attributes					
2. Store image	0.725				
3. Brand familiarity	0.507	0.522			
4. Brand trust	0.631	0.425	0.499		
5. Consumer satisfaction	0.723	0.587	0.547	0.779	

Source: Author's survey.

Because the variables used in our models were derived from self-reported data with various observed variables based on a 5-point Likert scale, it was necessary to assess the potential for common method bias. In this study, we applied Harman's single-factor test to address this issue [41]. The test indicated that the percentage of variance explained by a single factor was 38.4%, which is less than the threshold of 50%. This suggests that common method bias was not a significant issue.

4.2. Structural Equation Modelling (SEM) path (structural) analysis

The relationships among latent constructs in our proposed model were tested through SEM path analysis, as shown in Table 6. Overall, the structural model fitted the data well when all indices to measure the goodness of fit (CFI, GFI, TLI, and RMSEA) were satisfied. The exploratory variables predicted approximately 70% of the variance in consumer satisfaction.

As expected, brand trust was found to be the most important factor directly driving consumer satisfaction ($\beta = 0.541$, $p < 0.001$). Product attributes also had a positive direct effect on satisfaction. Unexpectedly, however, the direct effects of store image and brand familiarity on consumer satisfaction were not significant at the 10%

level. Notably, both product attributes and store image influenced brand-level perceptions (brand familiarity and brand trust). Specifically, product attributes significantly enhanced brand trust, while store image strongly contributed to both brand familiarity and brand trust.

Table 6. Estimations of the whole SEM model.

Paths	Standardised estimates	Bias-corrected bootstrap CI (95%)		p-value	Conclusions
		Lower bound	Upper bound		
H1. Product attributes → Satisfaction	0.254	0.097	0.425	0.006	Supported
H2. Product attributes → Brand familiarity	0.236	0.161	0.396	0.017	Supported
H3. Product attributes → Brand trust	0.688	0.526	0.972	0.000	Supported
H4. Store image → Satisfaction	0.083	-0.285	0.338	0.290	Not supported
H5. Store image → Brand trust	0.350	0.264	0.561	0.000	Supported
H6. Store image → Brand familiarity	0.421	0.263	0.729	0.000	Supported
H7. Brand familiarity → Brand trust	0.338	0.229	0.536	0.000	Supported
H8. Brand familiarity → Satisfaction	0.102	-0.037	0.281	0.137	Not supported
H9. Brand trust → Satisfaction	0.541	0.329	0.678	<0.001	Supported
Indices of the model fit					
CFI		0.965			
GFI		0.914			
TLI		0.956			
RMSEA		0.056			
Variance explained in satisfaction:		R-square=69.5%			

CFI (Comparative fit index), GFI (Goodness of fit index), TLI (Tucker-Lewis index), RMSEA (Root mean square error of approximation). Source: Author's survey.

Table 7 presents the mediating role of brand trust in the relationships between store image and consumer satisfaction, and between brand familiarity and consumer satisfaction, using the bootstrapping technique with 5,000 replications. The results indicate that the direct effects of both store image and brand familiarity on consumer satisfaction were statistically insignificant. However, the indirect effects of both variables through brand trust were positive and significant, with $\beta = 0.126$ and $\beta = 0.209$ for store image and brand familiarity, respectively, at the 1% level.

Table 7. Mediating role of brand trust using bootstrapping techniques (5,000 replications).

	Standardised estimates	p-value	Bias-corrected CI (95%)	
			Lower bound	Upper bound
Store image → satisfaction				
Direct effect: store image → satisfaction	0.076	0.436	-0.129	0.141
Indirect effect (through brand trust)	0.126	0.000	0.086	0.242
Familiarity → satisfaction				
Direct effect: Familiarity → satisfaction	0.117	0.327	-0.034	0.260
Indirect effect (through brand trust)	0.209	0.001	0.116	0.309

Source: Author's survey.

5. Discussion and implications

5.1. Discussion

There has been little evidence of how consumers are satisfied with safe vegetables in modern retailers (i.e. supermarkets and safe food shops) in developing countries such as Vietnam. This study contributes to the existing literature on the determinants of consumer satisfaction with safe vegetables across retail formats in Vietnam by integrating product attributes, store image, brand trust, and brand familiarity.

In this study, we found the important role of brand trust in increasing consumer satisfaction. Brand trust had the strongest direct effect on satisfaction, which is similar to the findings of J. Drennan, et al. (2015) [42]. These authors revealed that consumer satisfaction was mostly affected by brand trust, followed by experience. Similarly, M.U.H. Uzir, et al. (2025) [43] confirmed the positive relationship between brand trust and consumer satisfaction. In the Vietnamese context, cultural values such as collectivism, high uncertainty avoidance, and relational trust may further shape the role of brand trust in food-related satisfaction. Consumers often rely on interpersonal networks, word-of-mouth, and shared community experiences when evaluating the safety and reliability of food products, which can amplify the importance of trusted brands as risk-reducing signals.

This study confirmed the direct effect of product attributes (including price, appearance, and packaging) on satisfaction, as found in previous work [5, 44]. In a previous study, S. Dang, et al. (2019) [45] revealed that Vietnamese people prefer fresh vegetables. M. Malekpour, et al. (2022) [18] also indicated the importance of product attributes in improving customer satisfaction.

In this study, a direct effect of store image (store decoration, staff, and advertising) on satisfaction was not found. This finding differs from other work reporting a significant role of store image in consumer satisfaction [46]. This may be explained by the fact that safe vegetable supermarkets/shops have not yet fully satisfied Vietnamese

consumers. Despite the absence of a direct effect, store image had an indirect effect on satisfaction through brand trust. This is in line with the work of F.A. Konuk (2018) [27], who reported a significant effect of store image on trust in organic food, thereby motivating consumers' intention to purchase food. The effect of store image on consumer trust/brand trust leading to higher intention to buy is also consistent with a prior study [27]. This suggests that an attractive store image helps to increase consumer trust in brands, which in turn improves satisfaction.

Brand trust also acted as a mediator between brand familiarity and satisfaction. Brand familiarity increased brand trust, which improved brand loyalty, as found by M.U.H. Uzir, et al. (2025) [43]. This is similar to previous work, which suggested that building brand trust has become essential when food safety is of great concern [3, 39]. However, in contrast with these authors' findings [32], we did not find a direct influence of brand familiarity on satisfaction. Thus, our results reveal that increasing consumer awareness of brands (brand familiarity) motivates brand trust and then leads to higher satisfaction.

Furthermore, brand familiarity was strengthened by consumer perception and evaluation of product attributes and brand characteristics, as found by prior scholars [47]. This reveals that product attributes (i.e., packaging, labels, or brand names) designed to create unique signals can help consumers more easily recall, become familiar with, and differentiate brands from competing products. Similarly, the distinctiveness of store image facilitates the recognition of brands, as suggested by previous studies [24, 37]. As a result, greater brand familiarity strengthens consumer trust in the brand, thereby contributing to higher overall satisfaction levels.

It is also noted that the findings of this study may differ across emerging markets depending on institutional quality, food safety regulations, and consumer confidence in modern retail systems. In contexts with stronger regulatory enforcement, store image may exert a more direct influence on satisfaction, whereas in markets with weaker governance, brand trust may play a more central role as a substitute for formal quality assurance. Additionally, the relative importance of product attributes and branding cues may vary across retail formats, with tangible cues dominating in traditional markets and trust-based factors becoming more salient in organised retail settings.

5.2. Theoretical implications

This study contributes to the literature on consumer satisfaction and food retailing by refining theoretical perspectives on satisfaction formation in high-risk consumption contexts. Rather than reiterating specific empirical relationships, the findings collectively emphasise the centrality of trust-based mechanisms in explaining

satisfaction with credence goods such as safe vegetables. This advances satisfaction theory by highlighting that cognitive evaluations of safety and reliability may outweigh traditional evaluative cues in markets where product quality is difficult to verify *ex ante*.

Moreover, the study offers an integrative conceptualisation that bridges tangible retail cues (e.g., product- and store-related signals) and intangible brand-related constructs within a single framework. By positioning brand trust as a key transmission mechanism, the research extends prior models that often treated these constructs in isolation. This integrated approach provides a more holistic explanation of how consumers process multiple sources of information when forming satisfaction judgements in safe-food markets.

The results also contribute to retailing theory by suggesting a conditional role of store image. Rather than functioning as a universal antecedent of satisfaction, store image appears to operate through more abstract psychological pathways. This insight calls for a reconsideration of linear assumptions commonly embedded in store image-outcome models and supports more process-oriented explanations of consumer responses in emerging markets.

Finally, the study refines brand familiarity theory by demonstrating that familiarity alone does not necessarily generate favourable consumer outcomes in contexts characterised by perceived risk. Instead, familiarity must be accompanied by trust to be theoretically meaningful for satisfaction formation. This distinction enhances the explanatory precision of familiarity-based frameworks and suggests boundary conditions under which familiarity effects are likely to emerge.

Overall, the integrated framework advances beyond prior single-theory approaches by moving away from isolated explanations of satisfaction and instead modelling how tangible retail cues and intangible brand-related factors interact through trust-based mechanisms, thereby offering a more process-oriented and context-sensitive account of satisfaction formation in high-risk food consumption settings.

5.3. Practical implications

From a managerial perspective, these findings offer several actionable insights for vegetable retailers and policymakers. First, since brand trust is the strongest driver of satisfaction, retailers should prioritise building and maintaining trust through transparent sourcing, reliable safety certifications, and consistent product quality. For instance, retailers should implement a standardised in-store traceability system (e.g. QR codes on packaging linking to information on farm origin, safety certification, and inspection dates) and actively train staff to explain this information to consumers, thereby translating transparency initiatives into

tangible trust-building interactions at the point of purchase. Publicising credible vegetable safety labels and ensuring traceability can reinforce consumers' confidence in brand reliability.

Second, store image should be leveraged as a trust-building mechanism rather than as a direct satisfaction driver. Modern retailers in Vietnam can cultivate trustworthy images through professional staff training, hygienic store environments, and clear communication of food safety practices. Visual cues such as cleanliness, organisation, and informative signage can signal credibility and reinforce brand trust.

Third, enhancing brand familiarity - through consistent branding, recognisable packaging, and community engagement - can strengthen consumers' attachment to safe vegetable brands. However, familiarity must be coupled with trustworthiness to translate into satisfaction. Retailers should thus combine marketing communications with evidence of integrity and product authenticity.

Finally, policymakers and retail associations can support the development of trust-based marketing frameworks by establishing clear certification standards and promoting consumer education about safe vegetable systems. Specifically, policymakers should develop and enforce a unified national certification and labelling framework for safe vegetables, accompanied by public awareness campaigns that educate consumers on how to recognise and interpret certified safety labels, thereby reducing information asymmetry and strengthening trust in regulated retail channels. These institutional efforts will not only increase consumer satisfaction but also foster long-term loyalty and reduce scepticism towards domestic vegetable brands.

5.4. Limitations

The main limitations of this study should be addressed in further research. First, the use of a convenience sampling technique limits the generalisability of the findings. The sample was drawn from consumers shopping at selected supermarkets and safe food stores in Hanoi, which may not fully represent the broader population of Vietnamese consumers (i.e. the sample included a much higher proportion of female respondents) or those purchasing through other retail formats such as traditional markets and online platforms. For instance, the predominance of female participants in the sample may limit the extent to which the findings reflect men's food purchasing behaviour. Future studies should consider probability-based or stratified sampling methods to enhance representativeness and external validity.

Second, some constructs in the model, particularly product attributes and store image, were measured using

selected aspects with single-item indicators, which may constrain the reliability and depth of construct measurement. Future research should employ multi-item scales validated in prior studies to capture the complexity of consumer perceptions more effectively.

Third, although the study examined key determinants of consumer satisfaction, including product attributes, store image, brand familiarity, and brand trust, other potential factors such as perceived value, food safety knowledge, risk perception, and cultural or social influences were not included. Incorporating these variables could provide a more comprehensive understanding of satisfaction formation in the context of safe food consumption.

Finally, the findings are specific to safe vegetable products and may not be directly transferable to other food categories such as meat or dairy, where perceptions of risk, spoilage, and safety assurance mechanisms differ. Future studies should therefore extend the model to other food categories and conduct comparative analyses across product types to examine whether the relative importance of brand trust, product attributes, and store image varies with category-specific risk and handling requirements.

Despite these limitations, this work contributes to exploring the determinants of consumer satisfaction with safe food in modern retail systems in a developing country such as Vietnam. It can serve as a useful reference for food marketers in other countries in designing effective strategies to improve consumer satisfaction with safe food in modern outlets.

6. Conclusions

This study underscores the pivotal role of brand trust in enhancing consumer satisfaction with safe vegetables in modern retail systems in developing contexts such as Vietnam. Brand trust not only exerted the strongest direct influence on satisfaction but also mediated the effects of store image and brand familiarity. Additionally, product attributes, including appearance, price, and packaging, significantly contributed to consumer satisfaction. Although brand familiarity did not directly affect satisfaction, it enhanced satisfaction indirectly through brand trust.

From a managerial perspective, strengthening brand trust should be a core strategy for safe vegetable marketers. Efforts should focus on improving brand credibility through transparent product information, reinforcing brand reputation via communication and word-of-mouth, and ensuring supply chain reliability. Enhancing product and store attributes, together with expanding brand visibility through marketing campaigns and community engagement, can further increase brand familiarity, trust, and ultimately, consumer satisfaction.

Future research should employ more representative sampling strategies across diverse retail formats and geographical regions to improve the generalisability of

findings. Additionally, extending the conceptual model by using multi-item measures and incorporating broader psychological, social, and cultural factors, such as risk perception and food safety knowledge, would offer a more comprehensive understanding of consumer satisfaction with safe food products.

COMPETING INTERESTS

The author declares that there is no conflict of interest regarding the publication of this article.

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Brand positioning in the development of local specialty products: A case study of the Ha Long shrimp floss collective trademark in Quang Ninh

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Received 30 June 2025; revised 28 July 2025; accepted 4 February 2026

Abstract:

Collective trademarks (CTMs) are increasingly recognised as strategic instruments for upgrading local specialty products; however, empirical evidence from the consumer perspective in emerging economies remains limited. This study examines how consumers perceive and evaluate Ha Long shrimp floss - Quang Ninh and how these perceptions shape its brand-positioning potential under a CTM framework. A survey of 200 consumers in Ha Long, Hai Phong, and Hanoi in 2023 was conducted using a structured questionnaire covering brand awareness, perceived quality, packaging and traceability, communication channels, CTM awareness, and willingness to pay. CTM governance (quality control, traceability, and institutional coordination) is incorporated as a key analytical dimension. Data were analysed using descriptive statistics and one-sample t-tests, complemented by a SWOT analysis. The results show that perceived quality is the core strength, supporting a 10-15% price premium, while weak brand recognition, inadequate packaging and traceability, and limited communication constrain positioning. The study highlights that effective brand positioning requires the alignment of product quality, CTM governance, and strategic communication.

Keywords: brand positioning, collective trademark, Ha Long shrimp floss, intellectual property, specialty product branding.

Classification numbers: 2.1, 2.2, 2.3

1. Introduction

In the context of deepening globalisation and accelerating market integration, brand building has become a critical strategic instrument for enhancing competitiveness, achieving differentiation, and increasing the value of local specialty products. Beyond its conventional function of identification, branding is now regarded as a strategic intellectual asset that embodies the product's reputation, cultural identity, and economic value [1]. Collective forms of intellectual property (IP), including collective trademarks (CTMs), certification marks, and geographical indications (GIs), have increasingly been recognised as key mechanisms for strengthening value chains, protecting community interests, and expanding the market reach of region-based products [2, 3].

International research demonstrates that IP-based branding not only generates competitive advantage but also plays a fundamental role in rural development, value chain upgrading, and the preservation of traditional knowledge. Cases such as Darjeeling tea, Parmigiano Reggiano cheese, and Café de Colombia show that effective legal protection and stringent quality governance can lead to premium prices, enhance producers' bargaining power, and contribute to sustainable livelihoods [3, 4]. Theoretically,

brands rooted in cultural identity are conceptualised as forms of "cultural assets" that enable communities to resist name misappropriation and maintain authenticity [2, 5]. At the same time, well-designed IP systems reduce transaction costs and facilitate institutional coordination within the value chain [1].

In Vietnam, alongside the implementation of the "One Commune, One Product" (OCOP) programme, research on branding and IP at the local level has expanded significantly. Most studies focus on evaluating the economic impacts of OCOP [6], analysing the role of geographical indications for key products such as Phu Quoc fish sauce, Buon Ma Thuot coffee, or Thai Nguyen tea, or assessing policy frameworks for regional brand development. Q.N. Vu, et al. (2025) [7] further demonstrated that intellectual property factors shape consumers' purchase decisions for collective-branded Ha Long shrimp floss. However, existing studies remain largely descriptive, emphasising policy perspectives rather than the operational mechanisms and strategic implications of CTMs in brand positioning. Notably, empirical investigations into how consumers perceive, recognise, and evaluate local specialty products as a basis for brand positioning remain limited.

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The case of the collective trademark “Ha Long shrimp floss - Quang Ninh” - a long-standing specialty closely associated with coastal culinary culture and community knowledge - illustrates the common challenges faced by local specialty products in Vietnam. Despite possessing strong cultural identity and significant market potential, the product has yet to receive adequate legal protection and lacks a unified branding strategy. As a result, it faces risks of counterfeiting, name misappropriation, and declining market credibility. This situation highlights a substantial gap between the product’s intrinsic value and its current brand image, underscoring the need to better understand how consumers recognise, perceive, and evaluate the product.

Accordingly, this study focuses on analysing consumer perceptions and evaluations of key brand-related dimensions of Ha Long shrimp floss, including brand awareness, perceived quality, packaging and labelling, traceability, communication channels, and awareness of collective trademarks. Examining these dimensions not only reveals existing challenges in product governance and development but also provides an empirical foundation for proposing targeted solutions to strengthen brand positioning and enhance the value of this local specialty product.

2. Literature review

Research on branding, intellectual property (IP) protection, and the development of local specialty products increasingly demonstrates that brand value lies not only in product quality but also in its cultural, economic, and institutional functions. From a marketing perspective, a brand serves as a market signal that reduces information asymmetry, enhances differentiation, and shapes consumer expectations [8]. For region-based products, branding further operates as a “language of identity”, conveying cultural narratives, traditional knowledge, and community heritage [9, 10].

A substantial strand of the literature focuses on collective forms of IP such as CTMs, certification marks, and GIs. A. Marescotti, et al. (2017) [11] argue that CTMs and GIs not only generate commercial value but also contribute to preserving traditional knowledge and maintaining cultural diversity. S. Cavagnero and S. Giordano (2022) [12] further emphasise that linking products to origin creates “symbolic value”, enabling producers to access premium market segments. In the agricultural sector, CTMs have been shown to increase farmers’ income, strengthen bargaining power, and reduce dependence on intermediaries [13].

Another line of inquiry highlights that the effectiveness of CTMs largely depends on CTM governance and related institutional arrangements. J. Neilson, et al. (2018) [13], in their study of Gayo coffee (Indonesia), demonstrate that the benefits of GIs are realised only when supported by stringent quality control, stakeholder consensus, and

equitable benefit-sharing mechanisms. These findings align with arguments that CTMs require clear legal frameworks, transparent standards, and coordinated institutional management to prevent free-riding behaviour and protect brand value [12].

In Vietnam, the 2022 Intellectual Property Law defines CTMs as marks used to distinguish the goods or services of members of an organisation from those of non-members. This legal framework has facilitated the development of community-based brands, particularly within the national OCOP programme. Recent studies show that CTMs and traceability systems positively influence consumer trust, perceived quality, and loyalty [14, 15]. At the firm level, CTMs and GIs have been associated with improved business performance, though challenges remain regarding management capacity and utilisation levels [16]. Research on OCOP also highlights the essential roles of CTM governance capacity, communication strategies, and institutional coordination in enhancing the impact of CTMs on rural development [7].

Despite the growing body of literature, most studies focus on policy frameworks, governance models, or macro-level economic effects of CTMs and GIs. Research adopting a market-oriented perspective specifically examining consumer recognition, perceptions, and evaluations of products associated with collective trademarks remains limited. For the case of Ha Long shrimp floss - Quang Ninh, no systematic study has yet explored how consumers perceive brand identity, evaluate perceived quality, assess packaging and traceability information, or understand the necessity of collective trademark protection. This gap is particularly significant to be addressed because consumer feedback constitutes the most direct and practical foundation for designing branding strategies and improving CTM management in practice.

3. Research methodology

3.1. Research design and data collection

This study employs a mixed-methods research design integrating quantitative and qualitative approaches to assess brand positioning and identify key factors influencing the development of the collective trademark “Ha Long shrimp floss - Quang Ninh”. Primary data were collected through a structured questionnaire, supplemented by a limited number of open-ended items to contextualise consumer perceptions and expectations.

A total of 200 valid responses were collected between November and December 2023 from three selected market areas: Ha Long - Quang Ninh (production and local consumption market), Hanoi (major urban consumption market), and Hai Phong (coastal consumption market). Given the exploratory and market-oriented nature of

the study, convenience sampling was applied to ensure feasibility while capturing diverse consumer insights [17].

The questionnaire was developed based on prior studies on regional branding and specialty product development [18] and refined through expert consultation to ensure contextual relevance. It covered key dimensions including brand awareness, perceived product quality, packaging and labelling, traceability, communication channels, collective trademark awareness, and willingness to pay. These dimensions collectively capture the core determinants of brand positioning from a consumer perspective.

3.2. Scale development

Measurement scales were derived from well-established theoretical frameworks in branding and consumer behaviour research. Indicators for brand awareness and perceived quality were adapted from Keller's Customer-based Brand Equity (CBBE) model [8]. Items related to Packaging, labelling, and traceability reflect the literature on brand identity systems and information signalling in agri-food markets [19], while communication-related items draw on integrated marketing communications theory [8].

Consumer awareness of collective trademarks was operationalised following studies on collective marks and geographical indication systems, which conceptualise CTMs as institutional mechanisms that enhance consumer trust and protect collective reputation [9]. Willingness-to-pay items were constructed based on value-based pricing theory and contingent valuation approaches [20].

Detailed theoretical justifications, scale operationalisation, and item wording are provided in Appendix A and the methodological note to improve readability and avoid redundancy in the main text. The final questionnaire was tailored to local consumption conditions and the specific attributes of Ha Long shrimp floss.

3.3. Data analysis methods

Survey data were analysed using SPSS 22.0 software. Descriptive statistics were employed to summarise sample characteristics and assess consumer awareness, attitudes, and evaluations of the "Ha Long shrimp floss - Quang Ninh" brand. Mean values, standard deviations, frequencies, and percentages were used to provide an overview of market perceptions.

In addition, a SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis was conducted to systematically assess internal and external factors affecting the development of the collective trademark. Strengths include product quality and cultural reputation; weaknesses relate mainly to packaging, branding, and institutional coordination; opportunities arise from growing demand for local specialty products and supportive policy frameworks; while threats stem from counterfeiting risks and market competition.

The integration of quantitative survey results with SWOT analysis provides a concise yet multidimensional analytical framework, enabling the study to link consumer-based evidence with strategic recommendations for CTM governance, policy development, and long-term brand enhancement. For terminological consistency, this study uses the term CTM governance to refer to the institutional, regulatory, and operational mechanisms governing the use, protection, and collective management of collective trademarks.

4. Results

4.1. Overview of the survey sample

A total of 200 consumers from Quang Ninh, Hai Phong, and Hanoi - each of whom had previously purchased and consumed Ha Long shrimp floss - participated in the survey. The demographic and socioeconomic characteristics of the sample are summarised in Table 1.

Table 1. Characteristics of the survey sample.

Indicator	Unit	Result
Average monthly income	VND 1,000/month	11,386
Gender - Male	%	29.5
Gender - Female	%	70.5
Educational attainment - High school	%	81
Educational attainment - College/University	%	17.5
Educational attainment - Postgraduate	%	1.5
Age group 18-25	%	22
Age group 26-45	%	58
Age group 46 and above	%	20

Source: Author's survey data.

The findings indicate that respondents had an average monthly income of approximately 11.386 million VND, reflecting a relatively high level of purchasing power suitable for premium local specialty products. Female consumers accounted for 70.5% of the sample, emphasising their crucial role in household food purchasing and decision-making. Regarding educational attainment, the majority of respondents had completed high school education (81%), while 17.5% held college or university qualifications and 1.5% held postgraduate qualifications, corresponding to an average of 12 years of schooling and indicating a consumer base with moderate to relatively high levels of education. In terms of age structure, respondents aged 26-45 constituted the largest group (58%), followed by those aged 18-25 (22%) and those aged 46 and above (20%); this segment is typically characterised by stable income, strong product awareness, and extensive access to information, and therefore represents the principal consumer group for local specialty food products. Taken together, these demographic and socioeconomic characteristics provide an appropriate

empirical basis for analysing consumer perceptions and designing effective brand positioning strategies, communication campaigns, and market development initiatives tailored to the target consumer segment.

In addition to profiling the sample, the survey examined several core dimensions relevant to brand development, including brand awareness, the ability to differentiate Ha Long shrimp floss from competing products, perceived product quality, packaging and labelling evaluation, consumer perceptions regarding the necessity of CTM protection, and the effectiveness of communication and promotional channels.

4.2. Survey results

The survey of 200 consumers of Ha Long shrimp floss in Quang Ninh, Hai Phong, and Hanoi examined brand awareness, the ability to distinguish Ha Long shrimp floss from similar products produced elsewhere, perceived product quality, packaging and labelling evaluation, the perceived necessity of collective trademark protection, and the effectiveness of communication and promotional channels. The results for brand awareness are presented in Table 2.

Table 2. Statistical results for the brand awareness scale.

Variable code	Mean	SD	t-value	Sig.	Mean diff.
BA1 - I have previously heard about Ha Long shrimp floss	3.45	1.04	6.119	<0.001	+0.45
BA2 - I can recognise Ha Long shrimp floss through its packaging/labelling	3.01	0.97	0.146	0.884	+0.01
BA3 - I can distinguish Ha Long shrimp floss from similar products	2.08	1.32	-9.857	<0.001	-0.92
BA4 - I know clearly the origin of Ha Long shrimp floss	2.14	1.15	-10.576	<0.001	-0.86

Source: Author's survey data.

The results indicate that although consumers were generally familiar with the product name (BA1), they were unable to recognise it through packaging (BA2) and struggled to distinguish Ha Long shrimp floss from other competing products (BA3). Consumer knowledge about the product's origin was also notably low (BA4). These findings highlight substantial deficiencies in the brand identity system, which weaken product recall and restrict the brand's ability to establish a distinct market position.

Brand awareness varied significantly across regions: recognition was highest in Ha Long (54.3%) and lowest in Hanoi (22.6%), suggesting that the product's visibility and presence outside the production locality remain limited. Furthermore, only 28.5% of respondents reported being able to differentiate Ha Long shrimp floss from similar products based on sensory attributes or packaging. Most consumers stated that they were "uncertain about the product's origin", mainly due to insufficient information on packaging or the

prevalence of unverified products falsely labelled as "Ha Long" without legal authentication.

Table 3. Statistical results for the perceived quality scale.

Variable code	Mean	SD	t-value	Sig.	Mean diff.
PQ1 - The product has a rich and distinctive flavour	3.98	1.02	13.588	<0.001	+0.98
PQ2 - The product has a natural, unadulterated colour	3.65	0.89	10.329	<0.001	+0.65
PQ3 - The product is fine-textured, uniform, and consistently high quality	4.01	1.10	12.985	<0.001	+1.01
PQ4 - I feel assured about the product's quality when using it	4.07	0.94	16.098	<0.001	+1.07

Source: Author's survey data.

The analysis reveals that consumers hold consistently positive evaluations of the quality of Ha Long shrimp floss (Table 3). All items in the perceived quality scale have mean scores significantly higher than the neutral midpoint ($p < 0.001$), indicating strong agreement across respondents. The attributes rated most favourably were the product's distinctive flavour (PQ1) and its stable, uniform texture (PQ3). Natural colouration (PQ2) and the sense of safety and confidence when consuming the product (PQ4) also received high levels of agreement. Overall, perceived quality emerges as one of the strongest value dimensions of Ha Long shrimp floss and constitutes a core foundation for its brand-positioning strategy in the specialty food market.

Consistent with these findings, 72.0% of consumers rated the product as "good" or "very good". Positive attributes frequently mentioned include rich flavour (69% agreeing or strongly agreeing), natural colour (58%), and fine, uniform texture (61%). However, only 11.5% of respondents reported feeling "completely assured" about product quality in the absence of a recognised trademark or verified origin label. This underscores the direct linkage between brand credibility and consumers' perception of safety and quality.

The results for the packaging, labelling, and traceability scale are shown in Table 4.

Table 4. Statistical results for the packaging, labelling, and traceability scale.

Variable code	Mean	SD	t-value	Sig.	Mean diff.
PK1 - The packaging is attractive and professional	2.84	1.03	-2.198	0.029	-0.16
PK2 - Information on the packaging is clear and complete	2.91	0.98	-1.299	0.195	-0.09
PK3 - The product has an anti-counterfeit seal/CTM label	2.67	1.12	-4.167	0.001	-0.33
PK4 - The product includes a transparent QR traceability code	2.54	1.15	-5.657	<0.001	-0.46

Source: Author's survey data.

The results show that all four variables (PK1-PK4) have mean values below the neutral midpoint of 3. For PK1, PK3, and PK4, the differences are statistically significant ($p < 0.05$), indicating that consumers hold generally unfavourable perceptions regarding packaging professionalism, information transparency, and particularly the presence of anti-counterfeit and traceability features.

These deficiencies constitute one of the major weaknesses directly affecting consumer trust and the product's brand identity. Although 89% of respondents reported purchasing Ha Long shrimp floss with some form of packaging or labelling, only 36% rated the packaging as "agree" or above. The majority described the packaging as "below average", "lacking essential information", or "unprofessional". Moreover, 31% of sampled products had no QR code or traceability label, and many displayed only handwritten product names. Such shortcomings undermine consumer confidence and significantly restrict the product's ability to enter modern retail channels such as supermarkets or e-commerce platforms.

Table 5 presents the statistical results for the communication and information access scale.

Table 5. Statistical results for the communication and information access scale.

Variable code	Mean	SD	t-value	Sig.	Mean diff.
MC1 - Awareness through word-of-mouth	3.42	1.07	5.551	<0.001	+0.42
MC2 - Awareness through traditional markets/ retail shops	3.11	1.02	1.525	0.129	+0.11
MC3 - Awareness through social media platforms	2.36	1.14	-7.939	<0.001	-0.64
MC4 - Effectiveness of producers' communication activities	2.48	1.09	-6.744	<0.001	-0.52

Source: Author's survey data.

The results show that word-of-mouth and traditional retail channels are the primary sources of product awareness (MC1 and MC2>3), highlighting the continued dominance of informal and conventional communication pathways. In contrast, both social media channels (MC3) and communication efforts by producers and cooperatives (MC4) received significantly lower mean scores, with strong statistical significance ($p < 0.001$). These findings indicate substantial weaknesses in digital communication and modern marketing activities for Ha Long shrimp floss.

Meanwhile, the level of customer awareness of collective trademarks is presented in Table 6.

Table 6. Statistical results for the collective trademark awareness scale.

Variable code	Mean	SD	t-value	Sig.	Mean diff.
CT1 - I understand the concept of collective trademarks	4.12	0.83	19.083	<0.001	+1.12
CT2 - CTMs help increase consumer trust	4.32	0.78	23.930	<0.001	+1.32
CT3 - CTMs help prevent counterfeiting	4.41	0.75	26.588	<0.001	+1.41
CT4 - I am willing to prioritise products with CTMs	4.27	0.82	21.905	<0.001	+1.27

Source: Author's survey data.

All four CTM awareness variables (CT1-CT4) have exceptionally high mean values (>4.1) with strong statistical significance ($p < 0.001$), indicating a very high level of consumer recognition regarding the necessity of establishing a collective trademark. These results align with the broader survey finding that 98% of respondents agreed or strongly agreed on the importance of developing a CTM for Ha Long shrimp floss. The most frequently cited reasons include preventing counterfeiting and protecting consumer rights (59% agreeing or strongly agreeing).

Table 7 demonstrates customers' willingness to pay.

Table 7. Statistical results for the willingness-to-pay (WTP) scale.

Variable code	Mean	SD	t-value	Sig.	Mean diff.
WTP1 - Willing to pay a higher price if the product carries a CTM	3.88	0.97	12.831	<0.001	+0.88
WTP2 - Willing to pay a higher price if the product includes traceability information	3.94	0.93	14.294	<0.001	+0.94
WTP3 - The current price is appropriate given the product's quality	3.52	0.88	8.354	<0.001	+0.52

Source: Author's survey data.

The results indicate that consumers demonstrate a strong willingness to pay a premium for Ha Long shrimp floss when the product includes a collective trademark and transparent traceability features. This finding is consistent with the overall survey results, which show that 61.3% of consumers agreed or strongly agreed that they would pay 10-15% more if the product were CTM-certified,

Table 8. SWOT matrix for the development of the collective trademark "Ha Long shrimp floss - Quang Ninh".

Strengths	Weaknesses	Opportunities	Threats
- Shrimp floss is a traditional specialty product deeply rooted in Ha Long's culinary culture. - High product quality, positively rated by consumers (pleasant taste, natural colour, fine texture). - Readily available supply of wild-caught local shrimp, offering a competitive edge over farmed shrimp. - A large number of small-scale producers can potentially be organised into cooperatives to form the basis for a collective trademark.	- Weak brand recognition; consumers have difficulty distinguishing it from similar products from other regions. - Lack of standardised packaging; absence of QR codes for traceability; many products are hand-packed. - Fragmented production system with no unified standards for processing or quality assurance. - Absence of a competent legal entity to register, manage, and protect the collective trademark rights.	- Policy support from national programmes such as OCOP, intellectual property protection, and trade promotion. - Growing consumer demand for local specialties and increased awareness of traceability and food safety. - Strong potential for market expansion through tourism, e-commerce, premium gift markets, and supermarket channels. - Feasibility of developing a sustainable value chain if product standards and trademark usage regulations are established.	- Market distortion caused by the widespread presence of counterfeit or low-quality products falsely labelled as "Ha Long". - Limited awareness and engagement among some producers, coupled with low levels of community cooperation. - Supply instability due to fluctuations in marine shrimp availability, impacted by climate and environmental factors; rising production costs. - Increasing pressure to comply with stricter requirements on packaging, certification, and food safety, which raise input costs and hinder competitiveness for unprofessional producers.

Source: Author's synthesis based on survey data and secondary sources.

equipped with traceability codes, and packaged according to standardised requirements. These insights point to substantial commercial potential if a collective trademark is effectively developed and implemented.

To comprehensively assess the internal and external factors influencing the establishment and development of the collective trademark for Ha Long shrimp floss, a SWOT matrix was constructed. This analytical framework enables the identification of strategic measures to enhance brand value, strengthen competitiveness, and promote sustainable development. The resulting SWOT assessment in Table 8 forms a critical foundation for designing institutional, technical, and communication strategies aimed at supporting long-term brand advancement.

Table 9. Strategic SWOT matrix for the development of the collective trademark “Ha Long shrimp floss - Quang Ninh”.

	Opportunities (O)	Threats (T)
	SO Strategies (Leverage strengths to capitalise on opportunities)	ST Strategies (Leverage strengths to counteract threats)
Strengths (S)	- Leverage product quality and cultural heritage to craft a compelling brand narrative aligned with the OCOP framework and local tourism. - Develop premium packaging and traceability systems to meet growing consumer demand for transparency in specialty products. - Promote e-commerce and tourism gift channels by capitalising on the product's ease of transport and long shelf-life.	- Standardise household production processes to ensure consistent quality and prevent counterfeit or substandard products. - Establish an anti-counterfeiting system with verified QR codes and CTM-branded labels to protect product origin. - Conduct training on the use of community-based intellectual property to raise awareness and protect producer interests.
	WO Strategies (Address weaknesses to seize opportunities)	WT Strategies (Minimise weaknesses to avoid threats)
Weaknesses (W)	- Establish a collective trademark management entity (e.g., cooperative or sectoral association) to centralise oversight and leverage support from OCOP and IP programmes. - Standardise product packaging, design, and quality to enhance competitiveness on e-commerce platforms and in modern retail markets. - Develop an integrated brand communication strategy across both traditional and digital media channels.	- Enforce strict trademark usage regulations to control product quality and protect CTM reputation. - Organise small producers into cooperative models to conduct regular food safety inspections and implement traceability, ensuring compliance with high-standard markets. - Strengthen training in food safety and standardised processing procedures to improve market readiness and mitigate legal risks.

Source: Author's synthesis based on survey data and secondary sources.

Based on the results of the SWOT analysis, a strategic SWOT matrix was developed to identify feasible strategies for building and advancing the collective trademark “Ha Long shrimp floss Quang Ninh” (Table 9). The matrix integrates both empirical evidence and theoretical insights to propose strategic directions for enhancing brand value, competitiveness, and long-term sustainability.

5. Discussion

The empirical findings of this study reveal several notable insights regarding the current status and strategic potential of the Ha Long shrimp floss brand.

First, perceived product quality stands out as the strongest foundation of the brand. Consumers consistently rated core product attributes, such as distinctive flavour, natural colouration, and uniform texture, at high levels, with all mean scores significantly above the neutral point ($p < 0.001$). Combined with the strong willingness-to-pay results, where respondents were prepared to pay a 10-15% premium for products bearing a collective trademark and transparent traceability information, the findings confirm that perceived quality and authenticity serve as key value drivers. This result is consistent with prior empirical evidence from European GI systems, such as Parmigiano Reggiano and Darjeeling tea, where certified origin and quality signalling significantly enhance consumer trust and price premiums [3, 11]. Similar patterns have also been documented in Asian contexts, including Gayo coffee in Indonesia and regional rice brands in China, where institutionalised IP protection reinforces quality perception and market differentiation [13, 21]. Consistent with signalling theory and the literature on origin-based branding, these results suggest that Ha Long shrimp floss possesses favourable conditions to be positioned as a premium specialty product anchored in cultural identity and regional heritage.

Second, deficiencies in brand recognition and authentication remain major constraints. Despite the positive perception of product quality, brand awareness is weak: only 28.5% were able to distinguish it from competing products. The low scores related to packaging, labelling, and traceability - particularly the absence of QR codes and anti-counterfeiting seals - highlight structural weaknesses in the brand identity system. Comparable weaknesses have been observed in several emerging-economy CTM and GI cases, where insufficient visual identity, weak enforcement, and fragmented producer participation undermine the effectiveness of intellectual-property-based branding [12, 14]. Studies on GI products in Southern Europe further show that without standardised labelling and traceability systems, origin brands struggle to translate intrinsic quality into recognisable market

signals [9]. These issues not only diminish consumer trust but also restrict the product's competitiveness in modern retail environments and digital marketplaces, reflecting broader challenges faced by collective brands in emerging economies.

In addition, the findings highlight the critical role of CTM governance in transforming product quality into market-based brand value. Although product quality is highly evaluated, limitations in traceability, packaging, and authentication signals reflect deficiencies in governance mechanisms, particularly in quality control, information standardisation, and stakeholder coordination. This suggests that CTM governance functions as a mediating mechanism that determines the effectiveness of quality signalling and the ability to achieve brand positioning in the market.

Third, institutional expectations and community governance emerge as decisive factors for future development. An overwhelming 98% of respondents recognised the necessity of establishing a collective trademark, reflecting strong market demand for authenticated, origin-verified products. However, international evidence suggests that CTMs only yield sustainable benefits when supported by a capable CTM governance structure, typically a cooperative or producer association responsible for regulating usage, enforcing quality standards, and coordinating equitable benefit distribution. Empirical studies from Europe and Asia consistently demonstrate that weak governance leads to free-riding and reputational dilution, while well-structured CTM/GI institutions enhance collective action and long-term brand value [13, 21]. In this respect, the Ha Long shrimp floss case closely mirrors transitional CTM systems observed in Southeast Asia, where consumer demand for certification outpaces institutional readiness. This highlights the urgency of forming a competent collective body to operationalise trademark governance and align producer incentives.

Taken together, these findings mirror patterns observed in other developing economies: local specialty products often possess substantial cultural and commercial values but fail to fully harness this potential due to insufficient legal protection, weak brand identity systems, and fragmented producer coordination. By situating the Ha Long shrimp floss case alongside established GI and CTM experiences in Europe and Asia, this study strengthens the external validity of its findings and confirms that the challenges observed are systemic

rather than product-specific. The case underscores the importance of integrating value-based marketing approaches with intellectual property protection and community-based CTM governance to convert product distinctiveness into durable competitive advantage.

The results indicate that Ha Long shrimp floss can be effectively positioned as a premium regional specialty brand if three strategic dimensions are simultaneously strengthened: (i) standardising product quality and production processes, (ii) establishing a robust and transparent collective trademark governance system, and (iii) developing cohesive communication and branding strategies grounded in regional cultural narratives. This integrated framework aligns with international best practices in CTM and GI development and offers a transferable analytical model for upgrading local specialty products in other emerging economies undergoing similar institutional transitions.

6. Conclusions and policy recommendations

The findings of this study demonstrate that collective trademarks constitute a strategic mechanism for enhancing brand positioning, generating added value, and promoting the sustainable development of local specialty products. The case of Ha Long shrimp floss - Quang Ninh illustrates a common pattern: despite strong consumer appreciation for product quality, particularly distinctive flavour, natural attributes, and cultural embeddedness, critical weaknesses remain in brand recognition, authentication systems, packaging professionalism, and CTM governance capacity. These gaps limit the ability of the product to convert its cultural and intrinsic value into sustained market competitiveness. The results affirm that effective brand positioning for local specialties requires a coordinated strategy combining product quality standards, intellectual property protection, and coherent brand communication.

Based on empirical evidence, five strategic policy recommendations are proposed:

First, strengthen the CTM governance framework, including registration, quality control, and enforcement mechanisms. A clearly defined legal and operational structure is needed to regulate product quality standards, production processes, membership criteria, and the rights and responsibilities of trademark users. A robust governance mechanism is essential to ensure product consistency, avoid free-riding behaviour, and maintain long-term brand credibility.

Second, standardise production and upgrade technical and quality-control infrastructure. Uniform production protocols, compliance with food safety standards, adoption of traceability systems, and modernisation of packaging are critical. Implementing QR codes, anti-counterfeiting labels, and transparent traceability records will enhance consumer trust and facilitate entry into supermarkets, e-commerce platforms, and potential export markets.

Third, develop integrated communication strategies to reinforce regional brand identity. Brand promotion should shift from fragmented efforts to a cohesive storytelling approach that emphasises cultural heritage, geographical origin, and traditional craftsmanship associated with Ha Long. Expanding communication through digital platforms, social media, tourism linkages, and experiential marketing can significantly elevate brand visibility and consumer engagement.

Fourth, reorganise the value chain and strengthen production-market linkages. CTM development should be embedded within a more coordinated value chain, in which producers, cooperatives, enterprises, and distributors operate as interconnected partners. A synchronised chain, from raw material sourcing to processing and distribution, will help stabilise quality, reduce transaction costs, and increase value-added outcomes.

Fifth, reinforce state and local policy support. Government initiatives in trade promotion, digital transformation, human capital development, and market access should be aligned to create favourable conditions for CTM-based commercialisation. Supportive policies that encourage innovation, technology adoption, and brand protection activities will play a critical role in improving product competitiveness and market positioning.

In conclusion, brand development for local specialty products should be understood not merely as a marketing function but as an integrated socio-economic development strategy. Within this framework, collective trademarks serve as an institutional tool enabling the transformation of cultural identity, local resources, and traditional knowledge into tangible economic value. With coordinated quality standards, institutional protection, and strategic communication, Ha Long shrimp floss - Quang Ninh has strong potential to evolve into a leading regional specialty brand, contributing to rural economic development, strengthening community livelihoods, and enhancing the international visibility of Vietnamese products.

APPENDICES

Consumer survey questionnaire

A. General Information

1. Gender: ☐ Male ☐ Female
2. Survey location: ☐ Ha Long ☐ Ha Noi ☐ Hai Phong
3. Age group: ☐ 18-25 ☐ 26-45 ☐ 46 and above
4. Educational level: ☐ High school ☐ College/University
☐ Postgraduate
5. Monthly income (million VND): ☐ <7 ☐ 7-10 ☐ 10-15 ☐ >15
6. Frequency of using shrimp floss: ☐ Never ☐ 1-2 times/month
☐ 1-2 times/week ☐ Regularly

B. Survey Items (Likert scale 1-5): 1=strongly disagree; 2=disagree; 3=neutral; 4=agree; 5=strongly agree.

1. Brand awareness

Code	Item	1	2	3	4	5
BA1	I have heard of Ha Long shrimp floss.					
BA2	I can recognise it via packaging/label.					
BA3	I can distinguish it from similar products.					
BA4	I clearly know its origin.					

2. Perceived quality

Code	Item	1	2	3	4	5
PQ1	Rich, distinctive flavour.					
PQ2	Natural, unadulterated colour.					
PQ3	Fine, uniform texture.					
PQ4	I feel assured about the quality.					

3. Packaging, labelling and traceability

Code	Item	1	2	3	4	5
PK1	Attractive, professional packaging.					
PK2	Clear and complete information.					
PK3	Anti-counterfeit/CTM label.					
PK4	QR traceability code.					

4. Communication and information access

Code	Item	1	2	3	4	5
MC1	Awareness via word-of-mouth.					
MC2	Awareness via traditional markets.					
MC3	Awareness via social media.					
MC4	Producers' communication effectiveness.					

5. Collective trademark awareness

Code	Item	1	2	3	4	5
CT1	I understand the CTM concept.					
CT2	CTMs enhance consumer trust.					
CT3	CTMs prevent counterfeiting.					
CT4	I prefer products with CTMs.					

6. Willingness to pay

Code	Item	1	2	3	4	5
WTP1	Willing to pay more if CTM exists.					
WTP2	Willing to pay more if traceable.					
WTP3	Current price matches quality.					

7. Consumer suggestions

7.1. What should be improved? ☐ Quality ☐ Packaging ☐ Price

☐ Traceability ☐ Other:

7.2. Would you recommend this product? ☐ Yes ☐ No

7.3. Suggestions for CTM development:

COMPETING INTERESTS

The author declares that there is no conflict of interest regarding the publication of the article.

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Mapping carbon accounting research in ASEAN: A bibliometric analysis of Scopus-indexed literature, 2013-2023

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Received 10 July 2025; revised 11 August 2025; accepted 25 August 2025

Abstract:

Carbon accounting is fundamental to both national and corporate responsibility for mitigating carbon emissions associated with manufacturing and supply chain management. Considering the rapid economic growth of ASEAN countries and their consequent impacts on climate change, this bibliometric study aims to comprehensively capture the research landscape of carbon accounting in the region. Publications from 2013 to 2023 were retrieved from the Scopus database. Bibliometric analysis of publication numbers, citations, journals, and network mapping of countries and keywords was conducted using Microsoft Excel 365, VOSviewer 1.6.20, and RStudio. In total, 5,883 publications were included in the final analysis, with the number of articles steadily increasing over time. Singapore and Malaysia emerged as the two leading countries in Southeast Asia with the largest publication output and the highest citation counts. Singapore, Malaysia, and Indonesia also formed the most active collaboration network. Recent research trends on carbon accounting in ASEAN highlight chemistry and materials science within the manufacturing sector, while the social science aspects of data management have received less attention. In the future, ASEAN countries should strengthen mutual cooperation and place a greater emphasis on the quality of emission data, the impacts of energy consumption in the region, and the potential applications of machine learning in data management.

Keywords: ASEAN, bibliometric analysis, carbon accounting, greenhouse gas emissions, research trends.

Classification numbers: 2.1, 2.2, 7

1. Introduction

The increasing urgency of addressing climate change has spurred the development of carbon accounting as a critical tool for measuring and managing greenhouse gas (GHG) emissions. The concept of carbon accounting began to receive attention from researchers in the early 2000s such as N.H. Ravindranath, et al. (2008) [1] and J. Bebbington, et al. (2008) [2]. A more comprehensive framework was later introduced by K. Stechemesser, et al. (2012) [3], who expanded the definition of carbon accounting to encompass both monetary and non-monetary evaluation of carbon-related assets. With increasing societal and environmental concerns over time, the conceptual evolution of carbon accounting changes from measuring CO₂ emissions and carbon storage in biomass (2007) [1], to the estimation and removal of GHG emissions on a global scale (2012) [4], and, more recently, to the measuring, monitoring, reporting, and verification of GHG levels across supply chains and product life cycles (2023) [5]. These progressive transformations emphasise the crucial role of carbon accounting at both organisational and national levels in fulfilling the mission of carbon neutrality.

Previous studies on carbon accounting in ASEAN countries have largely focused on specific topics in isolation, leaving a gap in comprehensive assessments of the field. Existing research has primarily examined carbon emissions, emission drivers, carbon ecosystems, and the integration of corporate and natural climate solutions. Notably, recent studies have highlighted rapid carbon emission growth in the region, driven primarily by economic expansion, with biomass and coal as the dominant sources [6-8]. For instance, in Thailand, improvements in energy efficiency have been linked to a partial slowdown in emission growth [9]. ASEAN is also recognised as a global hotspot for organic carbon storage, hosting extensive mangrove and seagrass ecosystems [10-12]. Indonesia possesses vast mangrove areas, where preservation and restoration are critical for maintaining carbon stocks and mitigating emissions. Other strands of research have explored corporate carbon accounting, which faces challenges in integrating natural climate solutions [13, 14], and consumption-based carbon accounting, which shows household consumption as a major emission source - particularly in Malaysia, Singapore, and Thailand [15]. While these studies provide valuable insights into individual aspects of carbon accounting in ASEAN, no comprehensive review

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has yet synthesised research developments and identified emerging themes. This underscores the need for a holistic assessment of carbon accounting in ASEAN that considers its diverse dimensions from a sustainability perspective.

Unlike traditional literature reviews and systematic reviews, bibliometric analysis offers a quantitative, data-driven overview of a research field [16]. Although numerous bibliometric studies have been conducted on carbon accounting, the novelty of this research lies in its specific focus on the ASEAN region. For example, K. Kuriawan, et al. (2022) [17] performed a bibliometric analysis of carbon accounting research from 2012 to 2021 without regional restrictions. Their study predicted significant growth in research themes related to carbon accounting, reflecting increasing awareness among industrial companies of their environmental impacts and their responsibility for reporting GHG emissions. By contrast, Y. Zheng, et al. (2022) [18] provided a critical review of carbon accounting in social science-related studies between 1997 and 2020. Their results emphasised the need for more carbon reduction actions at the organisational level and recommended additional empirical research on responsibility allocation from a consumption perspective. Another scientometric study by Y. Du, et al. (2024) [19] focused specifically on responsibility accounting, while R. Kaur, et al. (2023) [20] reviewed conceptual developments in carbon accounting and offered practical implications for developing a standardised framework that integrates carbon accounting into manufacturing systems and supply chains. Collectively, these bibliometric analyses highlight significant advancements in the scientific understanding of carbon accounting and motivate the present study to provide a structured review of developments in ASEAN. By considering the distinctive developmental pace of ASEAN countries as transitioning economies, this review provides useful insights for shaping future carbon accounting research agendas in the region, which is vital to achieve long-term goals of mitigating global warming.

The novelty of this study is that it represents the first bibliometric review conducted to track research developments in carbon accounting within ASEAN countries. This research contributes to the existing literature in at least three ways: (1) by identifying the current research status of ASEAN carbon accounting through bibliometric indicators such as publications, citations, and country-level collaboration; (2) by determining research hotspots using a mix of analytical tools, including VOSviewer and RStudio, to enhance reproducibility; and (3) by providing guidance for future research directions related to carbon accounting in the region. By processing the increasing volume of ASEAN-focused publications, this bibliometric analysis identifies key themes and emerging areas, thereby guiding the knowledge base and informing both research and policymaking.

This study addresses four research questions (RQs):

RQ1: What is the current status of ASEAN carbon accounting research (e.g., growth rate, journal contributions)?

RQ2: What is the role of country interconnection in influencing ASEAN carbon accounting research?

RQ3: What are the common topics and emerging themes in the field?

RQ4: What are the future implications for ASEAN carbon accounting research?

The findings of this study have practical implications for strengthening environmental responsibility and sustainability initiatives in ASEAN. Results show that research productivity is largely concentrated in Singapore and Malaysia. Strengthening collaborative research across ASEAN should therefore be a priority to reinforce regional commitments to environmental preservation. Furthermore, the findings support future research on carbon data management and provide policy-relevant insights into mitigating the environmental impacts of economic growth, energy consumption, and deforestation. This bibliometric analysis also highlights the potential applications of artificial intelligence and machine learning in carbon accounting, which are likely to become critical research domains in the future.

The remainder of this article is structured as follows: first, a review of the conceptual progression of carbon accounting is provided, followed by a description of the methodology employed. Results and discussion are then presented, and finally, the article concludes with key findings and recommendations for future research and policy.

2. Methodology

2.1. Data source and search strategy

To conduct this bibliometric analysis, we employed Scopus, one of the most widely used databases for scholarly publications. Alongside the Web of Science Core Collection (WoS), Scopus is recognised as an optimal database for scientometric studies. It provides a large volume of publications across multiple disciplines and a comprehensive set of metadata for each document, which can be readily extracted and analysed using reference management software and other analytical tools.

There is no single “best” database for bibliometric analysis [21]. While WoS - established in 1964 - is the oldest scholarly database and is noted for its rigorous journal selection and coverage, Scopus is recognised for its broader journal inclusion, particularly in the humanities and social sciences, as well as for its utility in interdisciplinary research and research visualisation [22]. Given that approximately 99.11% of journals indexed in WoS are also covered in Scopus [22], the use of either database is justifiable for data collection in bibliometric studies.

The search strategy comprised three stages:

First, we executed a search query using the following keywords: “greenhouse gas”, “carbon”, “CO₂”, “carbon dioxide”, “accounting”, “calculation”, and “measurement”. These

keywords were adapted from a systematic review on carbon accounting [3] and a bibliometric analysis of carbon emissions [19], ensuring alignment of this scientometric study with existing research while focusing specifically on the Asian region. Boolean operators (AND/OR) were applied to the Topic search function (Title, Abstract, and Keywords). The full search string was: TITLE-ABS-KEY ("greenhouse gas" OR "carbon" OR "CO₂" OR "carbon dioxide" OR "greenhouse gas emissions") AND TITLE-ABS-KEY ("account*" OR "calculation" OR "measurement"). The total number of papers yielded was 458,258.

Second, various filtering processes were applied to refine the relevancy of publications. Since the search was performed in May 2024, papers published between January and May 2024 may not fully represent annual research trends. We therefore limited the dataset to a 10-year period (2013-2023) to comprehensively capture developments in carbon accounting research. In addition, we restricted the sample to publications written in English and classified as research articles, excluding reviews, books, book chapters, and other document types.

Finally, country filtering was applied to include only publications affiliated with some ASEAN countries: Brunei Darussalam, Myanmar, Cambodia, Indonesia, Lao PDR, Malaysia, the Philippines, Singapore, Thailand, and Vietnam (Timor-Leste was not included because it became ASEAN's 11th member after the study period).

In summary, the inclusion criteria were:

Publication year: Between 2013 and 2023;

Language: English;

Document type: Research articles;

Country/territory: ASEAN countries.

The final dataset comprised 5,883 publications. All three steps of the search process were independently conducted by two researchers, followed by a detailed review of the extracted information and a consensus on the final selection. Each publication was retrieved in full record format.

2.2. Data analysis

In this study, bibliometric analysis was applied to identify research trends in carbon accounting in ASEAN countries.

For descriptive statistics, we analysed the following indicators: number of publications by year, citation counts, and publication distribution by journal, affiliation, country, and research area. Data on articles specifically within the field of Economics were also obtained, along with the most impactful publications in this category. These analyses were conducted using Microsoft Excel 365. To generate mapping graphs of by-country collaboration networks and keyword co-occurrences, we used VOSviewer software (version 1.6.20). VOSviewer is extensively utilised in bibliometric analysis to visually reflect collaboration patterns between authors, organisations, and

countries [21, 23, 24]. It is also commonly used to analyse the links between keywords repeatedly cited in articles.

In addition, RStudio software was utilised to examine the temporal growth of research themes, which is essential for identifying emerging trends and research gaps in the field. RStudio is widely employed in bibliometric studies [17, 25], as it enables the analysis of bibliometric indicators and thematic developments from unstructured scientific data [26].

A summary of data extraction and analysis is presented in Fig. 1.

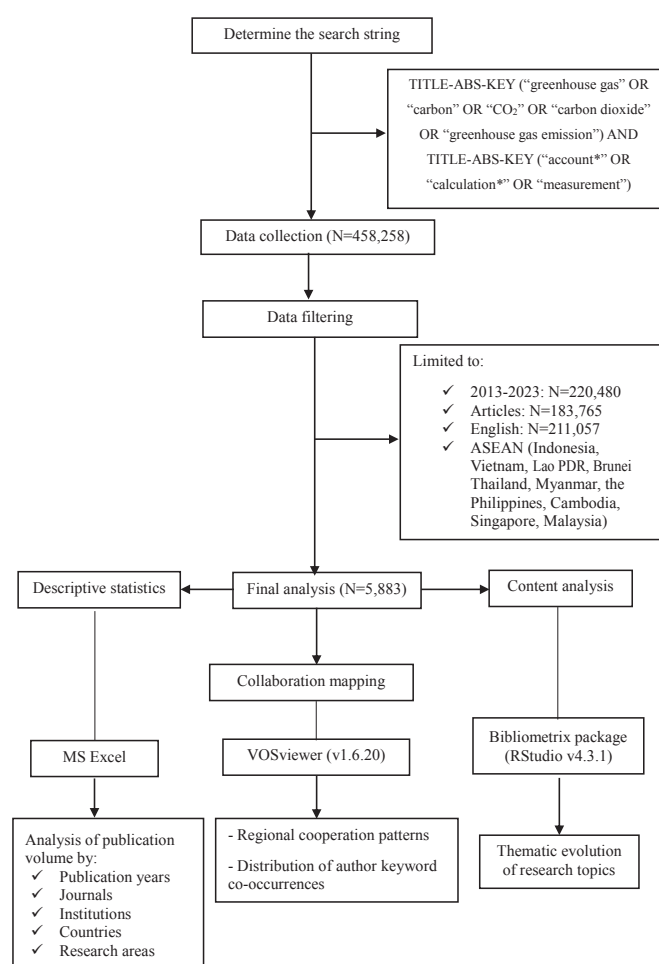


Fig. 1. Flow diagram of bibliometric analysis. Source: Authors' research results.

3. Results

3.1. Analysis of publication output

Figure 2 illustrates the variation in the number of publications over the 10-year period. A total of 5,883 publications were included in the final analysis, with the majority appearing in the past five years. The number of publications increased steadily, from 279 articles in 2013 to 840 articles in 2023 - almost tripling the initial level. The most substantial increase occurred between 2013 and 2019.

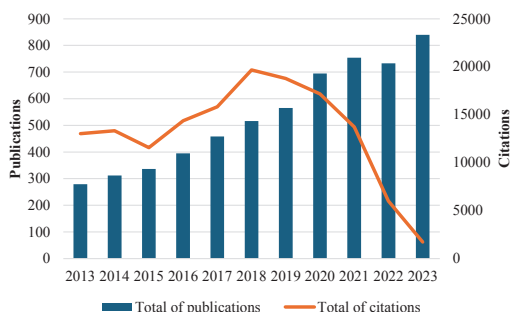


Fig. 2. Number of publications and citations from 2013 to 2023. Source: Authors' research results.

As shown in Fig. 2, total citations of carbon accounting-related articles also followed a strong upward trend from 2013 to 2021, before declining in 2022 and 2023. Annual citations stood at 13,025 in 2013, peaked at 19,663 in 2018, and then decreased slightly to 13,720 in 2021.

3.2. Analysis of journals

Figures 3 and 4 present the journals with the highest numbers of publications and citations, respectively. As shown in Fig. 3, the top three journals publishing the most articles related to carbon accounting in ASEAN are Chemical Engineering Transactions, RSC Advances, and Applied Surface Science, each with an average of 50 publications. By contrast, Fig. 4 highlights the journals with the highest citation counts in this field, including Nature Communications, Advanced Functional Materials, and Angewandte Chemie - International Edition, each with at least 3,000 citations. These results indicate clear differences between the journals with the greatest number of publications and those with the greatest citation impact.

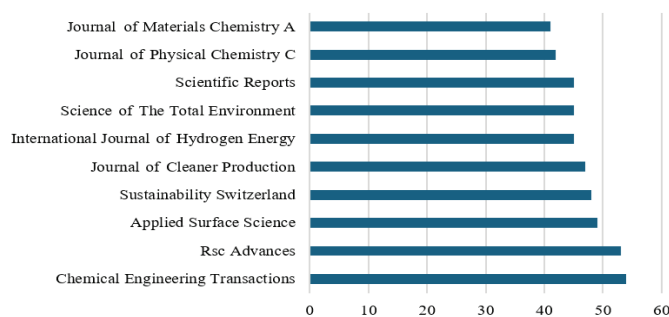


Fig. 3. Top 10 journals with the highest publications. Source: Authors' research results.

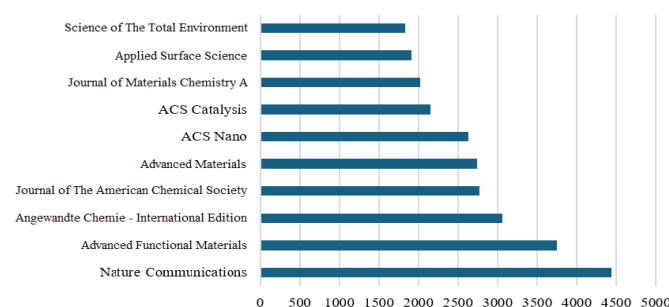


Fig. 4. Top 10 journals with the highest citations. Source: Authors' research results.

3.3. Analysis of institutions

Figure 5 presents the top 10 institutions with the highest number of publications across ASEAN countries. Malaysia holds the leading position in terms of the number of organisations contributing a large volume of research, with five of the top 10 institutions located there, including the University of Malaya, which ranked third. It is also noteworthy that four of the 10 most active educational institutions in carbon accounting research are based in Singapore. The National University of Singapore was the highest-ranking university overall, with 635 publications during the 10-year period, followed by Nanyang Technological University, also in Singapore. In addition to Malaysian and Singaporean institutions, several Indonesian organisations appeared in the top 10, alongside one Thai institution: Chulalongkorn University, which recorded 167 publications.

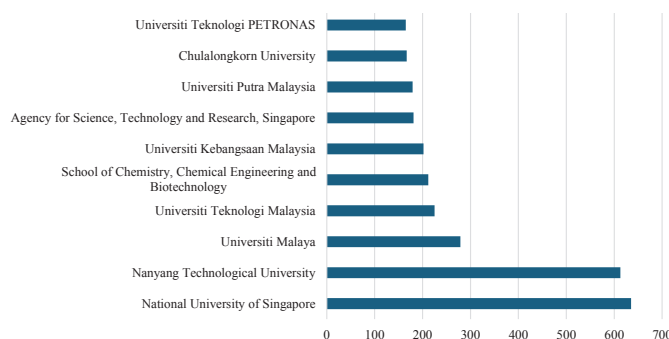


Fig. 5. Top 10 institutions with the highest publications. Source: Authors' research results.

3.4. Analysis of countries

Figure 6 compares the number of publications and citations across ASEAN countries in descending order. Malaysia holds the leading position in terms of publication output, with more than 1,600 articles published between 2013 and 2023. However, Singapore records the highest number of citations, almost doubling Malaysia's figure. Following these two are Thailand, Indonesia, Vietnam, and the Philippines, which rank among the most active ASEAN countries in carbon accounting research output. In terms of citations, the middle-ranking countries are Thailand, Vietnam, Indonesia, and the Philippines. By contrast, the remaining four countries - Brunei Darussalam, Cambodia, Lao PDR, and Myanmar - have produced the smallest volume of carbon accounting-related research and have also received the fewest citations.

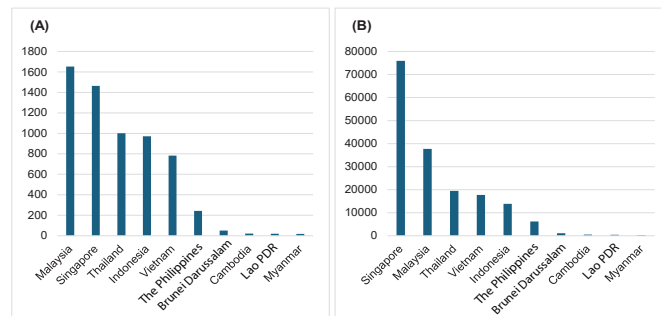


Fig. 6. Number of publications (A) and citations (B) by country. Source: Authors' research results.

3.5. Analysis of research areas

Figure 7 presents the 10 most prominent research areas in the field of carbon accounting. The most common topics fall within the natural sciences, with Chemistry (14%), Materials Science (13%), Engineering (12%), Environmental Science (10%), and Chemical Engineering (9%) accounting for the largest shares.

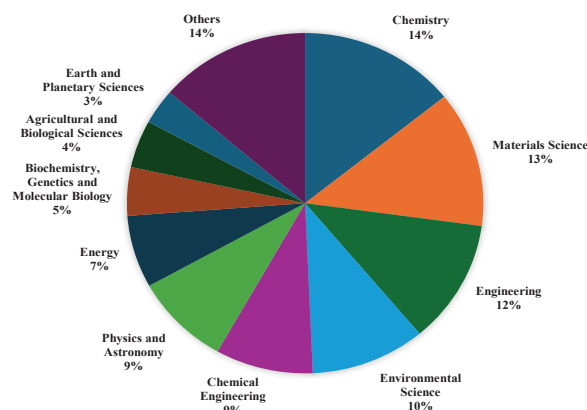


Fig. 6. Number of publications (A) and citations (B) by country. Source: Authors' research results.

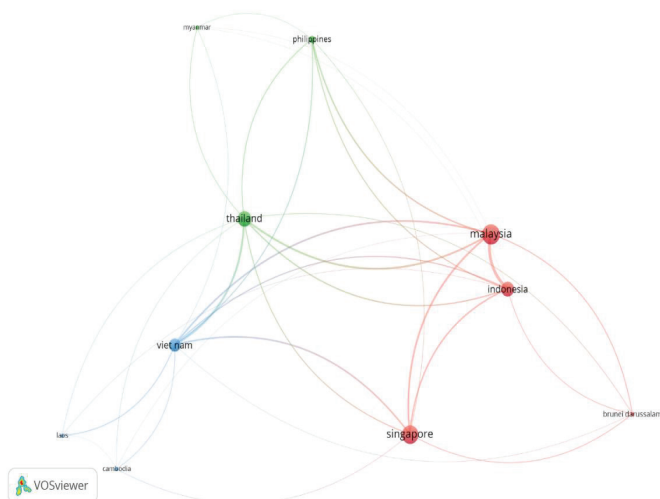


Fig. 7. Share of publications (%) by research areas. Source: Authors' research results.

3.6. Analysis of country collaboration

To aid interpretation of the VOSviewer graphs, a circle represents a particular term being analysed, such as an author, institution, country, or keyword. Based on the data networking algorithm, terms are distributed into colour-coded clusters. The larger the circle is, the more frequently the term appears in the dataset; the closer the circles are to one another, the stronger their connections are. The thickness of each line indicates the strength of the relationship between terms.

Figure 8 depicts the collaborative networks of ASEAN countries in carbon accounting research from 2013 to 2023. Three major clusters are identified: a red cluster (Malaysia, Indonesia, Singapore, and Brunei Darussalam), a green cluster

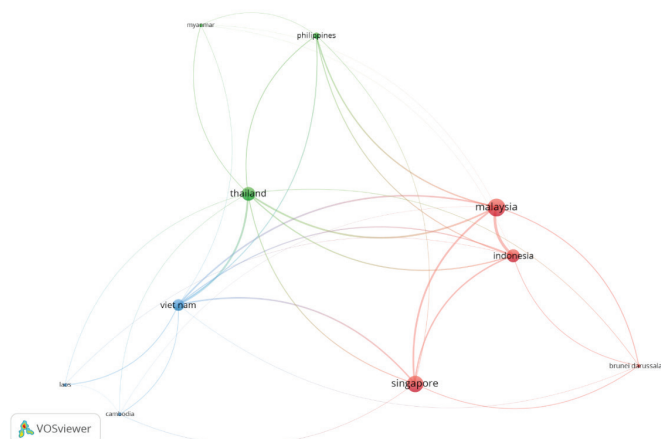


Fig. 8. Network visualisation of cooperation among ASEAN countries. Source: Authors' research results.

(Thailand, the Philippines, and Myanmar), and a blue cluster (Vietnam, Lao PDR, and Cambodia). These clusters were formed according to the link strengths of collaboration among countries. Notably, the representatives of each cluster are Singapore, Thailand, and Vietnam. Malaysia and Singapore emerged as the most productive countries in carbon accounting research and also received the highest citation counts over the 10-year period. Prominent collaboration networks include Malaysia-Singapore and Malaysia-Indonesia.

3.7. Analysis of keyword co-occurrences

Figure 9 illustrates the keyword co-occurrence clusters from carbon accounting research in ASEAN countries over the 10-year period. Using VOSviewer's word-mapping algorithm to analyse keywords in the titles and abstracts of each publication, only those appearing at least 30 times were included in the analysis. Of the 129,122 keywords identified, 896 met this threshold, resulting in the formation of three major clusters (red, green, and blue).

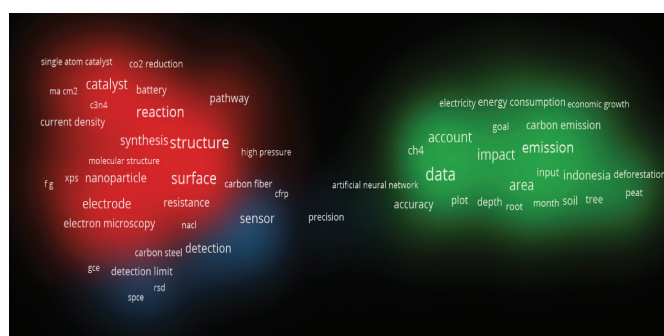


Fig. 9. Cluster density of keyword co-occurrences in ASEAN's carbon accounting research. Source: Authors' research results.

Visualised as the most common research keywords, Cluster 1 (red) reflects natural science developments in the field, particularly chemical engineering and materials science advancements focused on developing optimal materials

for carbon mitigation and energy conservation. Cluster 2 (green), the second largest cluster, comprises social science-related keywords such as “data”, “impact”, “emission”, and “deforestation”. This cluster centres on carbon emission assessments linked to consumption and economic growth, along with their corresponding regional impacts. Cluster 3 (blue) involves keywords related to viable techniques for carbon detection, such as “detection” and “sensor”.

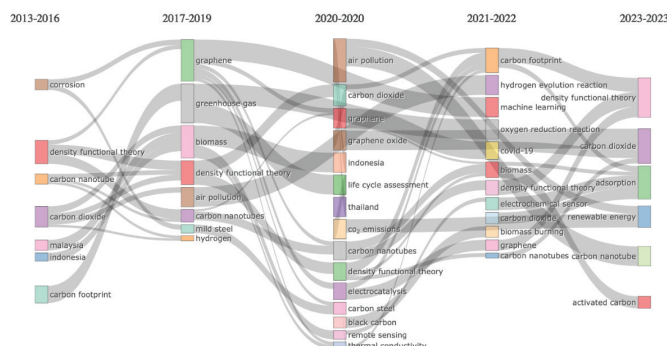


Fig. 10. Thematic evolution of ASEAN's carbon accounting research.
Source: Authors' research results.

Figure 10 depicts the thematic evolution of carbon accounting research papers within the ASEAN region. The diagram was generated using the Biblioshiny package in RStudio. To clearly present trends, the 10-year review period was divided into five sub-periods: 2013-2016, 2017-2019, 2020, 2021-2022, and 2023. Each column in the figure is segmented into widely researched topics, with the size of each segment corresponding to the prevalence of that theme. Certain topics remained consistently prevalent throughout the review period, including “density functional theory”, “graphene”, “carbon nanotube”, “biomass”, and “carbon footprint”. These align with transformative advancements in materials science, environmental science, and related fields aimed at sustainability engineering [27]. Density functional theory - a widely used method by physicists and chemists to study the structure of matter systems (e.g., atoms, molecules, solids) - has become a cornerstone across multiple scientific disciplines, ranging from energy storage and harvesting to molecular engineering and environmental protection [28]. This approach has been extensively applied to carbon-based nanomaterials, yielding results with both high accuracy and reproducibility.

4. Discussion

This section discusses the main findings of the study in relation to the four research questions (RQs):

1. What is the current status of ASEAN's carbon accounting research from (such as growth rate, journal contributions)?
2. What is the role of country interconnection in influencing ASEAN's carbon accounting research?
3. What are the common topics and emerging themes in the field?

4. What are the future implications in ASEAN's carbon accounting research?

To answer RQ1, the current status of carbon accounting research in ASEAN can be described as progressive. In terms of growth, although there was a slight decline of approximately 3% in 2021-2022, publication output recovered substantially in 2023, increasing by 15% to reach a peak of 840 articles. This trend aligns with Y. Du, et al. (2024) [19], who identified 2010-2017 as the preliminary development stage of carbon emission accounting publications, followed by 2018-2022 as a period of rapid development characterised by significant progress in the field. Citation analysis revealed that the most impactful articles were published between 2017 and 2020, which recorded the highest citation counts. Although citations have shown a slight downward trend since 2022, the steady rise in publication numbers underscores sustained scholarly interest in carbon accounting.

Regarding journal analysis, we found that among the top 10 journals with the largest volumes of publications, three - Applied Surface Science, Science of the Total Environment, and Journal of Materials Chemistry A - were also among the most frequently cited. One probable reason for their higher publication and citation counts is their broad interdisciplinary scope, which attracts submissions from multiple fields and appeals to a diverse readership. For example, Applied Surface Science and Journal of Materials Chemistry A publish across wide-ranging areas of materials science, physics, and chemistry, while Science of the Total Environment covers topics including sustainability, environmental science, ecology, pollution, and policy. Another reason is that these journals publish a high volume of articles annually and frequently feature trending topics beyond carbon accounting - such as carbon capture, nanomaterials, and renewable energy - that typically attract more citations and contribute to strong citation networks.

To answer RQ2, the analysis of university and country performance indicates strong contributions and collaborations in the field of carbon accounting across the region. Singapore, Malaysia, and Thailand, together with their leading universities, take the lead in terms of both research output and influence. This is consistent with the findings of N.M. Aris, et al. (2024) [29], which highlight these countries' strong performance in carbon management research. Their higher publication counts reflect a greater emphasis on research and development in this area. Specifically, Singapore became the first ASEAN member to introduce a carbon tax in 2019 [30]; Malaysia has made substantial investments in sustainability, renewable energy, and climate mitigation research through policies such as the Green Technology Master Plan and the Malaysia Green Transition [31]; and Thailand established the Thailand Greenhouse Gas Management Organization in 2008 to support GHG-related research and initiatives [32]. These policy frameworks and funding commitments have created fertile ground for research capacity and resources, enabling universities in these countries

to foster productive and impactful research environments that advance carbon accounting studies. In addition, strong collaboration networks - such as those between Singapore and Malaysia, and between Vietnam, Lao PDR, and Cambodia - can be partly attributed to geographical proximity, which facilitates joint research activities and regional knowledge exchange.

In response to RQ3, common topics in ASEAN carbon accounting are primarily situated within the natural sciences, particularly materials development, energy sources, and agricultural sciences. The emphasis on biochemistry and materials science reflects industrial priorities to design environmentally sustainable production systems. Carbon emissions arise mainly from two sources: energy demand and embedded carbon in materials across their life cycle, from production to disposal [33]. Alongside measuring direct emissions of carbon dioxide and other greenhouse gases from energy production and consumption, it is equally important to estimate the indirect emissions embedded in materials used for industrial activities. Identifying carbon values in different materials and resources enables evaluation of the total carbon output of production processes and supports carbon footprint management at the organisational level. Consequently, materials and chemicals with a low carbon footprint that are easily reused or recycled are increasingly preferred by industries seeking environmental sustainability. These innovations in energy use and materials development play a pivotal role in reducing overall carbon emissions and advancing sustainable industrial practices [19].

Our findings are consistent with previous studies showing that natural sciences dominate the carbon accounting research landscape compared with other fields [3, 18, 19]. Carbon accounting is a complex, multidimensional concept that varies according to disciplinary perspective [17, 34]. Broadly, it can be divided into two themes: non-financial and financial aspects, corresponding to the physical and social sciences, respectively [3]. Within the natural sciences, most research emphasises advancing carbon quantification in materials used during production and distribution processes, improving energy efficiency, developing renewable energy technologies, designing carbon capture materials, and addressing waste management and air emissions. By contrast, social science research places greater focus on financial reporting of environmental expenditures, strategic planning, evaluation of emission responsibility, corporate social responsibility, and life cycle costing [3]. Y. Zheng, et al. (2022) [18] further note that natural science research in carbon accounting is primarily concerned with improving the accuracy of carbon measurement, whereas social science research concentrates on developing equitable accounting standards.

Furthermore, our findings highlight research gaps in areas such as “carbon data”, “data accuracy”, “energy consumption”, and “economic growth”. Keywords in Cluster 2 (the smaller green cluster) reflect a growing need to improve the reliability and availability of data for carbon accounting. Mitigating carbon

footprints requires effective resource management strategies for complex supply chains that extend across national borders. However, the absence of standardised measurements for carbon input-output, together with the lack of practical frameworks for carbon tracing systems throughout product life cycles, continues to hinder companies from producing comprehensive reports on carbon emissions within global trade flows [20]. Accordingly, ASEAN-based research is encouraged to refine existing carbon accounting tools to enhance the quality of emissions data and generate empirical results on carbon accounting practices. Beyond addressing data transparency and accuracy issues, ASEAN countries should also promote research related to the carbon footprint associated with energy consumption and deforestation.

Changes in research trends over time, emerging themes include “machine learning”, “remote sensing”, and “life cycle assessment”. During the 2013-2016 period, research predominantly focused on topics such as “corrosion”, “density functional theory”, “carbon nanotube”, and “carbon dioxide”, with a significant number of studies originating from Malaysia and Indonesia. Between 2017 and 2019, attention gradually shifted towards material developments, including “graphene”, “hydrogen”, “mild steel”, and “biomass”, which hold promise for energy and environmental applications. In 2020, new terms gained prominence, such as “life cycle assessment”, “electrocatalysis”, “remote sensing”, and “thermal conductivity”. This reflects a growing focus on carbon sequestration technologies alongside greenhouse gas reduction strategies. Remote sensing has become increasingly popular as a reliable and cost-effective method for estimating carbon sequestration in biomass and calculating carbon stocks in land and forestry ecosystems - such as mangroves, seagrass meadows, and tidal marshes - using data gathered from satellites, aircraft, or vessels [35]. Similarly, thermal conductivity has attracted interest as a foundational concept for incorporating earth materials into sustainable building processes [36]. The emergence of life cycle assessment highlights the need for a more comprehensive evaluation of carbon emissions throughout supply chains [20]. In summary, while natural science themes - particularly material development, energy innovation, and environmental science - dominated ASEAN carbon accounting research over the past decade, recent years (2021-2023) have witnessed a notable upsurge in machine learning applications. With rapid advances in artificial intelligence, machine learning now offers a state-of-the-art framework for evaluating carbon footprints [37]. These models address practical business challenges by aggregating and analysing complex emissions data, thereby helping to navigate the intricate landscape of carbon quantification in product logistics from suppliers to consumers.

In response to RQ4, this bibliometric analysis offers practical research and policy implications for ASEAN's carbon accounting. Regarding research implications, while carbon accounting research in ASEAN has been heavily concentrated

on biochemistry and materials sciences, relatively limited attention to social science perspectives creates a significant knowledge gap. First, expanding research in areas such as data standardisation, forest conservation, and the socio-economic drivers of carbon emissions is essential to capture the multifaceted nature of carbon accounting in the ASEAN context. Second, the emergence of themes such as remote sensing, life cycle assessment, and machine learning presents valuable opportunities for integrating advanced technologies with region-specific environmental and economic conditions. Harnessing these methods could improve data transparency and enable more accurate emissions assessments across ASEAN supply chains. Third, future research should provide in-depth systematic reviews of these emerging themes to thoroughly map the research landscape and identify specific approaches to carbon accounting practices.

Regarding policy implications, the findings highlight the need to balance technological innovation with governance strategies that are tailored to regional conditions. Recent ASEAN-based studies have increasingly emphasised remote sensing, life cycle assessment, and machine learning. These advancements offer improved methods for monitoring ecosystem carbon stocks and managing emissions throughout product life cycles. Machine learning algorithms, in particular, have been shown to be highly effective in developing remote sensing models, which remain one of the most feasible approaches for calculating carbon values in forest biomass and tracking forest degradation [38, 39]. Accordingly, investments should prioritise the development of simplified, standardised tools for managing complex carbon data, thereby enabling consistent measurement and reporting across ASEAN member states. Moreover, fostering cross-border collaborations in applying AI and machine learning for environmental monitoring could strengthen the region's collective capacity to track emissions, prevent deforestation, and manage carbon values in manufacturing and supply chains. Such coordinated efforts would not only improve data accuracy and comparability but also reinforce ASEAN's position in global climate governance and sustainable economic development.

Our findings should be interpreted with certain limitations. First, this study relied exclusively on literature indexed in Scopus, which may limit generalisability due to the potential exclusion of relevant studies from other bibliometric databases. Nonetheless, Scopus is widely recognised as one of the largest curated research databases globally, offering rigorous content evaluation and advanced profiling across a broad range of scientific disciplines and journals [40]. This ensures a high level of representativeness for the present review. Second, although our analysis identified emerging research keywords, further studies are needed to investigate latent research topics in greater detail and to provide deeper qualitative insights into each theme, for example, through systematic reviews. Such investigations would help to identify specific areas of carbon accounting that warrant closer scholarly attention in the future.

5. Conclusions

This bibliometric study highlights a substantial increase in carbon accounting research across the 10 ASEAN countries between 2013 and 2023. The steady rise in publications reflects the region's growing commitment to addressing climate change and reducing carbon emissions. Singapore and Malaysia emerged as the leading contributors in terms of both research productivity and collaboration. To mitigate the carbon footprint associated with global trade flows, stronger cross-border collaboration among ASEAN countries is essential. Such cooperation can foster the exchange of knowledge, resources, and best practices, thereby advancing sustainable development in the region. Our findings also show that existing literature on carbon accounting has primarily emphasised sustainable materials, energy storage innovations, and carbon sequestration technologies. Looking ahead, future research and policy efforts should place greater emphasis on the social science dimensions of carbon accounting, including improving data accuracy, implementing effective deforestation countermeasures, and enhancing the integration of artificial intelligence and machine learning into carbon management across manufacturing and supply chain systems.

CRediT author statement

Nguyen Thi Xuan Trang: Conceptualisation, Data Collection, Data analysis, Writing; Trinh Xuan Thi Nguyen: Conceptualisation, Methodology, Data analysis, Writing, Validation.

COMPETING INTERESTS

The authors declare that there is no conflict of interest regarding the publication of this article.

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Digital transformation indicators and GRDP in the former Hau Giang Province, Vietnam: An exploratory analysis for 2015-2023

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Received 9 April 2025; revised 9 October 2025; accepted 9 December 2025

Abstract:

In the context of the Fourth Industrial Revolution, digital transformation has become a crucial driver of economic growth. In Vietnam, this process has made a positive contribution to economic development, particularly in the information and communication technology (ICT) sector. In Hau Giang Province (before the administrative merger) in 2025, digital transformation has yielded promising results; however, its specific impact on economic growth has not been comprehensively assessed. This study examined the relationship between digital transformation and economic growth in Hau Giang during the period 2015-2023. Data from the Hau Giang Statistical Yearbook and reports from the Department of Information and Communications were used to estimate an Ordinary Least Squares (OLS) regression model using STATA software. The results indicate that digital transformation positively impacts Gross Regional Domestic Product (GRDP). Specifically, information technology infrastructure (HTCN) and investment capital (K) have significant effects, whereas information technology human resources infrastructure (HTNL) has not demonstrated a clear impact, indicating the need for greater investment in workforce training. Based on the research findings, the paper proposes several solutions, including investment in IT infrastructure development, encouraging businesses to adopt digital technologies, enhancing workforce training, and providing incentives for digital transformation projects. These solutions will enable Hau Giang to effectively leverage digital transformation, foster sustainable economic growth, and establish a modern digital economy.

Keywords: digital transformation, economic growth, Hau Giang Province, Ordinary Least Squares.

Classification numbers: 2.1, 2.3, 7

1. Introduction

The Fourth Industrial Revolution has ushered in a new era of economic development, driven by the rapid advancement of digital technologies such as artificial intelligence (AI), the Internet of Things (IoT), cloud computing, and big data analytics. These innovations are reshaping the foundations of governance, business operations, and social interactions on a global scale. Digital transformation, in this context, is not merely a technological shift but a systemic restructuring of production, management, and service delivery models [1].

Numerous empirical studies confirm that digital transformation plays a critical role in enhancing productivity, fostering innovation, and accelerating growth. The World Bank [2] highlights digital technologies as a key driver of development, particularly in lower-middle-income countries. In Asia, digital economy activities were projected to contribute up to 60% of regional

GDP by 2021 [3]. More recent projections suggest that effective digitalisation strategies can raise GDP growth by 1.5-2.5% in emerging economies [4]. These findings reinforce the view that digital transformation is not optional but a strategic imperative for long-term economic competitiveness.

In Vietnam, digital transformation has been officially recognised as a national priority through Resolution No. 52-NQ/TW and the National Digital Transformation Programme to 2025, with a vision to 2030. Provinces are encouraged to develop and implement localised digital agendas aligned with national goals [5]. Among them, Hau Giang Province, located in the Mekong Delta, stands out for its early and comprehensive digital adoption. Unlike other rural provinces, Hau Giang has systematically promoted digital governance, the digital economy, and a digital society since 2020, following Resolution No. 02-NQ/TU of the Provincial Party Committee [6].

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Between 2021 and 2023, the province invested more than 338 billion VND in digital transformation, prioritising the development of ICT infrastructure, cloud-based administrative systems, and AI-assisted platforms in public services [7]. In addition, 525 digital community groups with over 3,700 grassroots members have been formed to raise awareness and enhance digital skills [6]. Hau Giang ranked second in the Mekong Delta and 17th nationwide in the 2021 and 2022 Digital Transformation Index (DTI), and was among the top ten provinces in digital infrastructure readiness in 2023 [8]. These achievements position Hau Giang as a regional leader in digital transformation despite its rural context.

Yet, despite these developments, no empirical study to date has systematically quantified the economic impact of digital transformation at the provincial level in Hau Giang. The lack of evidence limits the ability of local authorities to optimise strategies and allocate resources effectively. Additionally, while many studies have examined digitalisation at the national or cross-country level [1, 4], there remains a gap in understanding how such transformation unfolds in smaller, less developed provinces - particularly within the Vietnamese context.

This study offers three key innovations. First, it fills a significant empirical gap by examining the economic impact of digital transformation at the provincial level, specifically in Hau Giang - a rural province in the Mekong Delta that has achieved notable progress in digital development. Second, the study extends the traditional Cobb-Douglas production function by incorporating digital transformation indices as explanatory variables alongside capital and labour, providing a more comprehensive analytical framework. Third, the analysis draws on localised data from 2015 to 2023, contributing valuable insights for policy formulation in contexts where digital infrastructure and human capital remain unevenly distributed. These contributions enhance both the theoretical and practical understanding of digital transformation in Vietnam's subnational settings.

Therefore, this study aims to empirically assess the impact of digital transformation on economic growth in Hau Giang Province between 2015 and 2023. To achieve this, the study applies an extended Cobb-Douglas production function and estimates the model using the OLS method. Digital transformation is operationalised through three main dimensions: digital infrastructure, digital human resources, and digital application. The ultimate goal is to generate evidence-based policy recommendations to support Hau Giang's aspiration of becoming a smart, inclusive, and sustainable province in the digital age.

2. Theoretical framework

2.1. Literature review

2.1.1. Digital transformation

Digital transformation (DT) has become a central concept in scholarly debates on economic modernisation, institutional restructuring, and innovation-led development. As Gregory Vial (2019) argues, DT can be defined as “a process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies” [9]. This definition emphasises DT as a strategic and systemic transformation, extending beyond the technical deployment of digital tools. It involves profound and multidimensional changes in organisational structure, value creation logic, business models, and institutional arrangements.

The literature highlights the persistent terminological conflation between digitisation, digitalisation, and digital transformation, which has hindered conceptual precision in prior studies [9]. Digitisation refers to the technical process of converting analogue information into digital form to enhance data storage, access, and processing capacities. Digitalisation involves integrating digital technologies into existing organisational processes to improve operational efficiency, automate workflows, and reduce transaction costs, while leaving the organisational structure largely unchanged. Digital transformation, by contrast, entails a strategic reconfiguration of systems, including value chain restructuring, redefinition of customer interfaces, organisational culture shifts, and the adoption of entirely new business models (Table 1).

Table 1. Conceptual clarification: Digitisation, digitalisation, and digital transformation.

Concept	Core focus	Objective	Scope of impact	Example
Digitisation	Data conversion	Enhancing data storage and access	Technical, operational	Scanning paper documents into digital files
Digitalisation	Process automation	Improving operational efficiency	Organisational processes	Automating accounting or sales workflows
Digital Transformation	Strategic restructuring	Innovation and value creation	Organisational, sectoral, societal	Transitioning from traditional retail to platform-based business

Source: Adapted from G. Vial (2019) [9].

This conceptual distinction is not merely semantic. It delineates incremental technological upgrading from transformational, system-wide change, with DT typically characterised by disruptive technologies such as SMACIT (Social, Mobile, Analytics, Cloud, and IoT). These technologies reshape industries, redefine competitive boundaries, and alter institutional configurations.

2.1.2. *Economic growth*

Economic growth remains a fundamental goal in development economics and policy. Classical growth theory identifies labour, capital, and technological progress as key drivers [10, 11]. In the neoclassical model, technological change is treated as exogenous, whereas Romer's endogenous growth theory conceptualises innovation as an outcome of intentional investment in knowledge and human capital [12].

The Cobb-Douglas production function provides a widely accepted empirical framework to model the relationship between inputs (e.g., labour, capital, and technology) and output. Contemporary extensions of this model incorporate ICT infrastructure and digital capacity as production inputs to capture the role of DT in enhancing productivity [13, 14]. These models help explain regional growth differentials based on digital readiness.

In Vietnam, Gross Regional Domestic Product (GRDP) serves as the standard measure of provincial economic performance. GRDP reflects the total value of goods and services produced within a locality, offering a comprehensive indicator for subnational economic analysis. Incorporating lagged GRDP as an explanatory variable in time-series models helps account for inertia and path dependency in regional growth [15].

2.2. *Related studies*

2.2.1. *International evidence*

A substantial body of international research has established that DT is closely associated with economic growth, innovation, and productivity improvements. At the national level, cross-country panel analyses demonstrate that investments in ICT infrastructure significantly contribute to GDP growth and productivity gains in both advanced and developing economies [16-18]. These studies emphasise the role of digital infrastructure as a core production input that complements labour and capital, thereby enhancing total factor productivity (TFP).

At the firm level, DT fosters innovation and efficiency through multiple mechanisms, including automation, data-driven decision-making, and resource optimisation. Z. Lei, et al. (2023) [19] provide empirical evidence from Chinese firms showing that digitalisation leads to significant improvements in TFP by reducing transaction

costs and strengthening technological capabilities. At the sectoral and regional levels, DT acts as a catalyst for foreign direct investment inflows, structural transformation, and deeper economic integration, particularly in emerging economies [20, 21].

Moreover, DT is increasingly recognised as a leapfrogging mechanism that enables latecomer economies to bypass traditional industrialisation paths, accelerating their transition towards knowledge- and innovation-based growth models. A.P. Sharma, et al. (2023) [13] demonstrate that digital infrastructure enhances disaster resilience and institutional responsiveness in India, while H. Guo, et al. (2020) [14] show that digital readiness contributes to improved environmental and economic performance in Chinese provinces. These findings underscore the multidimensional impacts of DT beyond conventional economic indicators.

2.2.2. *National and subnational evidence*

In Vietnam, the relationship between DT and economic growth has recently gained scholarly attention, particularly in the context of regional disparities. H.Q. Vu, et al. (2025) [22] provide robust empirical evidence showing that ICT development significantly enhances provincial GDP growth by increasing the productivity of both capital and labour and amplifying the effects of foreign direct investment (FDI) and governance efficiency. Their findings highlight the strategic role of DT in fostering regional competitiveness and accelerating economic development in Vietnam.

At the subnational level, H.T.T. Ngan, et al. (2021) [23] conducted an empirical study on eight provinces in Vietnam's Southern Key Economic Region using the Difference GMM (DGMM) method. Their findings show that a 1% increase in the ICT readiness index leads to a 0.84% increase in provincial GRDP. The ICT infrastructure and application components have significant positive effects on economic growth, while human resource infrastructure has no statistically significant impact, indicating a digital skills gap at the local level. These findings highlight both the potential and the structural challenges of subnational digital transformation in Vietnam.

In empirical applications, DT in Vietnam is often operationalised through composite indices encompassing three key dimensions: (i) HTCIN, representing the availability and accessibility of ICT infrastructure; (ii) HTNL, measuring digital literacy and workforce readiness; and (iii) UDCN, capturing the adoption of digital technologies across public and private sectors (Ministry of Information and Communications of Vietnam, 2023) [24]. These dimensions align with international digital readiness frameworks and provide a useful basis for subnational economic analysis.

Table 2. Selected empirical studies on digital transformation and economic growth.

No.	Author(s) and year	Country/Region	Methodology	Key variables	Main findings
1.	T. Niebel (2018) [16]	59 countries	Panel econometrics (OLS, RE, FE, IV)	ICT capital, non-ICT capital, labour, GDP	ICT capital positively impacts GDP growth (elasticity≈0.09); effect similar across country groups; leapfrogging not confirmed.
2.	G. Vial (2019) [9]	Global	Systematic literature review	8 DT building blocks (disruption, strategy, value creation, structure, culture, barriers, outcomes, ethics)	SMACIT technologies drive disruption; digital strategy and organisational transformation are central; emphasises ethical and social dimensions.
3.	B.G. Choy (2020) [25]	Russia	Bayesian multilevel GLMM + MCMC	Digital transformation index, labour productivity, GDP	DT positively affects GDP in both fixed and random effects; productivity effect stronger in random effect; short-run price increase observed.
4.	H.T.T. Ngan, et al. (2021) [23]	Vietnam (8 provinces)	DGMM (Arellano & Bond)	ICT Readiness Index, Digital Infrastructure (HTCN), Digital Human Resources (HTNL), Digital Application (UDCN), GRDP	1% increase in ICT readiness → GRDP ↑ 0.84%; infrastructure and application have significant positive effects; human resources not significant.
5.	M. Olczyk, et al. (2022) [18]	EU-28	Panel FE	Digital Economy and Society Index (DESI), GDP per capita, TFP	DESI has a positive and significant impact on GDP per capita; strongest in lower-income countries; connectivity and digital integration are key drivers.
6.	M.B. Tudose, et al. (2023) [26]	46 high-income countries	OLS panel regression	Network Readiness Index (NRI), Future Technologies (FTH), Business (BUS), Economic Impact (ECN), GDP per capita	NRI significantly increases GDP per capita; FTH and BUS positive; ECN negative; stronger effects pre-pandemic.
7.	A. Wardhono, et al. (2023) [27]	Indonesia	PVAR, IRF, VD	Internet usage, investment, credit, inflation, GRDP	Internet contributes ~25% to GRDP variation; investment short-run negative but long-run positive; credit positive, inflation negative.
8.	Z. Lei, et al. (2023) [19]	China	Panel regression, 2SLS	Digital transformation index, total factor productivity (TFP), R&D expenditure, human capital	Digital transformation increases TFP through technological innovation, cost reduction, and human capital improvement; stronger effect in private and competitive sectors.
9.	X. Zheng, et al. (2023) [28]	China (Yangtze River Delta, 25 cities)	Feder Two-Sector Model, Mediation Analysis	Digital transformation in manufacturing (DOM), Advanced Industrial Structure (AL), Rationalised Industrial Structure (RI), Industrial Integration (II), Industrial Chain Length (Length), Human Capital Stock (HCS), Government Size (CS), Total Fixed Assets (TFA), Enterprise Size (ES)	DOM drives economic growth through four mediating mechanisms: industrial upgrading, rationalisation, integration, and value chain extension; AL and Length strongest mediators.
10.	H. Jangid, et al. (2024) [29]	G20	Panel ARDL	Secure Internet servers, commercial bank branches, gross fixed capital formation (GFCF), population, GDP	Digitalisation has a significant long-run positive but short-run negative impact on GDP; capital and population have positive long-run effects.
11.	Q. Zhang, et al. (2024) [30]	China (286 cities)	Fixed-effects, Spatial Durbin Model (SDM), 2SLS	Digital Industrialisation (supply of digital technologies, products, infrastructure), Industrial Digitisation (digital upgrade of traditional sectors), Economic Growth Efficiency	Both digitalisation factors positively affect growth efficiency; strong spatial spillovers; policy should reduce regional digital gaps.
12.	W.J. Jiang, et al. (2024) [31]	China (listed firms)	Firm-level panel regression	Digital transformation index, resource allocation efficiency, productivity	Digital transformation significantly improves corporate resource allocation efficiency and productivity at the firm level.

Source: Authors' synthesis. OLS = Ordinary Least Squares; RE = Random Effects; FE = Fixed Effects; IV = Instrumental Variables; ARDL = Autoregressive Distributed Lag; PMG = Pooled Mean Group; DFE = Dynamic Fixed Effects; DGMM = Difference Generalized Method of Moments (Arellano & Bond); GLMM = Generalized Linear Mixed Model; MCMC = Markov Chain Monte Carlo; PVAR = Panel Vector Autoregression; IRF = Impulse Response Function; VD = Variance Decomposition; 2SLS = Two-Stage Least Squares; SDM = Spatial Durbin Model; DESI = Digital Economy and Society Index; NRI = Network Readiness Index; ICT = Information and Communication Technology; DT = Digital Transformation; SMACIT = Social, Mobile, Analytics, Cloud, Internet of Things; GRDP = Gross Regional Domestic Product; TFP = Total Factor Productivity; GFCF = Gross Fixed Capital Formation; HTCN = Digital Infrastructure Index; HTNL = Digital Human Resources Index; UDCN = Digital Application Index; DOM = Digital transformation in Manufacturing; AL = Advanced Industrial Structure; RI = Rationalised Industrial Structure; II = Industrial Integration; HCS = Human Capital Stock; CS = Government Size; TFA = Total Fixed Assets; ES = Enterprise Size.

2.2.3. Research synthesis

To systematically synthesise empirical evidence on the relationship between DT and economic growth across different levels of analysis, this section reviews and classifies key studies according to country context, methodology, variables, and main findings. The inclusion criteria are: (i) peer-reviewed journal articles from reputable academic sources; (ii) clear operationalisation

of digitalisation or digital transformation (e.g., ICT capital, DESI, firm-level digital indices, internet usage); and (iii) quantitative analysis linking DT to economic outcomes such as GDP growth, productivity, and structural transformation. This structured synthesis enables meaningful cross-country, cross-sector, and subnational comparisons, thereby identifying empirical gaps. Table 2 presents the key studies that inform this research.

2.2.4. Research gap and contribution

As Table 2 illustrates, across global and regional studies, digital transformation consistently shows a positive and statistically significant impact on economic growth, though the magnitude and transmission mechanisms differ depending on national income levels, institutional capacity, and digital readiness.

- National and global studies [16, 18, 26] underline the macroeconomic significance of digital infrastructure.
- Firm- and sector-level analyses [19, 31] reveal mechanisms through innovation, cost reduction, and resource allocation.
- Subnational evidence from developing contexts [23, 27] highlights infrastructure and digital literacy gaps as critical bottlenecks.
- Recent Chinese studies [28, 30] emphasise structural transformation and spatial spillovers as essential pathways through which digitalisation enhances growth efficiency.
- Finally, G. Vial (2019) [9] provides a conceptual foundation for understanding DT beyond technology - as a strategic, structural, and institutional shift.

This synthesis shows that while evidence is robust at the global and national levels, empirical research remains limited at subnational scales, especially in rural and latecomer regions - which is precisely where this study on Hau Giang Province aims to contribute.

To address this gap, the present study investigates the relationship between HTCEN, HTNL, and UDCN, and subnational economic growth - measured by GRDP - in Hau Giang Province from 2015 to 2023. By integrating these DT dimensions into an extended Cobb-Douglas production framework, the study contributes localised empirical evidence from a rural province, offering both theoretical insights and policy implications for inclusive digital transformation strategies.

The theoretical framework of the study is illustrated in Fig. 1, which depicts the relationships among HTCEN, HTNL, UDCN, and GRDP within an extended Cobb-Douglas production function framework.

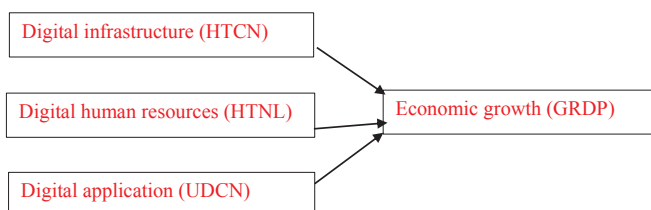


Fig. 1. The theoretical framework. Source: Authors' research results.

3. Research methodology

3.1. Research model

To analyse the factors influencing economic growth in Hau Giang Province, this study constructs an econometric model grounded in classical and contemporary growth theories, while integrating empirical insights from digital transformation research.

The Cobb-Douglas production function, introduced by Cobb and Douglas in the 1920s, serves as a foundational framework for modelling the relationship between output and inputs of production. It posits that economic output depends primarily on two input factors: capital and labour. The model assumes constant returns to scale and has been widely adopted in empirical studies due to its analytical simplicity and explanatory power [32].

The standard form of the Cobb-Douglas function is represented as follows:

$$GRDP_t = \beta_0 + \beta_1 K_t + \beta_2 L_t + \varepsilon_t$$

In addition to this classical structure, the model is extended to incorporate the effects of digital transformation, based on contemporary theories and empirical findings. Solow's neoclassical growth model (1956) highlighted the role of technological progress as an exogenous determinant of long-term growth [11], while Romer's endogenous growth theory (1990) emphasised that innovation and knowledge accumulation - especially in the form of technological investment - are key drivers of sustainable growth from within the economic system [12].

Further empirical evidence supports the inclusion of DT as a production factor. Studies by H. Aly (2020) [33] and S.A. Gusarova, et al. (2023) [34] found that digital technologies significantly enhance productivity, support innovation, and contribute to national and regional economic growth. These insights provide justification for extending the Cobb-Douglas model as follows:

$$\ln GRDP_t = \beta_0 + \beta_1 \ln K_t + \beta_2 \ln L_t + \beta_3 DT_t + \varepsilon_t$$

where, t represents the year, K represents capital, L represents labour, and DT represents the digital transformation variable.

This extended model allows for empirical investigation of the direct impact of digital transformation on regional economic performance, while controlling for traditional growth inputs - capital and labour.

Based on prior research, all three independent variables (K_t , L_t , DT_t) are expected to exert a positive influence on GRDP. Specifically, capital investment is expected to improve infrastructure and productive capacity, labour reflects the quality and availability of human capital, and digital transformation enhances innovation, efficiency, and connectivity.

While classical growth models treat technology as an exogenous factor (R.M. Solow (1956) [11]) or as part of human capital investment [12], recent empirical studies conceptualise digital transformation as a distinct, multidimensional driver that affects production efficiency, coordination, and innovation beyond traditional inputs [33, 34]. Therefore, in this study, DT is included as an independent variable to reflect its direct and indirect impact on economic output.

The proposed research model is synthesised in Table 3, which outlines the variables, measurement methods, and expected signs for hypothesis testing.

Table 3. Research model.

References and foundation for model construction	Variable	Notation	Measurement	Sign expectation	Data source
Dependent variable					
	Economic growth	$GRDP_t$	The natural logarithm of the gross domestic product of the locality in year t		
Independent variable					
Cobb-Douglas production function; growth theory proposed by R.M. Solow (1956) [11] and P.M. Romer (1990) [12]	Investment Capital	K_t	The natural logarithm of the investment capital of the locality in year t	+	Statistical Yearbook of Hau Giang Province 2015-2023.
	Human Capital	L_t	The natural logarithm of the labour force of the locality in year t	+	
H. Aly, (2020) [33] (Ministry of Information and Communications, 2023) [34]	Digital transformation	Information and Communication Technology (ICT)	The readiness index for information technology application and development	+	Report on the Readiness Index for Information Technology and Communication Development and Application of Hau Giang Province (2021) [35]
		Digital Infrastructure (HTCN)	Information technology infrastructure index	+	
		Digital Human Resources (HTNL)	Information technology human resources infrastructure index	+	
		Digital Applications (UDCN)	Information technology human resources infrastructure index	+	

Source: Research team compilation, 2024. GRDP = Gross Regional Domestic Product; ICT = Information and Communication Technology Readiness Index; HTCN = Digital Infrastructure Index; HTNL = Digital Human Resources Index; UDCN = Digital Application Index. All monetary variables (GRDP and K) are transformed into natural logarithms to reduce heteroscedasticity and interpret coefficients as elasticities.

The ICT Index is disaggregated into three components:

- HTCN (Digital Infrastructure): Measures availability and quality of internet, cloud computing, and digital platforms.

- HTNL (Digital Human Resources): Captures percentage of ICT-trained workers, digital literacy programmes, and e-government training.

- UDCN (Digital Applications): Reflects adoption of digital technologies in public administration and business, including e-services and integrated databases. These indices are sourced from the Hau Giang Provincial ICT Readiness Reports (2015-2023) and are constructed based on guidelines from the Ministry of Information and Communications.

The three DT indices used in this study - HTCN, HTNL, and UDCN - are constructed following the framework developed by the Ministry of Information and Communications [24] for evaluating provincial digital transformation performance.

- HTCN (IT Infrastructure Index) reflects access to and deployment of digital infrastructure (e.g., broadband internet, fibre-optic cable, 4G/5G coverage). It is computed as a weighted composite index of four sub-indicators: (1) broadband access rate, (2) percentage of households with internet connection, (3) public Wi-Fi coverage, and (4) mobile network density. Weights are assigned according to MIC guidelines (e.g., 30%, 30%, 20%, and 20%).

- HTNL (IT Human Resources Index) captures the availability of digitally skilled human capital in the public sector. It includes: (1) the ratio of ICT-trained staff in local government, (2) participation in digital skills training, and (3) ICT staff per capita. The MIC allocates equal weights (33.3%) to these indicators.

- UDCN (IT Application Index) measures the extent and effectiveness of digital technology applications in public administration and services. Sub-indicators include: (1) the rate of online public service provision, (2) usage rate of digital platforms (e.g., e-portal, e-Cabinet), and (3) integration of administrative procedures. Weights are 40%, 30%, and 30%, respectively.

These indices range from 0 to 1, with higher values indicating better performance. The raw data were obtained from the Annual Provincial Digital Transformation Reports (2015-2023) issued by the Hau Giang Department of Information and Communications.

3.2. Research data

For this study, the research team uses secondary data from the Statistical Yearbook of Hau Giang Province and the Report on the Readiness Index for the Development and Application of Information and Communication Technology in Hau Giang Province, provided by the Department of Information and Communications of the Province. The data collection period spans from 2015 to

2023. Data for 2023 were obtained from official provincial reports finalised in early 2024, thus reflecting actual outcomes rather than projections.

3.3. Estimation method

This study employs the OLS method to estimate the parameters of the proposed regression model. Originally introduced by C.F. Gauss in 1809, OLS remains one of the most widely used techniques in econometric analysis due to its simplicity, computational efficiency, and capacity to yield unbiased and efficient estimators under the classical linear regression assumptions [36].

OLS operates by minimising the sum of squared residuals—the differences between observed and predicted values of the dependent variable. The coefficients obtained under this method are considered Best Linear Unbiased Estimators (BLUE) if key assumptions are satisfied, including linearity, absence of multicollinearity, homoscedasticity, no autocorrelation, and correct model specification [37]. To ensure the robustness and reliability of the model, this study performs the following diagnostic tests:

Model fit and significance test: The F-test is used to assess the overall statistical significance of the model. The null hypothesis H_0 assumes that all regression coefficients (except the intercept) are jointly equal to zero, implying no explanatory power of the independent variables. Rejecting H_0 at the 5% significance level indicates that the model is well fitted and statistically significant [38].

Homoscedasticity test: Homoscedasticity assumes that the variance of the error terms is constant across all observations. The Breusch-Pagan/Cook-Weisberg test is employed to detect heteroscedasticity. A p-value greater than 0.05 indicates that the null hypothesis of homoscedasticity cannot be rejected, validating this assumption of the OLS model [39].

Autocorrelation test: The absence of autocorrelation in residuals is another assumption of OLS. The Breusch-Godfrey test is used to examine serial correlation in the residuals. A p-value above 0.05 suggests that the residuals are not autocorrelated, confirming that the model does not violate this assumption [40].

Model specification test: The Ramsey RESET test is applied to evaluate the functional form and detect any model specification errors, such as omitted variables or incorrect transformations. If the p-value exceeds 0.05, the null hypothesis that the model is correctly specified cannot be rejected, supporting the adequacy of the chosen model structure [41].

Together, these diagnostic procedures ensure the reliability of the OLS estimates and reinforce the internal validity of the study's findings.

4. Results and discussion

4.1. Descriptive statistics

Table 4 presents descriptive statistics for the variables used in the regression analysis, covering the period from 2015 to 2023. The data were compiled from the Statistical Yearbook of Hau Giang Province and ICT Readiness Reports issued by the Department of Information and Communications.

Table 4. Descriptive statistics of variables in the model.

Variable	Unit	Obs	Mean	Std. Dev.	Min	Max
Gross regional domestic product	Billion VND	9	37,109.38	10,680.32	25,247.45	58,504.99
Investment capital	Billion VND	9	18,497.53	2,791.71	14,328.50	22,700.36
Labor force	Persons	9	436,677.6	36,490.68	394,077	481,200
ICT readiness index	Ratio (0-1)	3	0.3436	0.1250	0.1031	0.4834
IT infrastructure index	Ratio (0-1)	9	0.2867	0.1990	0.0500	0.5300
IT human resources index	Ratio (0-1)	9	0.4656	0.1379	0.2500	0.6200
IT application index	Ratio (0-1)	9	0.2922	0.1450	0.0600	0.4900

Source: Compiled from the Statistical Yearbook of Hau Giang Province [42-44] and the ICT Readiness Reports by the Department of Information and Communications (2015-2023) [35, 45-47].

During this period, the average GRDP was approximately 37,109.38 billion VND, with a standard deviation of 10,680.32 billion VND, ranging from 25,247.45 to 58,504.99 billion VND. The mean investment capital (K) reached 18,497.53 billion VND, while the labour force (L) averaged 436,677.6 persons, suggesting a stable human capital base.

With regard to digital transformation, the ICT averaged 0.3436, based on three years of available data (2021-2023). The HTCN showed a mean value of 0.2867, while HTNL and UDCN recorded average values of 0.4656 and 0.2922, respectively. These indices, which range from 0 to 1, indicate moderate levels of digital maturity in Hau Giang Province across infrastructure, human capital, and application dimensions.

This statistical overview reflects both economic and technological development patterns in Hau Giang Province and provides an empirical foundation for the regression analysis presented in subsequent sections.

4.2. Discussion of model specification and non-significant coefficients

Using STATA software and data provided by the Hau Giang Provincial Statistics Bureau and the Hau Giang Department of Information and Communications, the

descriptive statistics measuring the characteristics of the research variables are presented in Table 4.

The research team used STATA software to perform the data analysis for Hau Giang Province, covering the period from 2015 to 2023. This period is significant, as it marks numerous economic and social changes in the region. Therefore, analysing data from this period is crucial for gaining a deeper understanding of local economic development trends.

Applying statistical techniques to estimate the economic models, the use of STATA not only ensures high accuracy in data processing but also allows for the effective execution of complex analyses. The variables and models were carefully selected to accurately reflect the economic conditions of the locality over the study period. The results of this estimation process are summarised and presented in Table 5.

Table 5. The estimated results of the models regarding the impact of digital transformation on economic growth in Hau Giang Province.

Explanatory variable	Model 1	Model 2	Model 3	Model 4
Investment capital	1.481975**	1.18414**	0.5113313	1.310142**
Human capital	0.5602741	1.339615	-2.946819	-0.528588
Digital transformation				
Readiness index	0.7886264			
IT infrastructure index		0.9887265*		
IT human resource infrastructure index			-1.120669	
IT application index				0.4494669
Prob>F	0.0104	0.0040	0.0079	0.0076
R-squared	0.8767	0.9160	0.8898	0.8916
Adj R-squared	0.8028	0.8656	0.8238	0.8266
Breusch-Pagan/Cook-Weisberg p-value	0.2262	0.3523	0.2701	0.4137
Breusch-Godfrey p-value	0.4208	0.0667	0.1571	0.2472
Ramsey RESET p-value	0.6171	0.2295	0.1500	0.5257

Source: Statistical Yearbook of Hau Giang Province 2015-2023. **, * denote statistical significance at the 5% and 10% levels, respectively.

The estimation results of the models examining the impact of digital transformation on economic growth in Hau Giang Province were obtained using the OLS method. Prob>F represents the p-value of the F-test, indicating the statistical significance of the overall regression model. R-squared (coefficient of determination) shows the proportion of variation in the dependent variable explained by the independent variables in the model. Adjusted R-squared is the adjusted coefficient of determination and serves as an important indicator for assessing model strength (expected >50%). The Breusch-Pagan/Cook-Weisberg p-value refers to the p-value of the Breusch-Pagan/Cook-Weisberg test, which is used to detect heteroscedasticity (i.e. non-constant error variance). The Breusch-Godfrey p-value denotes the p-value of the

Breusch-Godfrey test, used to detect autocorrelation in the regression residuals. The Ramsey RESET p-value represents the p-value of the Ramsey RESET test, which is applied to examine potential omitted variables or functional form misspecification in the linear regression model.

The estimation results presented in Table 5 indicate that the proposed regression models are statistically significant. The p-values associated with the F-tests are below the conventional threshold, suggesting that at least one independent variable exerts a statistically significant influence on the GRDP. Moreover, the R-squared and adjusted R-squared values exceed 50%, implying that the models explain a substantial proportion of the variation in economic growth and demonstrate good overall fit.

Regarding diagnostic testing, the Breusch-Pagan/Cook-Weisberg test for heteroscedasticity yields p-values greater than 0.05, indicating no statistical evidence to reject the null hypothesis of constant error variance. This result supports the assumption of homoscedasticity and, consequently, the efficiency and validity of the OLS estimators [39].

The Breusch-Godfrey test for autocorrelation produces p-values exceeding the 5% significance level across all four models. Notably, Model 2 yields a p-value of 0.0667, which lies close to the 5% threshold. Although this value does not warrant rejection of the null hypothesis of no autocorrelation at the 5% level, its proximity suggests that caution is advisable. Specifically, while the assumption of independent errors holds statistically, this result may indicate weak evidence of potential serial correlation. This nuance should be considered when interpreting the reliability of Model 2, and additional tests incorporating further lags may enhance robustness [40].

Furthermore, the Ramsey RESET test yields p-values above 0.05, indicating no evidence of functional form misspecification. This suggests that the models are appropriately specified and that no significant explanatory variables have been omitted [41].

4.2.1. Impact of digital transformation

The regression coefficient for the variable HTCN (information technology infrastructure index), representing digital transformation, is estimated at 0.9887 and is statistically significant at the 10% level. This result indicates a positive relationship between digital transformation and economic growth in Hau Giang Province. Specifically, a 1% increase in the HTCN index is associated with an approximate 0.99% increase in GRDP, ceteris paribus. This finding is consistent with previous research by S. Gomes, et al. (2022) [48], E. Kvochko (2013) [49], and R.L. Katz (2017) [50], which

emphasise the critical role of digital infrastructure in promoting economic development. Additionally, the results corroborate the study by H.T.T. Ngan, et al. (2021) [23], which found that a 1% increase in the digital infrastructure index led to a 0.84% increase in GDP among provinces in the Southern Key Economic Region, also significant at the 10% level.

However, the variables ICT, HTNL, and UDCN are not statistically significant in the Hau Giang context. There are several potential explanations for this outcome.

First, from a data perspective, the ICT readiness index is available only for a limited number of years (2021-2023), resulting in a small sample size and reduced statistical power. This restricts the ability of the model to detect significant effects, especially in panel regressions with few observations.

Second, regarding measurement and construct validity, the HTNL and UDCN indices may not fully capture the depth or quality of human capital and digital service integration. For instance, the HTNL index emphasises the quantitative availability of staff but may overlook qualitative aspects such as skill relevance, digital competency, or adaptability to technological changes.

Third, in terms of implementation, several digital initiatives in Hau Giang remain underutilised. Preliminary interviews with officials from the Department of Information and Communications revealed that many IT applications in public services are only partially deployed or face limited usage due to low citizen digital literacy or a lack of training at the commune level. This implementation gap likely reduces the measurable impact of UDCN on economic output.

Together, these factors help explain the non-significance of these digital transformation subcomponents in the regression analysis and highlight the need for improved data collection, targeted training programmes, and outcome-based evaluation of digital projects at the provincial level.

4.2.2. *Impact of capital and labour*

In addition to digital transformation, the regression results show that investment capital (K) has a positive and statistically significant effect on GRDP. This finding is aligned with classical and modern growth theories, particularly those of R.M. Solow (1956) [11] and P.M. Romer (1990) [12], which emphasise the critical role of capital accumulation in driving long-term economic growth. It also echoes the empirical findings by H.T.T. Ngan, et al. (2021) [23], who identified capital investment as a key determinant of economic growth at the provincial level.

Conversely, the labour variable (L) does not exhibit a statistically significant relationship with GRDP in this study. This result mirrors the insignificance of the HTNL, suggesting that existing human capital in Hau Giang Province may not yet be effectively leveraged to stimulate growth. Possible explanations include a mismatch between workforce skills and market demand, or the limited integration of human resources into the digital economy. These limitations indicate a need for greater investment in workforce development and training to fully capitalise on the province's labour potential.

5. Conclusions and policy recommendations

5.1. *Conclusions*

This study examines the relationship between digital transformation and economic growth in Hau Giang Province from 2015 to 2023, utilising secondary data from provincial statistics and ICT performance reports. The regression analysis was conducted using the OLS model, with diagnostic tests confirming the absence of heteroscedasticity, autocorrelation, and model specification errors, thus ensuring the robustness of the empirical results.

The findings reveal that the HTCN coefficient was positive and marginally significant at the 10% level in the reported specification. Specifically, a 1% increase in HTCN corresponds to approximately a 0.99% rise in GRDP, highlighting the importance of digital infrastructure in driving regional development. In contrast, the ICT, HTNL, and UDCN did not exhibit statistical significance, pointing to limitations in digital adoption and capacity utilisation.

Among traditional factors, investment capital (K) remains a robust and significant determinant of economic growth, consistent with established growth theories. However, labour (L) did not show a statistically significant impact.

Building on the empirical results, this section discusses theoretical and practical implications in comparison with prior studies. The findings contribute to the literature by providing subnational empirical evidence from a rural province in a developing country context. The significance of HTCN aligns with global and regional research emphasising the foundational role of digital infrastructure in enabling economic growth [16, 18].

The non-significance of HTNL and labour reflects similar observations in subnational studies in Vietnam (e.g. H.T.T. Ngan, et al. (2021) [23]) and can be explained by the mismatch between skill supply and the requirements of digital economies. Similarly, the non-significance of UDCN may point to implementation gaps in policy execution and digital services utilisation.

These outcomes underscore the importance of investing not only in infrastructure but also in human capital development and actual technology adoption. Future research should extend the analysis to other provinces, apply longitudinal or mixed-methods approaches, and consider mediating or moderating factors such as governance, FDI, or institutional readiness. These implications underline the need for holistic digital strategies - ones that go beyond infrastructure investment to include workforce upskilling and institutional innovation.

5.2. Policy recommendations

To enhance the economic benefits of digital transformation, Hau Giang Province (before the administrative merger) should pursue a comprehensive digital strategy that targets infrastructure, human capital, governance, and cross-sectoral engagement.

First, expanding IT infrastructure should remain a strategic priority. The significance of HTCN in the regression results aligns with Hau Giang's achievements in ensuring 100% computer usage among civil servants and deploying integrated digital platforms across departments [7]. To sustain and scale this impact, investments should be directed towards broadband expansion, especially in remote communes, and cloud-based data management systems to support digital services.

Second, while the UDCN shows a positive coefficient, its lack of statistical significance reflects an adoption gap at the user level. Despite efforts such as the 2023 Digital Transformation Week, which engaged over 50 businesses and nearly 90 tech booths [47], digital platforms remain underutilised in both public and private sectors. Addressing this requires targeted support for SMEs, including digital skills training, subsidised access to enterprise software, and incentives for process digitisation.

Third, the HTNL index's insignificance points to a structural gap in human capital development. Although the province trained more than 4,000 members of community digital task forces and rolled out awareness programmes in all districts [7], digital skills among local workers and officials remain limited. Strengthening human capital will require public-private partnerships to design industry-relevant training curricula, introduce digital apprenticeships, and create talent retention mechanisms such as scholarships and job guarantees.

Fourth, the ICT readiness index was constrained by limited data availability (2021-2023). Nonetheless,

the province has made progress in institutional ICT governance, with all departments maintaining digital transformation units and public-facing portals [35, 45-47]. Further efforts should focus on standardising digital maturity assessments, integrating digital dashboards for performance monitoring, and ensuring data transparency across sectors.

Fifth, promoting public-private partnerships (PPPs) is critical for scaling digital initiatives. The province has involved youth organisations in digital outreach and collaborated with private firms during awareness campaigns [7]. To institutionalise such efforts, Hau Giang should offer tax incentives for tech start-ups, create digital innovation zones, and establish regulatory sandboxes that encourage experimentation with emerging technologies.

Finally, the development of a secure and enabling legal framework is essential. As digital services expand, data protection and cybersecurity policies must evolve accordingly. Hau Giang should align local regulations with national cybersecurity standards, raise public awareness of digital rights and privacy, and develop risk management protocols to ensure resilience in digital projects [45].

In summary, Hau Giang Province has made considerable progress in digital infrastructure and policy orientation. However, to fully harness the economic benefits of digital transformation, a stronger focus on digital workforce development, adoption capacity, and institutional innovation is needed. The policy recommendations presented herein are grounded in empirical evidence and contextualised within the province's digital transformation trajectory. These strategies provide a roadmap for building a resilient, inclusive, and innovation-driven digital economy.

5.3. Limitations and directions for future research

This study contributes to the growing body of literature examining the impact of digital transformation on provincial economic growth in the Vietnamese context. However, several limitations should be acknowledged to enhance the scientific rigour and reliability of the findings.

First, the regression analysis shows that the variables representing HTNL and labour (L) do not exhibit statistical significance. While the paper proposes preliminary explanations, the underlying causes of these insignificant results have not been fully identified. Potential factors include measurement errors, temporal lags in impact, or skill-job mismatches within the local digital economy. Future research should explore these possibilities through

refined variable construction, qualitative methods such as expert interviews or enterprise surveys, and extended datasets to reassess the role of human capital in digital economic growth.

Second, the study relies heavily on secondary data from provincial reports, which may be subject to reporting bias, especially when digital transformation indicators are linked to administrative performance targets. Additionally, the time series is relatively short (2015-2023), limiting the ability to assess long-term trends or lagged policy effects.

Moreover, the model may suffer from omitted variable bias, as it excludes potentially important determinants such as FDI, public governance quality, or sector-specific labour productivity. These factors could serve as mediators or moderators in the relationship between digital transformation and economic performance at the subnational level.

Finally, the sample size remains modest, particularly for digital transformation variables, reducing statistical power and generalisability. Future studies should consider expanding the dataset through a multi-provincial or panel approach and adopt mixed-methods designs to better capture the pathways through which digital transformation influences economic development at the local level.

CRediT author statement

Vo Thanh Tuyen: Conceptualisation, Methodology, Writing original draft, Writing - Reviewing & Editing; Nguyen Hoang Huy: Formal analysis, Validation; Hoang Thi Hoai Nga, Nguyen Thi Tieu Phung, Le Quang Hau: Data curation, Investigation, Writing - Reviewing & Editing.

COMPETING INTERESTS

The authors declare that there is no conflict of interest regarding the publication of this article.

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Finding the “Sweet Spot”: Nonlinear effects of board size on firm performance in Vietnam

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Received 10 September 2025; revised 5 October 2025; accepted 9 January 2026

Abstract:

This study investigates the relationship between board size and the financial performance of non-financial firms listed on the Hanoi Stock Exchange (HNX) over the period 2013-2022. To ensure robust estimation, the Feasible Generalised Least Squares (FGLS) method is employed to control for heteroscedasticity and autocorrelation commonly present in panel data. The empirical findings indicate a positive but nonlinear (U-shaped) association between board size and firm performance, as measured by return on assets (ROA) and return on equity (ROE). Specifically, firms with very small boards tend to exhibit weaker performance, whereas performance improves significantly when the board comprises at least four to five members. This result suggests that an adequately sized board can enhance managerial monitoring, enrich expertise diversity, and support more effective strategic decision-making. The study contributes to the corporate governance literature by providing evidence from an emerging market context and offers practical insights for managers and policymakers seeking to design board structures that are better suited to the operational characteristics and governance needs of Vietnamese enterprises.

Keywords: board size, financial performance, nonlinear relationship.

Classification numbers: 2.2, 2.3

1. Introduction

The Board of Directors (BOD) serves as the cornerstone of corporate governance, holding primary responsibility for oversight and strategic direction to maximise shareholder value [1-2]. Board size is widely recognised as a key structural attribute that reflects governance capacity, as it directly influences the quality and effectiveness of decision-making through two core functions: monitoring and strategic advisory roles [1, 3]. A well-structured board enhances accountability and transparency, strengthens stakeholder trust, and ultimately improves firm performance [4].

The relationship between board size and firm performance has long been a focal issue in corporate governance research, both globally and within the Vietnamese context. From a resource dependence perspective, larger boards may enhance firm efficiency by combining diverse expertise, experience, and networks, thereby strengthening their monitoring and strategic planning capabilities [5, 6]. Conversely, agency theory suggests that excessively large boards can hinder coordination, dilute individual accountability, and slow

down decision-making [3, 7]. Empirical evidence across countries reveals that the board size-performance nexus may follow either a linear [5, 8, 9] or a nonlinear pattern [10-12]. For instance, M.B. Lehri, et al. (2024) [13] identified a U-shaped relationship. In contrast, S. Potharla, et al. (2021) [10], and R. Sharma (2023) [11] documented an inverted U-shaped pattern, indicating declining performance once the board exceeds its optimal size [10-11]. Additionally, C. Liang (2022) [14] reported a cubic relationship with two turning points, underscoring the complex and dynamic nature of board effects on performance. These findings suggest that the impact of board size on firm performance is not purely linear, but somewhat contingent upon the alignment between board structure, corporate strategy, and the firm's operating environment. In essence, each firm may have an optimal board size threshold at which the advantages of diversity are balanced against the costs of coordination and decision-making. Hence, determining an appropriately sized board is critical, one that is sufficiently large to ensure adequate oversight without being so large as to undermine efficiency.

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In Vietnam, research on the relationship between board size and corporate performance remains limited, with a predominant linear perspective [15-18]. A few studies, such as L.T.X. Nguyen, et al. (2021) [19] have suggested potential nonlinear effects; however, the nonlinear relationship has yet to be empirically clarified within the Vietnamese context, where ownership structures (state-owned, private, and equitised enterprises) and governance institutions remain underdeveloped [20]. Moreover, international evidence indicates that the optimal board size varies considerably across countries: approximately 7-8 members in the United States [21, 22], 10-12 in Thailand [23], 10-13 in India [11], 13-17 in France [12], 8-10 in England [24], and 10-18 in China [14, 25]. In Vietnam, although the Law on Enterprises stipulates that boards must comprise between 3 and 11 members, it does not differentiate by firm type, ownership, or scale. Consequently, identifying the optimal threshold of board size for maximising firm efficiency is both theoretically important and practically relevant, particularly given the emerging evidence of a nonlinear relationship between board size and performance.

To address this gap, the study is guided by two main research questions. First, does board size significantly affect firm performance in Vietnam? Second, is this relationship linear or nonlinear, and if nonlinear, what is the optimal board size that maximises firm performance? Notably, this study explains the link between board size and firm performance by integrating competing theoretical perspectives. Agency theory suggests that larger boards weaken monitoring efficiency due to coordination problems and free-riding, thereby increasing agency costs and reducing performance. In contrast, resource dependence theory argues that larger boards enhance performance by providing diverse expertise and external networks that improve strategic decision-making and resource access. Meanwhile, stewardship theory highlights the role of trust and collaboration in strengthening governance effectiveness. Taken together, these perspectives imply that board size influences firm performance through monitoring, advisory, and resource channels. As board size increases, its benefits may initially outweigh coordination costs, but beyond a certain threshold, inefficiencies may dominate, leading to a nonlinear relationship between board size and firm performance.

Building upon this, the study examines both the linear and nonlinear relationships between board size and financial performance among non-financial firms listed on the HNX from 2013 to 2022. The findings

provide empirical evidence of a U-shaped relationship between board size and firm performance in an emerging market. Specifically, firm performance tends to decline when board size is small but improves once the board surpasses a minimum threshold of approximately four to five members. This result suggests that smaller boards may lack the diversity and expertise necessary for effective oversight, while moderately larger boards enhance monitoring, strategic decision-making, and overall governance quality. These findings offer valuable implications for corporate governance practice and policy-making in Vietnam. They emphasise the need for regulators and firms to establish an optimal and balanced board structure, one that aligns with firm characteristics and market conditions, to enhance governance efficiency and sustainable performance.

2. Literature review and hypothesis development

2.1. Theoretical framework

Agency Theory suggests that conflicts of interest can arise between shareholders and managers due to the separation of ownership and control within corporations [26]. In this context, the board of directors plays a crucial role in overseeing managerial actions and reducing agency costs that result from the misalignment of interests between managers and shareholders [27]. Accordingly, effective corporate governance mechanisms, particularly regarding the board's structure and size, are considered essential for protecting and enhancing shareholder value. However, this viewpoint has faced criticism, as various studies indicate that an increase in size may lead to inefficiencies. These can arise from coordination difficulties and the development of internal "cliques", which may compromise accountability and diminish the effectiveness of oversight [28].

In contrast to Agency Theory, which posits that directors' behaviour is primarily self-serving, Stewardship Theory challenges this notion. It argues that many board members act as responsible stewards, motivated by intrinsic values and a sense of organisational loyalty. As a result, they prioritise the long-term development of the firm [29]. This perspective emphasises that trust, cooperation, and a commitment to mutual benefit are essential to effective board dynamics. Consequently, the board functions not only as a monitoring mechanism but also as a foundation for sustainable strategic alignment [30].

Building on these perspectives, Resource Dependence Theory [31] emphasises the board's role in external networking and boundary-spanning activities.

Thus, the board not only addresses internal conflicts of interest and functions as a dedicated manager, but also acts as a vital link to acquire essential external resources such as capital, expertise, and legitimacy. From this standpoint, larger boards can offer broader networks and a deeper reservoir of knowledge, ultimately enhancing the firm's adaptive capacity and improving its competitive positioning [32].

When considered together, these three theoretical lenses provide a more comprehensive and nuanced understanding of the relationship between board size and firm performance. Agency Theory focuses on monitoring and control to reduce agency costs, while Stewardship Theory emphasises the importance of trust and long-term strategic collaboration. Meanwhile, Resource Dependence Theory underscores the significance of accessing and mobilising external resources. This synthesis suggests that the effects of board size are not uniform; instead, they can be both advantageous and disadvantageous, depending on the governance context and the firm's strategic objectives.

2.2. Hypothesis development

2.2.1. Linear relationship

Boards of directors are entrusted with overseeing critical organisational decisions, including investment strategies, executive remuneration, and governance structures [4]. The relationship between board size and firm performance has been extensively examined; however, empirical findings remain inconclusive.

A segment of the literature posits that larger boards can positively impact firm performance by bringing together diverse perspectives and a broader range of expertise. A. Kalsie, et al. (2016) [5], analysing 145 non-financial firms listed on India's NSE across 16 industries from 2008 to 2012, revealed that larger boards were positively linked to both accounting-based measures (such as ROA and ROCE) and market-based indicators (including Tobin's Q and the Market-to-Book Ratio). Similarly, H. Boussenna (2020) [12], investigating non-financial firms listed on the CAC 40 in France from 2005 to 2017, found a positive correlation between board size and performance (ROA, ROE, Tobin's Q, and Market-to-Book Ratio). Notably, the study identified an optimal size of 13-17 members as most beneficial for enhancing firm outcomes. Z. Yuanyuan, et al. (2024) [9], analysing 203 public and private Chinese non-profit organisations, showed a positive association between board size and organisational performance. S.M. Hasan, et al. (2024) [8], analysing annual data from 20 major financial institutions

in Bangladesh, including banks, non-bank financial institutions (NBFIs), and insurance companies, covering the period 2011-2022, found that board size has a significant positive impact on the performance of financial institutions (ROA, ROE, Net Asset Value). Larger boards facilitate strategic decision-making and safeguard stakeholder interests, ultimately enhancing overall organisational efficiency. Consequently, financial institutions may benefit from optimising board size to strengthen governance and boost performance.

Conversely, other studies underscore the potential disadvantages of larger boards. S.D. Nath, et al. (2015) [33] in their examination of 20 publicly listed pharmaceutical firms on the Dhaka Stock Exchange from 2003 to 2015, identified a negative correlation between board size and firm performance, as measured by ROA and Tobin's Q. They argued that smaller boards can enhance efficiency and generate greater shareholder value. In a similar vein, O.R. Uwuigbe, et al. (2012) [34] found that firms with smaller boards achieved higher ROEs, attributing this success to stronger cohesion and quicker decision-making. These findings resonate with the concerns raised by M. Lipton (1992) [22], who warned that larger boards might encounter coordination difficulties that ultimately hinder performance. Furthermore, P.M. Guest (2009) [3] posited that large boards could adversely affect profitability, particularly regarding earnings and Tobin's Q.

The complexity of the relationship between board size and firm performance has been further underscored by some scholars who report no significant correlation. B.I. Ehikioya (2009) [35] in Nigeria and J. Yammesri, et al. (2010) [36] in Thailand concluded that board size alone may not serve as a reliable predictor of firm performance. They suggest that its impact is contingent on contextual factors, including industry characteristics, governance frameworks, and national institutional environments.

This discourse has garnered increasing importance in emerging economies, such as Vietnam. Some studies indicate that larger boards may positively influence firm performance by enhancing decision-making and oversight. Q.M. Nguyen, et al. (2024) [16], using data from 30 large-cap firms listed on the Ho Chi Minh City and Hanoi Stock Exchanges, typically included in the VN30 or HNX30 indices, covering 2010-2021, showed that larger board size is significantly associated with higher financial performance (ROA). V.C. Nguyen, et al. (2023) [17], using data from 52 representative firms listed on the Vietnamese stock exchanges, covering the period from 2006 to 2020, indicated that board size, the

proportion of female directors, meeting frequency, and board members' education levels have positive effects on financial performance (ROA and ROE). T.K. Pham, et al. (2023) [37], using data collected from the annual reports of Vietnamese banks, covering the period 2011-2021, revealed that board size contributes positively to bank performance. However, excessively large boards might lead to inefficiencies, including weakened communication and accountability. H.T.M. Le, et al. (2023) [15], analysing the top 200 listed firms on the Vietnam Stock Exchange from 2014 to 2015, noted that larger boards tend to exacerbate leadership dominance and intra-board conflicts, ultimately detracting from performance. V.H. Duc, et al. (2013) [18], analysing 77 listed companies between 2006 and 2011, and D. Vo, et al. (2014) [38], utilising FGLS on a dataset of 177 listed firms from 2008 to 2012, found no consistent evidence to support the claim that larger boards enhance firm performance. The latter even proposed that board size may insufficiently reflect the board's proper role in management.

Building on theories that emphasise the board's role in securing essential external resources and supported by empirical evidence indicating that diverse and well-connected boards can enhance firm performance, this study argues that in Vietnam, where boards play a pivotal role in corporate direction and oversight, a larger board may foster greater expertise diversity, strengthen monitoring, broaden networks, and enhance corporate reputation. Accordingly, the following hypothesis is proposed:

H1: Board size has a positive impact on firm performance.

2.2.2. Nonlinear relationship

Prior empirical research consistently indicates that the relationship between board size and corporate performance is nonlinear. The debate surrounding the ideal board size remains unresolved, as the optimal point appears to be highly context-dependent, influenced by various factors, including company characteristics, institutional frameworks, laws, and economic conditions.

M.B. Lehri, et al. (2024) [13], analysing 500 publicly listed companies over the period 2010-2024 using PLS-SEM, reported a U-shaped association between board size and financial performance. Similarly, S. Potharla, et

al. (2021) [10], analysing Indian non-financial firms from 2011 to 2018, identified an inverted U-shaped relationship between board size and firm performance (measured by ROA and Tobin's Q), suggesting that medium-sized boards yield the most favourable outcomes [10]". R. Sharma (2023) [11], examining 213 Indian firms over the period 2001-2019, revealed an inverted U-shaped nonlinear relationship between board size and firm performance. Initially, performance improves as board size increases, but beyond a certain point, it begins to decline. Specifically, an increase in board size enhances firm performance up to an optimal threshold (13 members for Tobin's Q and 10 members for ROE), after which diminishing returns set in. C. Liang (2022) [14], examining 14 Chinese hotel firms listed on the Shanghai Stock Exchange and the Shenzhen Stock Exchange from 1999 to 2018, found a nonlinear relationship between board size and financial performance [14]. Specifically, board size exhibits a cubic effect on hotel growth opportunities, measured by Tobin's Q, with critical turning points at 12 and 18 members. K. Silpachai (2023) [23], employing a panel dataset of 1,768 firm-year observations of Thai companies (2014-2020), found a curvilinear relationship between board size and performance [23]. The study revealed that the optimal board size for maximising ROA and ROE was 10 directors, with peak values of 3.4% and 14.8%, respectively. For Tobin's Q, the optimal number was 12 members, corresponding to a peak value of 2.39. Beyond these thresholds, firm performance declined. P.N. Vaidya (2019) [24], using data from 100 companies listed on the London Stock Exchange (2018-2019), examined board size in relation to various financial metrics including ROA, EBIT, ROE, EPS, Dividend per Share, and Tobin's Q. The findings indicated that firms with 8-10 directors consistently outperformed those with either smaller or larger boards, further reinforcing the argument for an optimal range. J. Wang, et al. (2018) [25] also confirmed an inverted U-shaped relationship, pointing to 10 members as the optimal board size for enhancing ROA, ROE, and Tobin's Q. L.T.X. Nguyen, et al. (2021) [19], examining the manufacturing firms of the emerging East Asian markets between 2011 and 2016, explored an inverse U-shaped relationship between board size and environmental performance. In addition, other scholars have similarly proposed specific ranges: 13-17 members [12], 7-8 members [21-22].

Taken together, this body of evidence strongly supports the view that the board size-performance nexus is nonlinear. Accordingly, the following research hypothesis is proposed:

H2: There is a nonlinear relationship between board size and firm performance.

3. Data and methodology

3.1. Data

Data for this study were collected through a combination of manual methods and supporting software. Key corporate governance characteristics, such as board size, the number of female directors, CEO age, and CEO ownership, were primarily extracted from corporate governance reports, annual reports, and publicly disclosed consolidated financial statements. Additional information was sourced from reputable financial websites, including *cafe.vn* and *vietstock.vn*. Financial data were obtained from the FinPro database. According to the State Securities Commission of Vietnam, as of 2022, the HNX listed 341 firms. The following exclusion criteria were applied: (i) firms engaged in the financial, insurance, or banking sectors because of possessing distinct financial structures, leverage ratios, and accounting regulations compared to others; (ii) firms founded after 2013; and (iii) firms with incomplete or missing data. After applying these filters, the final sample consisted of 203 firms, resulting in a panel dataset of 2,030 firm-year observations spanning the period from 2013 to 2022. Due to missing values in a small number of explanatory variables (10 firm-year observations), the regression analyses were estimated using 2,020 observations after listwise deletion.

3.2. Variable measurement

3.2.1. Dependent variable: Firm performance

Firm performance is assessed using accounting-based indicators, namely ROA and ROE. These measures are widely recognised in the corporate governance literature as reliable proxies for firm performance due to their availability, ease of calculation, and frequent application in prior studies [39].

3.2.2. Independent variable: Board size (BS)

Board size serves as the primary explanatory variable and is measured by the total number of directors serving on the board [40]. Prior research has considered board size a critical determinant of board effectiveness [4]. The board plays a central role in monitoring managerial activities; an increase in board size may strengthen the board's monitoring capacity and thereby improve governance effectiveness [5, 10]. Thus, board size can

be viewed as a proxy for a firm's governance capability, potentially influencing the board's ability to fulfil its monitoring and advisory responsibilities.

3.2.3. Control variables

To accurately assess the relationship between board characteristics and firm financial performance, it is necessary to include additional control variables to reduce omitted variable bias and enhance the reliability of the results. First, the presence of women on the board (FIB) increases diversity and improves monitoring effectiveness [41]. Meanwhile, CEO characteristics may shape managerial behaviour and the firm's strategic orientation [42]. CEO age (AGE) reflects prudence and risk-taking propensity [43], whereas CEO ownership (OWN) indicates a more substantial alignment of managerial interests with corporate objectives [39]. Finally, firm-specific characteristics must also be controlled, as they directly affect performance. Financial leverage (LEV) captures the impact of debt obligations and financial risk exposure [44], while firm size (FS) may provide advantages in terms of resources, market position, and profitability [45].

Measures of the variables are presented in Table 1.

Table 1. Variable measurements.

Variable	Measurement	Research
Return on Assets	Earnings after tax on total assets	[39]
Return on Equity	Earnings after tax on equity	[39]
Board size	The number of members on board	[40]
Leverage	Total debt on total assets	[44]
CEO age	CEO age	[43]
CEO ownership	The number of shares owned by the CEO over the total outstanding shares	[39]
Gender diversity on the board of directors	Dummy variable: 1 if there are women on the board of directors, 0 otherwise	[41]
Firm size	Ln(assets)	[45]

3.3. Research model

This study inherits the research model of R. Sharma (2023) [11] to test the linear relationship between board size and firm financial performance, the general model is specified as follows:

$$PER_{i,t} = \beta_0 + \beta_1 BS_{i,t} + \sum \theta_j (\text{Control})_{i,t} + \varepsilon_{i,t} \quad (1)$$

In the regression model, PER is designated as the dependent variable, reflecting operating efficiency, and represented by ROA and ROE. The primary independent variable, BS, indicates the size of the board of directors. Additionally, several control variables are included to

account for firm- and governance-specific characteristics, such as CEO age (AGE), the CEO's equity ownership ratio (OWN), gender diversity on the board of directors (FIB), firm size (FS), and financial leverage (LEV). Consequently, the model is specified as follows:

$$ROA_{i,t} = \beta_0 + \beta_1 BS_{i,t} + \beta_2 AGE_{i,t} + \beta_3 OWN_{i,t} + \beta_4 LEV_{i,t} + \beta_5 FS_{i,t} + \beta_6 FIB_{i,t} + \epsilon_{i,t}$$

$$ROE_{i,t} = \beta_0 + \beta_1 BS_{i,t} + \beta_2 AGE_{i,t} + \beta_3 OWN_{i,t} + \beta_4 LEV_{i,t} + \beta_5 FS_{i,t} + \beta_6 FIB_{i,t} + \epsilon_{i,t}$$

Then, to examine the potential nonlinear effect of board size on financial performance, following R. Sharma (2023) [11], the squared term of board size (BS^2) is incorporated into the model. The regression model is specified as follows:

$$Y_{i,t} = \beta_0 + \beta_1 X_{i,t} + \beta_2 X_{i,t}^2 + \epsilon_{i,t} \quad (2)$$

$$ROA_{i,t} = \beta_0 + \beta_1 BS_{i,t} + \beta_2 BS_{i,t}^2 + \beta_3 AGE_{i,t} + \beta_4 OWN_{i,t} + \beta_5 LEV_{i,t} + \beta_6 FS_{i,t} + \beta_7 FIB_{i,t} + \epsilon_{i,t}$$

$$ROE_{i,t} = \beta_0 + \beta_1 BS_{i,t} + \beta_2 BS_{i,t}^2 + \beta_3 AGE_{i,t} + \beta_4 OWN_{i,t} + \beta_5 LEV_{i,t} + \beta_6 FS_{i,t} + \beta_7 FIB_{i,t} + \epsilon_{i,t}$$

3.4. Research approach

The dataset was initially assessed to ensure its validity and to minimise the impact of outliers. Variables exhibiting high skewness and kurtosis, such as ROA and ROE, were winsorised at the 5th and 95th percentiles to mitigate extreme values, thus enhancing the reliability of the subsequent regression analysis. The initial estimations utilised Ordinary Least Squares (OLS) along with control variables, followed by Fixed Effects Model (FEM) and Random Effects Model (REM) to address potential endogeneity stemming from unobserved heterogeneity. The appropriate specification was determined using the Hausman and F-tests. To ensure robustness, diagnostic tests were performed to check for multicollinearity (Variance Inflation Factor), heteroscedasticity (Wald test), and autocorrelation (Wooldridge test). When necessary, the Feasible Generalised Least Squares (FGLS) method was employed to achieve efficient and unbiased estimates.

4. Results and discussion

4.1. Descriptive statistics

The sample firms exhibit moderate financial performance (Table 2), with a mean ROA and ROE of 5.6% and 10.6%, respectively. Board size varies between 3 and 9 members, with an average of around 5, suggesting stability in the governance structure. Although Vietnamese law permits boards of directors to have up

to 11 members, the maximum board size observed in the final sample is 9 due to the applied sample selection criteria and the characteristics of listed non-financial firms during the study period. The average age of a CEO is approximately 49, reflecting career maturity. CEO ownership averages 3.6% but is widely dispersed, while firm size and leverage show moderate variation across firms. Female representation on boards is nearly balanced, at 49.3%.

Table 2. Descriptive statistics.

Variable	N	Mean	Std.	Min	Max
ROA	2,030	0.056	0.053	-0.003	0.194
ROE	2,030	0.106	0.085	-0.010	0.305
BS	2,030	5.189	0.925	3	9
AGE	2,024	48.833	8.398	24	73
OWN	2,025	0.036	0.071	0.000	0.506
FS	2,030	26.457	1.379	23.330	30.915
LEV	2,030	0.490	0.236	0.007	1.376
FIB	2,030	0.493	0.500	0	1

ROA: Return on assets; ROE: Return on equity; BS: Board size; AGE: CEO age; OWN: CEO ownership; FS: Firm size; LEV: Leverage; FIB: Gender diversity on the board of directors.

The descriptive statistics in Table 3 indicate that board size ranges from 3 to 9 members, with a mean of 5.19 and a median of 5, suggesting that most firms maintain a moderately sized board. The positive skewness (0.99) reveals a slight rightward asymmetry, implying the presence of firms with relatively larger boards. Moreover, the high kurtosis (6.43) suggests that the distribution is sharply concentrated around the mean.

Table 3. Distribution of board size.

Percentile	Minimum			
1%	3	3		
5%	4	3		
10%	5	3		
25%	5	3	N	2,030
50%	5		Mean	5.189
		Largest	Std. Deviation	0.925
75%	5	9		
90%	7	9	Variance	0.855
95%	7	9	Skewness	0.993
99%	8	9	Kurtosis	6.430

Table 4 presents the correlation matrix of the independent and dependent variables. Overall, the correlations are low to moderate, suggesting limited risk of multicollinearity and supporting the reliability of subsequent regression analysis [46].

Table 4. Variable correlation matrix.

Variable	ROA	ROE	BS	AGE	OWN	FS	LEV	FIB
ROA	1							
ROE	0.869***	1						
BS	0.100***	0.110***	1					
AGE	0.295***	0.247***	0.055**	1				
OWN	-0.018	-0.019	-0.038*	0.162***	1			
FS	-0.204***	0.000	0.149***	-0.158***	-0.100***	1		
LEV	-0.457***	-0.093***	-0.005	-0.146***	0.023	0.517***	1	
FIB	0.174***	0.086***	0.139***	-0.008	0.059**	-0.116***	-0.213***	1

ROA: Return on assets; ROE: Return on equity; BS: Board size; AGE: CEO age; OWN: CEO ownership; FS: Firm size; LEV: Leverage; FIB: Gender diversity on the board of directors. P-value (***, **, *) indicate statistical significance at the 1%, 5% and 10% levels, respectively.

To assess multicollinearity, the study employed the Variance Inflation Factor (VIF) test. All VIF values were below the conventional threshold of 5, indicating that multicollinearity is not a significant issue among the explanatory variables [47].

4.2. Regression results

4.2.1. Linear relationship

The study estimated OLS, FEM, and REM regression models, using firm performance as the dependent variable. Model selection was performed utilising the Hausman test to determine the appropriate choice between FEM and REM, and the F-test to compare OLS and FEM. The findings indicated that the FEM was the most suitable specification for both ROA and ROE. Additionally, the Wald test produced a p-value of 0.000, confirming the existence of groupwise heteroscedasticity. In contrast, the Wooldridge test for autocorrelation in panel data yielded a p-value of less than 0.05, indicating the presence of first-order autocorrelation. The regression results are presented in Table 5.

To manage these challenges and ensure robust estimates, the FGLS method was utilised. The FGLS results, presented in Table 6, show that board size has a positive and statistically significant impact on firm performance at the 1% level, thereby supporting hypothesis H1. This finding suggests that an increased board size enhances diversity, monitoring capabilities, and managerial oversight, ultimately leading to improved firm performance. This conclusion is consistent with previous research indicating that larger boards can positively affect firm outcomes by providing a broader range of expertise and diverse perspectives [5, 10].

In the context of an emerging market like Vietnam, where the board of directors plays a pivotal role in strategic decision-making and management oversight,

Table 5. Regression results of Ordinary Least Squares, Fixed Effects and Random Effects models.

	ROA			ROE		
	OLS	FEM	REM	OLS	FEM	REM
BS	0.004*** (0.001)	0.002 (0.147)	0.002* (0.071)	0.007*** (0.001)	0.003 (0.230)	 (0.065)
AGE	0.002*** (0.000)	0.000 (0.407)	0.000*** (0.002)	0.003*** (0.000)	0.000 (0.546)	0.001*** (0.004)
OWN	-0.034** (0.019)	0.012 (0.506)	0.002 (0.924)	-0.065** (0.014)	0.018 (0.582)	-0.003 (0.913)
FS	0.002** (0.036)	0.003* (0.060)	0.002* (0.064)	0.004*** (0.008)	0.000 (0.907)	0.002 (0.466)
LEV	-0.096*** (0.000)	-0.100*** (0.000)	-0.101*** (0.000)	-0.027*** (0.003)	-0.025* (0.067)	-0.030** (0.012)
FIB	0.009*** (0.000)	0.003 (0.161)	0.005** (0.038)	0.012*** (0.001)	0.004 (0.388)	0.006 (0.165)
_cons	-0.044* (0.060)	0.003 (0.952)	0.007 (0.835)	-0.154*** (0.000)	0.103 (0.231)	0.016 (0.799)
N	2020	2020	2020	2020	2020	2020
R-sq	0.279	0.108		0.084	0.004	
F test	Prob>F=0.0000			Prob>F=0.0000		
Hausman test	Prob>chi2=0.0000			Prob>chi2=0.0000		
Wald test	Prob>chi2=0.0000			Prob>chi2=0.0000		
Wooldridge test	Prob>F=0.0000			Prob>F=0.0000		

ROA: Return on assets; ROE: Return on equity; BS: Board size; AGE: CEO age; OWN: CEO ownership; FS: Firm size; LEV: Leverage; FIB: Gender diversity on the board of directors. P-value (***, **, *) indicate statistical significance at the 1%, 5% and 10% levels, respectively.

increasing the number of members not only enhances the diversity of experience, expertise, and viewpoints but also strengthens the capacity to monitor and regulate management activities. These mechanisms help mitigate the risks associated with potential opportunistic behaviour

Table 6. Linear and Nonlinear Effects of Board Size on Performance.

	ROA		ROE	
	Linear	Non-linear	Linear	Nonlinear
BS	0.002*** (0.000)	-0.008** (0.015)	0.007*** (0.000)	-0.019** (0.022)
BS2		0.001*** (0.002)		0.002*** (0.002)
AGE	0.001*** (0.000)	0.001*** (0.000)	0.002*** (0.000)	0.003*** (0.000)
OWN	-0.020*** (0.010)	-0.022*** (0.005)	-0.063*** (0.000)	-0.063*** (0.000)
FS	0.001** (0.016)	0.001** (0.026)	0.003** (0.014)	0.003** (0.014)
LEV	-0.098*** (0.000)	-0.097*** (0.000)	-0.021*** (0.002)	-0.021*** (0.001)
FIB	0.005*** (0.000)	0.005*** (0.000)	0.008*** (0.002)	0.008*** (0.003)
_cons	-0.005 (0.737)	0.027 (0.111)	-0.122*** (0.000)	-0.05 (0.182)
N	2020	2020	2020	2020

ROA: Return on assets; ROE: Return on equity; BS: Board size; BS²: Squared term of board size; AGE: CEO age; OWN: CEO ownership; FS: Firm size; LEV: Leverage; FIB: Gender diversity on the board of directors. P-value (***, **, *) indicate statistical significance at the 1%, 5% and 10% levels, respectively.

by board members, while simultaneously promoting decisions that are advantageous for shareholders. Consequently, the findings align with practices in Vietnam, indicating that the effectiveness of the Board is bolstered by both its size and composition, ultimately leading to improved performance.

4.2.2. Nonlinear relationship

The study further investigated the nonlinear impact of board size on firm performance by introducing BS² into the regression model. As reported in Table 6, BS² exhibits a positive and statistically significant effect in both the ROA and ROE models. Specifically, the results reveal a U-shaped relationship between board size and performance, evidenced by the significant negative coefficient of BS and the significant positive coefficient of BS². This indicates that firm performance initially declines as board size increases but subsequently improves once the size surpasses a certain optimal threshold. These findings underscore the importance of firms carefully designing their board structure, striking a balance between effective monitoring and decision-making efficiency to enhance overall performance.

This conclusion is consistent with prior studies that documented a U-shaped nonlinear relationship between board size and performance [13].

The relationship between board size and both ROA and ROE exhibits a U-shaped nonlinearity, with the inflection point calculated following the method proposed by F. Plassmann, et al. (2007) [48]:

The findings indicate that the minimum point occurs at approximately 4 members in the ROA model and 4.75 members in the ROE model. This pattern suggests that financial performance tends to decline as board size increases up to these thresholds, but subsequently improves once additional members are added. In this context, the study identifies the range of four to five members as the turning point, highlighting the critical role of designing board structures that achieve an appropriate balance between enhanced monitoring capacity and the rising coordination costs associated with larger boards.

These findings are consistent with prior literature documenting nonlinear governance effects and highlight the importance of identifying an optimal board size that balances monitoring effectiveness and coordination costs. From a theoretical perspective, the U-shaped pattern provides empirical support for the integration of agency theory and resource dependence theory. At smaller board sizes, firms may suffer from weak monitoring, limited expertise, and concentrated decision-making power, leading to lower performance. However, as board size exceeds a critical threshold, the benefits of diversity, expertise, and external linkages become dominant, thereby improving firm outcomes. In addition, the results are partially aligned with stewardship theory, suggesting that moderately sized boards may foster better collaboration and trust among members.

The nonlinear relationship observed in this study can be further understood within the specific institutional and corporate context of Vietnam. Vietnamese firms are predominantly small and medium-sized, with relatively simple organisational structures and a high concentration of decision-making authority within the board. In such settings, very small boards may lack sufficient diversity in expertise and experience, limiting their ability to monitor management and provide strategic guidance effectively. At the same time, increasing board size in the early stages may introduce coordination challenges, including communication inefficiencies, unclear role allocation, and potential free-rider problems. These factors can temporarily reduce firm performance, explaining the negative slope observed at lower board sizes. However,

once the board reaches a moderate size (around 4 to 5 members), the benefits of additional expertise, improved monitoring, and broader perspectives begin to outweigh coordination costs, leading to enhanced performance.

Additionally, the findings reveal significant cross-country differences in optimal board size. Prior studies suggest optimal board sizes of 7-8 members in the United States [21, 22], 13-17 members in France [12], 10-13 members in India [11], and approximately 10-18 members in China [25]. These differences reflect variations in institutional quality, firm complexity, and governance systems. In developed economies, firms are typically larger and operate in more complex regulatory environments, requiring broader expertise and stronger monitoring mechanisms. Similarly, in countries such as China and India, firms often face complex institutional settings and stakeholder networks, where larger boards can help manage political connections and strategic uncertainty. In contrast, the smaller optimal board size identified in Vietnam reflects its unique context. The predominance of small and medium-sized firms reduces the need for large advisory boards, while the relatively underdeveloped governance environment limits the effectiveness of overly large boards. Moreover, the Law on Enterprises (2020) of Vietnam, which stipulates a board size of 3 to 11 members, also constrains the board structure. As a result, moderately sized boards are more effective in maintaining coordination efficiency and decision-making speed while still providing sufficient oversight and expertise.

Taken together, the results indicate that the effect of board size is nonlinear and varies across governance stages. In the Vietnamese context, smaller boards may initially face limited expertise and weak monitoring capacity, whereas larger boards enhance performance through improved oversight and greater resource diversity. This U-shaped pattern underscores that board effectiveness depends critically on achieving an appropriate balance between coordination efficiency and governance capacity. More broadly, the findings highlight that optimal board structures are context-specific and should be aligned with firm characteristics and the institutional environment rather than universally prescribed.

In conclusion, this finding extends the existing literature by demonstrating that the effect of board size is not only nonlinear but also highly context-dependent in emerging markets. While prior studies have primarily identified optimal board sizes in developed economies, the significantly lower threshold observed in Vietnam

reflects differences in institutional quality, firm scale, and governance maturity. This implies that the effectiveness of governance mechanisms cannot be universally generalised across countries. Instead, it depends critically on how internal governance structures interact with external institutional conditions. Consequently, the study contributes to the literature by providing empirical evidence that optimal board design should be tailored to the specific economic and governance context of each market.

5. Conclusions

This study examines the impact of board size on firm performance in non-financial firms listed on the HNX over the period 2013-2022. Using FGLS estimation, the results provide robust evidence of a nonlinear (U-shaped) relationship between board size and firm performance, with an optimal threshold of approximately 4 to 5 members. Importantly, this study contributes to the corporate governance literature by demonstrating that the effectiveness of board size is nonlinear and highly context-dependent in emerging markets. The relatively smaller optimal board size identified in Vietnam reflects differences in institutional quality, firm size, and governance maturity compared to those in developed economies.

These findings have several important implications. For managers, maintaining a board size of 4 to 5 members or more can effectively balance monitoring capacity and coordination costs. Further performance improvements may be achieved by ensuring that additional members bring complementary expertise, diverse experience, and strong governance skills. For policymakers, these results suggest that guidelines on board composition should focus on balancing board size, professional diversity, and oversight capacity, particularly in small- and medium-sized enterprises, to foster effective and sustainable corporate governance.

This study has some limitations. Although the FGLS regression method effectively addresses issues of first-order autocorrelation and heteroscedasticity, the challenge of endogeneity remains inherent in panel data and could significantly impact the findings. Therefore, future studies should employ endogenous treatment methods, such as two-stage least squares (2SLS) and generalised method of moments (GMM), to achieve the best results. Additionally, evaluating board effectiveness solely based on size offers a limited perspective and may overlook the complexities of governance mechanisms. Subsequent studies should incorporate additional factors,

such as board independence, ownership structure, and remuneration policies, to provide a more comprehensive understanding.

Overall, the study underscores that optimal board design is not a “one-size-fits-all” phenomenon; rather, it must be contingent upon firm-specific characteristics and the broader institutional landscape of emerging markets.

COMPETING INTERESTS

The author declares that there is no conflict of interest regarding the publication of this article.

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Packaging and social signals associated with Vietnamese consumers' stated willingness to pay a premium for green last-mile delivery packaging

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Received 22 May 2025; revised 25 June 2025; accepted 5 October 2025

Abstract:

This study investigates the factors affecting Vietnamese consumers' willingness to pay extra for green express packaging in last-mile delivery. Using signalling theory and survey data from 416 participants, the research assesses the impact of environmental signals (eco-labels, recyclability information) and social cues (government policy, peer behaviour). The results show that clear and credible eco-information strongly increases willingness to pay, while recyclable or reused materials alone have little effect due to concerns over hygiene. Social cues-particularly government initiatives and peer influence-positively shape consumer willingness. Notably, only peer behaviour among individuals with green values moderates this effect. The findings recommend that businesses enhance eco-label clarity, governments expand green packaging incentives, and social campaigns leverage peer influence to promote sustainable choices.

Keywords: environmental signals, green express packaging, last-mile delivery, signalling theory, willingness to pay.

Classification numbers: 2.2, 2.3

1. Introduction

The rapid growth of the e-commerce market has significantly increased consumer demand for last-mile delivery services, where plastic packaging remains the preferred material due to its affordability, durability, and effectiveness in protecting products during transit [1, 2]. However, its widespread use, particularly of non-recyclable plastics, poses serious environmental challenges. When improperly managed, plastic waste is often incinerated or sent to landfills, contributing to pollution and endangering both human health and ecosystems [3]. In response, sustainable alternatives such as paper and cardboard packaging have gained attention, though their adoption faces barriers including higher costs, limited durability, and increased resource demands [2, 4]. This creates a trade-off between operational efficiency and environmental responsibility that businesses must navigate.

Recently, consumers' environmental awareness has increased, leading to greater interest in environmental protection initiatives and commitments. As [5] noted, customers purchase eco-friendly products because they believe this is a strategy to mitigate adverse environmental impacts, improve personal health, and provide support for local sustainability. Recyclable or renewable packaging is increasingly viewed as a viable solution for waste reduction [6] and global demand is rising, projected to reach 22 million

tons by 2030 under regulatory and consumer pressure [7]. However, sustainable express packaging typically incurs higher costs than conventional plastic bags [8], and while some consumers are willing to pay a premium for eco-friendly options [9-11], others remain reluctant despite acknowledging the environmental risks posed by plastic [12]. This reluctance may stem from differing perceptions: while green products are often viewed as offering direct benefits, packaging is seen as disposable, making consumers less willing to pay extra. In fact, many previous studies have primarily investigated consumer willingness to pay (WTP) for green products in general retail settings, while green express packaging at the delivery stage has received limited attention [13]. This is especially true in emerging economies, where rapid e-commerce growth intersects with evolving environmental policies, such as in Vietnam.

While signalling theory has been widely used to explain how consumers interpret product cues in retail or shelf-based contexts, this study extends its application to delivery-stage packaging-a less visible, post-purchase component often overlooked in signalling literature [9, 14]. Unlike traditional product packaging, green express packaging in e-commerce logistics serves not only as protection but also as a medium for sustainability communication after purchase. Moreover, this study combines both packaging-level signals (e.g. eco-labels) and macro-level signals (e.g. policy, social norms)

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into a single framework and investigates how individual green values moderate these effects, an area rarely addressed in previous work [15]. However, few studies have examined how environmental and social signals jointly influence green behaviour in emerging economies. In Vietnam, where environmental policies are evolving and collectivist culture shapes peer influence, understanding these dynamics is crucial for promoting sustainable packaging adoption [14, 16]. This study responds to that need by examining how multidimensional environmental and social signals, viewed through the lens of signalling theory, influence Vietnamese consumers' willingness to pay more for green express packaging. Moreover, this research aligns with broader international goals such as the UN Sustainable Development Goal 12 on responsible consumption and production [17] enhancing its relevance in the global context.

In addition, this research aims to address the following key questions:

RQ1: Which express packaging signals influence consumers' willingness to pay more for green parcels?

RQ2: Which societal signals influence consumers' willingness to pay more for green express packaging?

RQ3: How does green perception moderate the effects of these signals on consumers' willingness to pay more for green express packaging?

By addressing these research questions, this study not only clarifies the distinct and combined roles of environmental and social signals in shaping green purchasing behaviour, but also highlights the moderating influence of individual green values, an underexplored factor in the context of emerging economies. Through the Vietnamese lens, where cultural, regulatory, and environmental factors intersect uniquely, this research aims to provide actionable insights for policymakers, logistics providers, and e-commerce platforms seeking to design more effective green packaging strategies. Ultimately, the study contributes to extending signalling theory beyond traditional marketing settings, emphasising its relevance in post-purchase, sustainability-driven contexts.

2. Literature review and theoretical framework

2.1. Signalling theory in green delivery packaging

Signalling theory, originally developed by [15], explains how individuals or organisations convey information to reduce asymmetry between parties. In green express packaging, it describes how post-purchase packaging serves as a communication tool, signalling environmental responsibility through elements such as minimalist design, biodegradable labels, or reused materials. Compared to theories such as the Theory of Planned Behaviour (TPB) or the Norm Activation Model (NAM), which focus on internal

motivations or norms, signalling theory is more applicable in contexts where consumers rely on limited external cues to infer sustainability [18, 19]. This makes it especially relevant in online delivery, where consumers cannot inspect packaging before purchase. Furthermore, prior studies confirm that signals such as eco-labels, material claims, or price positioning significantly influence perceived credibility and willingness to pay [20-22]. When these signals lack clarity or credibility, consumers may become sceptical, reducing their trust and engagement with green packaging claims [10].

These signals are particularly relevant in the express delivery sector, where packaging is primarily designed for transportation and protection, rather than presentation. Eco-labels or sustainable design elements serve as "green signals" to consumers, reducing uncertainty and influencing purchasing decisions [23-24]. However, misleading or weak signals can create scepticism or perceptions of greenwashing, thereby weakening trust [10, 25]. In this study, signalling theory is employed to investigate how various packaging-related signals impact consumers' willingness to pay more for environmentally responsible delivery.

In emerging market contexts, previous studies have underscored the importance of innovation capacity, ESG orientation, and stakeholder responsiveness in shaping green practices and consumer attitudes. Numerous studies have emphasised the role of innovation, stakeholder engagement, and ESG strategies in influencing organisational behaviour and consumer attitudes in emerging markets [26-29]. These findings support the relevance of green initiatives and contextualise consumer responses to sustainability signals, particularly in transitional economies such as Vietnam.

2.2. Multidimensional signals from the environment

Signalling theory also acknowledges that message interpretation is influenced by the broader environment, including social and policy contexts. In Vietnam, the government has implemented frameworks such as Decree No. 08/2022/ND-CP [30], which mandates Extended Producer Responsibility (EPR), requiring companies to take greater accountability for their packaging waste. This regulation acts as a strong macro-level signal, shaping both business practices and consumer expectations around sustainable packaging [31]. In green packaging, multidimensional signals are classified into two categories: packaging-level cues (e.g. recyclable materials, eco-labels) and macro-level influences (e.g. social norms, government policy).

At the packaging level, signals such as recyclable content or reused packaging aim to highlight environmental value. However, prior studies show that these attributes may also trigger negative perceptions due to concerns

about contamination or product quality degradation [32, 33]. Eco-labels and clear green information, when supported by third-party certification, help reduce ambiguity and build trust [34-35].

From the environmental context, government incentives and evolving social norms also play a crucial signalling role. Public policies such as subsidies for green packaging or environmental taxes send institutional cues encouraging eco-conscious consumption [36]. Likewise, consumer behaviours such as public green participation or social media advocacy can act as behavioural signals influencing peer decisions [37-38].

Lastly, how consumers interpret these signals depends on their personal green perception-their values, concern, and awareness regarding environmental protection. Consumers' green perception, defined as their environmental awareness, values, and attitudes, significantly influences how they interpret external signals [9, 39]. Individuals with strong green values are more attuned to both policy and social signals; however, prior research suggests they may respond differently depending on the perceived credibility and relevance of the source. For example, institutional cues (e.g. government policy) may require cognitive alignment with personal norms, while social cues (e.g. peer behaviour) trigger affective or normative conformity responses [38, 40]. Therefore, this study explores whether green perception moderates each signal type differently, potentially enhancing the effect of peer norms more than institutional mandates.

2.3. Research hypotheses

The role of green express packaging in last-mile delivery has emerged as a key signal of environmental responsibility in the e-commerce sector. However, consumer responses to this signal are not uniform; they depend on factors such as the clarity of the messaging and the individual's environmental values. This section delves into the conceptual foundations of signalling theory and draws on empirical studies to outline the development of the research hypotheses. By integrating these insights, the study aims to explore how different types of signals, both institutional and social, impact consumers' willingness to pay for environmentally friendly packaging. Based on this framework, the following hypotheses are proposed to further examine the factors shaping consumer behaviour in this context.

While recyclable and reused materials are intended to promote environmental sustainability and contribute to circular economy principles, they often provoke mixed consumer reactions. Although these materials help reduce landfill waste and minimise resource consumption [41], they may also be perceived as inferior in terms of quality or hygiene. This phenomenon, known as "perceived contamination", creates psychological discomfort,

particularly in contexts where packaging cleanliness is closely linked to product safety, such as in food or cosmetics [32-33]. G. Lin, et al. (2022) [42] and Y.G. Gencer (2016) [43] further emphasise that reused materials can lead to a diminished sense of value or freshness, especially when they are not communicated clearly. If not carefully managed, these associations can weaken the positive effect of sustainability on consumer decision-making and reduce willingness to pay a premium [44]. Recent studies [13, 20] confirmed that clear, credible packaging cues such as eco-labels and green claims are essential to enhance trust and support consumer willingness to pay.

H1: The recyclable and used attributes of express packaging negatively affect consumers' willingness to pay more.

Packaging that includes clear and credible environmental information, such as recyclability symbols, third-party certifications, or biodegradable claims, acts as a strategic communication tool to reduce information asymmetry [18-19]. These signals help consumers recognise the environmental value of packaging, especially when such claims are backed by external validation [34]. M. Gupta (2021) [45] and S.G. Tawde, et al. (2024) [39] found that transparent and informative labelling boosts trust and enhances perceived product quality. On the other hand, vague or exaggerated claims can lead to confusion or scepticism, commonly known as greenwashing [46]. From the perspective of signalling theory, the credibility and clarity of such eco-information determine its effectiveness in influencing willingness to pay more for sustainable alternatives. Based on this, the study proposes:

H2: Eco-friendly information on packaging positively affects consumers' willingness to pay more.

Macro-level signals such as public policy frameworks and social norms exert a substantial influence on consumer behaviour. Social norms, encompassing what is perceived as socially acceptable or desirable, can shape sustainable behaviours by triggering conformity or social approval mechanisms [40, 47]. Simultaneously, government regulations, including environmental taxes, incentives, or Extended Producer Responsibility (EPR) frameworks, serve as institutional signals for legitimising and promoting sustainable consumption [36]. In Vietnam, policies such as Decree No. 08/2022/ND-CP on EPR send strong messages to both businesses and consumers about the importance of adopting eco-friendly practices and environmental responsibility. Prior studies show that such aligned institutional and social cues enhance consumers' willingness to pay for green alternatives [48]. Hence, the following hypothesis is proposed:

H3: Government policies and social norms positively influence consumers' willingness to pay more.

In today's interconnected world, consumer behaviours—especially sustainable actions—are increasingly shaped by the actions of others. When individuals observe peers using green packaging or advocating for sustainability online, these behaviours serve as social proof, indicating that such actions are appropriate and beneficial [37, 49]. This phenomenon is especially influential in collectivist cultures or digital environments where public actions—such as unboxing content or eco-themed user reviews—are easily visible and widely shared [38, 50]. These forms of consumer engagement generate symbolic value and reinforce normative expectations, making consumers more receptive to green packaging even at a higher price point [51]. Consequently, peer behaviour becomes a powerful form of signalling that can alter perceived value. Thus:

H4: Consumers' engagement positively affects the willingness of consumers to pay more.

Consumers' green perception, defined as their environmental awareness, values, and attitudes, significantly influences how they interpret external signals [9], [39]. Those with a strong green mindset are more sensitive to packaging cues, policy signals, and social behaviours, and more inclined to align their choices with sustainability goals [52]. In contrast, consumers with low environmental concern may require stronger external signals or visible social engagement to be persuaded [53]. C. Cong, et al. (2023) [9] suggest that green values moderate the relationship between signal type and behaviour, especially in pricing contexts. Additionally, familiarity and cultural resonance may alter how individuals perceive environmental claims [54]. Accordingly, this study proposes that green perception not only drives direct willingness to pay but also moderates how consumers respond to different types of environmental signals.

This distinction is echoed in [21], who found that consumers with high environmental concern tend to be more discerning and demand stronger justification for green claims. Similarly, P. Plotkina, et al. (2025) [22] emphasised that green brand image and peer validation become particularly influential among eco-conscious buyers, reinforcing the role of social influence in shaping sustainable choices.

H5a: Consumer's green perception moderates the relationship between attitudes towards recyclable and used packaging and willingness to pay more.

H5b: Consumer's green perception moderates the relationship between awareness of eco-friendly information on packaging and willingness to pay more.

H5c: Consumer's green perception moderates the relationship between government policy and norm awareness and willingness to pay more.

H5d: Consumer's green perception moderates the relationship between the perception of other consumers' engagement and willingness to pay more.

Based on the hypotheses developed above, the proposed research framework is presented in Fig. 1. The model proposes that four multidimensional signals influence consumers' willingness to pay more, with consumers' green perception acting as a moderator.

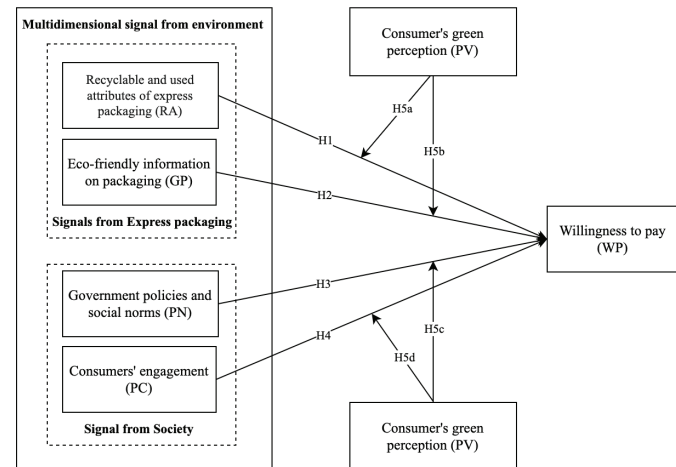


Fig. 1. Research framework.

3. Methodology

3.1. Measurement and data collection

This study examines the impact of multidimensional environmental signals on customers' willingness to pay for green express packaging. The study focuses on Vietnamese customers (aged 18 years and above) who have purchased, or intend to purchase, products using green express packaging. In this study, the snowball sampling method was employed to recruit Vietnamese consumers who have experience with online shopping and receiving goods using green express packaging. Snowball sampling is a non-probability sampling technique in which initial participants refer other individuals who also meet the research criteria. This method is especially effective for reaching specific or hard-to-access populations, particularly when a complete sampling frame is unavailable [55].

The survey was distributed through both online and offline channels. The online version was administered via Google Forms and circulated through social media and email. The offline version was delivered using paper-based questionnaires distributed at local delivery hubs and eco-conscious retail locations. Most respondents were based in Ho Chi Minh City (HCMC), which is recognised as the leading region for e-commerce development in Vietnam due to its high internet penetration, consumer activity, and logistics infrastructure [56-57]. A smaller proportion of responses were collected from other provinces to ensure broader demographic inclusion, although at a lower percentage.

A survey questionnaire comprising 18 items was utilised to gather data for the assessment of six variables. These items were adapted from the previous studies on green express packaging and willingness to pay: three items for recyclable and used attributes of express packaging from G. Pretner, et al (2021) [25], three items for eco-friendly information on packaging [54, 58, 59], three items for government policies and social norms [4, 60, 61] three items for customers' engagement [59, 62, 63], three items for customers' green perception [64, 65]. Finally, three items for willingness to pay were adapted from research conducted by Y. Namkung, et al. (2017) [66]. All items were measured using a seven-point Likert scale.

A pilot test with 20 participants was conducted to evaluate the initial questionnaire's clarity and internal consistency. Cronbach's alpha was calculated for each construct, with values ranging from 0.71 to 0.82, indicating acceptable reliability [67]. Minor wording adjustments were made based on participant feedback to improve comprehension. After modifying the measurement scale, a formal survey was conducted with a sample size that met the basic requirements suggested by C. Ringle, et al. (2015) [68]. The responses were reviewed, and 34 cases were removed based on data quality criteria: (1) completion time under three minutes, and (2) suspicious response patterns. Responses were flagged if participants provided identical or highly repetitive answers across unrelated items, such as using the same rating across all Likert-scale variables or repeating short phrases in open-ended responses. These patterns indicated low engagement or inattentive response behaviour.

A total of 450 questionnaires were collected, of which 416 were deemed valid (92.4%). The detailed demographic characteristics of the 416 valid respondents are presented in Table 1.

Table 1. Sample characteristics.

Measure	Category	N	Percent (%)
Gender	Female	235	56.5
	Male	181	43.5
Age	18-23	125	30.0
	24-30	189	45.4
	31-40	68	16.3
	Above 40	34	8.2
Income	Under 4 million VND	66	15.9
	4-8 million VND	92	22.1
	9-15 million VND	143	34.4
	Over 15 million VND	115	27.6

3.2. Data analysis

A survey questionnaire comprising 18 items was utilised to gather data for the assessment of six variables, including recyclable and used attributes

of express packaging, eco-friendly information on packaging, government policies and social norms, consumers' engagement, consumers' green perception, and willingness to pay. The Partial Least Squares (PLS) approach using SmartPLS 3.0 was employed to assess the proposed hypotheses that were developed [68]. As it does not require data normality and enables the optimisation of correlations between latent variables and observed indicators, the PLS approach is appropriate for survey-based samples [67, 69]. J.F. Hair, et al. (2019) [67] state that three metrics are required to evaluate construct reliability and convergent validity: Cronbach's alpha ($\alpha > 0.70$), composite reliability ($CR > 0.70$), and average variance extracted ($AVE > 0.50$). Discriminant validity was assessed using the Fornell-Larcker criterion, while predictive relevance was evaluated using the R^2 values of the endogenous latent variables.

PLS-SEM utilises a composite-based estimation model, enabling the generation of consistent estimates while facilitating exploratory studies that integrate both explanatory and predictive perspectives [70]. Although covariance- and variance-based modelling techniques have been employed in prior research [71, 72], the inherent uncertainty of survey data may result in estimation errors. PLS-SEM, which does not require normally distributed data, is therefore more appropriate for mitigating estimation bias [73]. Furthermore, PLS-SEM allows for the estimation of complex measurement models and is suitable for multi-group analysis (MGA) [74]. Accordingly, this study employed SmartPLS 3 software to conduct the PLS-SEM analysis (Appendix 1).

4. Results and discussion

4.1. Measurement model assessment

Measurement model evaluation involves assessing the relationships between measurement items and latent variables, as well as determining the fit between the theoretical model and the sample data. This study employed composite reliability (CR) and Cronbach's alpha (CA) to assess internal consistency reliability. Hair et al. (2017) [75] determined that a CR value exceeding 0.7 signifies high reliability, while a CA value above 0.7 indicates good reliability. Table 2 demonstrates that the CR values for all latent variables exceed 0.8, while the CA values surpass 0.7, signifying a high level of internal consistency in the scale. Notably, the CA values for some constructs, such as green perception (0.734) and recyclable attitudes (0.738), are relatively close to the threshold of 0.7. However, both achieved high CR (above 0.85) and AVE (above 0.65), supporting acceptable reliability and convergent validity. These results suggest that the scale is adequate but may benefit from refinement in future applications.

According to the research conducted by J.F. Hair, et al (2012) [70], factor validity is assessed using the outer loadings index, with a threshold of ≥ 0.7 considered acceptable. The outer loading values presented in Table 2 all exceed 0.7; therefore, the measurement items are considered valid for further analysis. According to H. Cooper, et al. (2014) [76], convergent validity refers to the degree of correlation among observed variables measuring the same construct. To assess convergent validity, the average variance extracted (AVE) is used. J.F. Hair, et al. (2021) [77] propose that an AVE value of 0.5 or higher is acceptable, indicating that the latent variable explains more than half of the variance in its observed indicators, or that the scale demonstrates adequate convergent validity. If the AVE value is less than 0.5, it indicates that the latent variable does not sufficiently explain the observed variables and that measurement error may be present. As shown in Table 2, the AVE values of the research model range from 0.654 to 0.741, all exceeding the recommended threshold of 0.5. Therefore, the measurement scale of the model demonstrates satisfactory convergent validity.

Table 2. Construct reliability (CR), Cronbach's alpha (CA), average variance extracted (AVE), and outer loadings.

		Outer loadings	CA	CR	AVE
GP	GP1	0.800	0.734	0.850	0.654
	GP2	0.856			
	GP3	0.768			
PC	PC1	0.836	0.754	0.859	0.669
	PC2	0.798			
	PC3	0.820			
PN	PN1	0.854	0.741	0.853	0.659
	PN2	0.812			
	PN3	0.766			
RA	PV1	0.822	0.738	0.851	0.655
	PV2	0.799			
	PV3	0.806			
WP	RA1	0.857	0.825	0.896	0.741
	RA2	0.842			
	RA3	0.884			

According to C. Fornell, et al. (1981) [78], discriminant validity is established if the square root of the AVE for each latent variable is greater than all correlations between that latent variable and the others. In other words, if the square root of the AVE of a latent variable exceeds the corresponding inter-construct correlations in both the same row and column, the construct can be considered distinct. As shown in Table 3, the square root

of the AVE for each latent variable in the measurement model is greater than the cross-construct correlation values with other latent variables in the same row and column. Therefore, all constructs satisfy the discriminant validity criterion proposed by Fornell and Larcker.

Table 3. Fornell and Larcker criteria.

	GP	PC	PN	RA	WP
GP	0.809				
PC	0.621	0.818			
PN	0.606	0.573	0.812		
RA	0.562	0.488	0.502	0.809	
WP	0.652	0.571	0.599	0.557	0.861

Bold numbers represent the square roots of AVEs.

4.2. Structural model assessment

The structural model was evaluated using R^2 , variance inflation factor (VIF), and the significance of the path coefficients for hypothesis testing. The R^2 value for the dependent variable, willingness to pay (WP), is 0.533, indicating that approximately 53.3% of the variance in WP is explained by the four independent variables: green perception (GP), policy cue (PC), peer norm (PN), and risk aversion (RA). According to J.F. Hair, et al. (2019) [67], this represents moderate explanatory power, which is considered acceptable in behavioural research. To ensure the robustness of the model, multicollinearity was assessed using VIF values. As shown in Table 2, all VIF values range from 1.370 to 2.018, which are well below the threshold of 3.3 [75], indicating that multicollinearity is not a concern among the predictors.

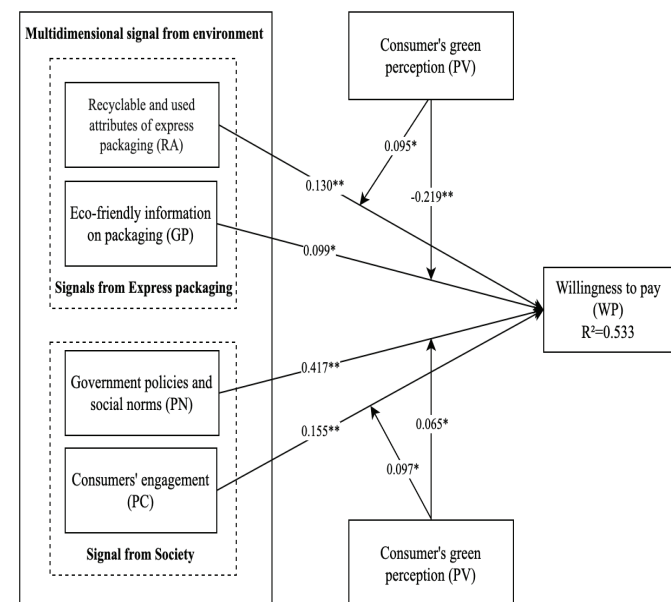


Fig. 2. Statistical significance test results at research model.
Note: *: $p < 0.05$; **: $p < 0.01$.

The path coefficient represents the regression coefficient within the path model and illustrates the relationships between latent variables in the SEM framework. J.F. Hair, et al. (2012) [70] describe bootstrapping as a technique that involves random sampling from the original dataset to repeatedly estimate the path model, thereby capturing variability in the data. The bootstrap standard error facilitates the computation of t-values and p-values, which are used to evaluate the statistical significance of the effects within the model. J.F. Hair, et al. (2012) [70] indicate that the t-value thresholds for a two-tailed test are ≥ 1.65 (p-value = 0.10), ≥ 1.96 (p-value = 0.05), and ≥ 2.57 (p-value = 0.01). A higher p-value indicates lower reliability of the hypothesis, whereas a p-value below 0.05 signifies a statistically significant relationship. Table 4 presents the path coefficient results, indicating the statistical support for six hypotheses and the rejection of two.

Table 4. Bootstrapping results and path coefficients.

	Path coefficients	T-values	p values	Results
H1: RA → WP	0.130	3.664	<0.001	Not supported
H2: GP → WP	0.099	1.990	0.047	Supported
H3: PN → WP	0.417	9.749	<0.001	Supported
H4: PC → WP	0.155	4.051	<0.001	Supported
H5a: PV x RA → WP	0.095	2.159	0.031	Supported
H5b: PV x GP → WP	-0.219	4.001	<0.001	Not supported
H5c: PV x PN → WP	0.065	2.035	0.042	Supported
H5d: PVx PC → WP	0.097	2.025	0.043	Supported

4.3. Multigroup analysis

After analysing the data and testing the hypotheses using SmartPLS 3 software, the moderating effects were examined. PLS-MGA was employed in this study to conduct multigroup structural analysis. This study uses a seven-point Likert scale to assess respondents' personal green values and divides them into two groups based on the consumers' green perception questionnaire shown in Table 2. Respondents with low personal green perception are represented by the first group, which selected scores between 1 and 3, corresponding to *strongly disagree* to *disagree*. The second group represents respondents with high personal green values, who selected scores from 5 to 7 (*slightly agree* to *strongly agree*).

Of the 416 valid responses obtained, 341 respondents belong to the high personal green perception group (Group 2), while 75 respondents belong to the low personal green perception group (Group 1).

Table 5. Multigroup analysis results.

	Path coefficients-diff	p-value		p-value welch -satterwaith test
		Group 1	Group 2	
GP → WP	0.036	0.051	0.720	0.862
PC → WP	0.312	0.000	0.936	0.013
PN → WP	-0.007	0.000	0.013	0.963
RA → WP	0.045	0.000	0.334	0.776

When analysing the differences between the two groups for each relationship based on the path coefficients and p-values of Group 1 and Group 2, the authors found that the relationship between PC and WP is statistically significant for respondents with low personal green values (p-value = 0.000), but not statistically significant for respondents with high personal green values (p-value = 0.936) [79].

According to L. Matthews (2017) [80], the path coefficients - diff value is defined as the difference in standardised impact coefficients between two comparison groups. This index is used to assess differences in impact across groups and is calculated by subtracting the path coefficient value of Group B from that of Group A. In this study, Group A and Group B correspond to respondents with low personal green values and high personal green values, respectively. As shown in Table 5, the path coefficient-diff value for the relationship between PC and WP is 0.312, indicating that low personal green values exert a stronger influence on this relationship than high personal green values.

4.4. Discussion

This study applied signalling theory to explore how green express packaging attributes and broader societal cues influence consumers' willingness to pay (WTP) more for environmentally friendly delivery services in Vietnam. The findings offer a nuanced perspective on how different types of environmental signals-packaging-level, societal, and personal-interact to shape green behaviour.

First, at the packaging level, the study reveals diverging impacts. The presence of eco-friendly information on packaging (H2) positively affects WTP, confirming that clear, credible messages such as eco-labels, symbols, or verified claims serve as effective signals to reduce uncertainty and build trust. This aligns with the core tenets of signalling theory, which highlight the importance of auxiliary cues in bridging the gap between unobservable product attributes and consumer perception. This effect is consistent with M. Gorton, et al. (2021) [81], who emphasise that label credibility and third-party verification are central to enhancing consumer trust. Conversely, recent evidence also shows that graded or detailed eco-labels outperform generic claims, suggesting that design richness is crucial for maximising WTP [82]. In contrast, recyclable or reused packaging

materials (H1), although carrying environmental benefits, had a negative but significant effect on WTP. This suggests that consumers may associate such materials with perceived contamination or inferior quality, especially in the absence of strong information to counter these assumptions. These results are consistent with prior literature noting consumer concerns about reused packaging being unhygienic or second-hand in nature. Clearer communication strategies, such as hygienic certification, visual design adjustments, or third-party endorsements, could help mitigate this negative perception and enhance consumer confidence.

Second, societal-level signals show a stronger influence. Government policy and social norms (H3) positively impact WTP, reflecting the role of institutional mechanisms and collective behaviour in driving sustainable choices. National policies such as Decree No. 08/2022/ND-CP on Extended Producer Responsibility and the Green Growth Strategy have likely contributed to normalising eco-conscious consumption in Vietnam. Furthermore, consumer engagement (H4), observable through peer actions such as reusing packaging or sharing eco-friendly practices, exerts a positive effect, indicating that social proof and normative influence play a vital role in encouraging individual behaviour change. This finding resonates particularly well in the context of Vietnamese collectivist culture, where conformity to community standards and shared behaviours is a strong motivator. Peer-driven influence may function as a shortcut for trust, reinforcing behavioural norms without requiring deep cognitive processing. This interpretation is consistent with recent meta-analytic and empirical evidence showing that peer influence and social norms often outweigh formal policy instruments in shaping sustainable behaviour, especially among younger and socially connected populations [83-84]. The contrast with findings from mature markets, where policy tools are typically more effective, suggests that in urban, youth-heavy contexts such as Ho Chi Minh City, peer effects may dominate. While not explicitly grounded in social learning theory, the results suggest a possible direction for future research to examine how individuals emulate sustainable practices observed in their immediate environments.

Finally, the study examined the moderating role of green perception across multiple pathways. Among the four hypotheses (H5a-H5d), only H5d was supported, indicating that consumers with strong green values are more responsive to peer-related signals than to institutional or packaging messages. This reinforces the idea that individual values amplify the influence of socially driven cues, especially when those cues align with personal environmental priorities.

Notably, H5b, which examined whether green perception enhances the impact of eco-information, was statistically

significant but showed a negative interaction. This suggests that highly eco-conscious consumers may become more sceptical of generic or superficial green claims. Rather than reinforcing positive effects, strong green perception may intensify critical evaluation of claims lacking credibility, thus lowering WTP. This finding aligns with research documenting that eco-aware consumers tend to be more sceptical when exposed to vague or unverified environmental information [79, 85]. Distrust and scepticism towards green claims, including concerns about “greenwashing”, play a significant role. Environmentally conscious consumers are often more knowledgeable and attentive to sustainability issues. As such, they may scrutinise green signals more critically, especially if information lacks credibility, transparency, or third-party verification [86]. This interpretation is consistent with de S.V.F. Netto, et al. (2020) [85] and M. Gorton, et al. (2021) [81], who document that eco-aware consumers are more prone to scepticism when facing vague claims. If eco-friendly information on packaging is perceived as vague or misleading, highly aware consumers may discount such claims, resulting in a negative impact on their willingness to pay. This aligns with growing evidence that consumer scepticism is greater among individuals with stronger environmental values. Therefore, the negative moderation observed here should not be viewed as an anomaly but rather as an important boundary condition in signalling theory, where signal effectiveness depends not only on content but also on audience sophistication.

In summary, these findings suggest that the strength of packaging-, policy-, and peer-based signals is highly context-dependent. Label credibility, policy design and enforcement, and demographic and social conditions (such as urban, youth-heavy samples) together form the boundary conditions shaping signal effectiveness. By integrating these nuances, the study extends signalling theory beyond its traditional assumptions of uniform effects, demonstrating a more contingent and context-sensitive mechanism of consumer response [82-83].

5. Conclusions and management implications

5.1. Conclusions

This study explored how green signals at both the packaging and societal levels influence consumers' willingness to pay (WTP) more for eco-friendly express delivery. By applying signalling theory as the primary analytical lens, the research confirms that eco-friendly information on packaging, government policy, and peer influence all positively affect consumer WTP, whereas recyclable or reused packaging attributes alone show no significant effect unless clearly supported by credible cues. Among societal signals, both institutional trust (government

policy) and social proof (peer engagement) were found to exert strong influence, indicating that external environmental cues play a critical role in shaping consumer behaviour in emerging markets. Furthermore, consumers' green perception was found to selectively moderate these effects, particularly amplifying the influence of peer behaviour (H5d) while exhibiting a negative moderating effect for basic eco-information (H5b), suggesting a more critical mindset among highly eco-conscious consumers. These results point to an important conclusion: effective green marketing must go beyond material attributes and instead rely on message credibility, social context, and value alignment to resonate with diverse consumer segments.

Overall, the findings validate the proposed theoretical framework and contribute to extending signalling theory into the underexplored domain of post-purchase packaging in emerging markets. The results also offer theoretical contributions by demonstrating how green perception can both amplify and weaken signal effects depending on content type—a pattern not widely addressed in prior studies. In practical terms, these insights suggest that firms, particularly e-commerce and logistics providers, should not only invest in eco-friendly materials but also communicate their environmental value effectively. Policymakers can further reinforce green adoption by strengthening normative influence through public campaigns and institutional endorsement. Meanwhile, marketing professionals should leverage culturally resonant messages and social proof to activate peer-driven change. Ultimately, this study underscores that a multi-actor effort spanning policy, business, media, and consumer education is essential to shifting consumption towards more sustainable packaging.

5.2. Theoretical implications

This study contributes to the theoretical advancement of signalling theory by emphasising the differentiated roles of environmental cues in influencing consumers' willingness to pay (WTP) for green express packaging. Specifically, the findings demonstrate that the impact of green signals is not uniform across packaging-level, societal-level, and peer-based signals, and that consumers' green perception selectively moderates their effectiveness. While signalling theory traditionally focuses on the clarity and credibility of signals themselves, this study underscores that the receiver's internal disposition—particularly green perception—also shapes signal interpretation. This insight aligns with and extends previous research by showing that signalling effects are not merely message-dependent but also shaped by contextual and psychological factors.

For instance, consumers with high green perception amplify the influence of peer engagement cues (H5d), but may become more sceptical toward weak or generic

eco-information (H5b), as indicated by its significant yet negative interaction. This nuanced role of green perception contributes to prior research such as White et al. (2019) [87], which emphasised psychological levers, and builds on signalling literature by explicitly integrating attitudinal moderators.

These results reinforce earlier findings that green perception acts as a selective amplifier, enhancing the effectiveness of strong and credible signals while discounting vague or potentially misleading ones [61, 64, 88, 89]. Furthermore, this study highlights an important limitation of signalling theory: its relative inattention to emotional or habitual drivers of behaviour. While signalling theory emphasises rational evaluation of cues, it often overlooks the extent to which consumer decisions are shaped by habits and affective responses—factors that are critical to sustainable behaviour. For instance, habitual purchasing patterns and emotional attachment to convenience or cleanliness may override signal clarity, limiting message effectiveness despite strong eco-claims. Thus, this study contributes to the theoretical discourse by integrating cognitive, emotional, and habitual elements within the signalling framework and by demonstrating how these dynamics operate in a post-purchase context, an area rarely addressed in prior studies. These insights align with the perspectives of K. White, et al. (2019) [87], who emphasised psychological levers such as emotion and identity in sustainable behaviour, and B. Verplanken, et al. (2022) [90], who argued that habit can often override conscious intentions. Future research should further explore how emotional and habitual heuristics interact with green signals to provide a more comprehensive understanding of behaviour change mechanisms.

In sum, this study not only extends signalling theory by demonstrating the selective moderating role of green perception and contributes to the emerging stream of post-purchase signalling research, but also critiques the assumption of purely rational processing, proposing a broader framework that incorporates psychological and habitual dimensions.

5.3. Practical implications

To foster the adoption of green packaging in the e-commerce sector, both policymakers and businesses have important roles to play. Policymakers can contribute by introducing stronger financial incentives, such as tax deductions or grants, to encourage businesses to adopt sustainable practices [88, 91]. In Vietnam, the government has already taken a significant step with Decree No. 08/2022/ND-CP, which establishes the Extended Producer Responsibility (EPR) framework requiring companies to

manage the entire lifecycle of their packaging [30]. This regulatory shift encourages firms to invest in recyclable materials and reduce their environmental footprint, while also ensuring alignment with eco-labelling standards to build consumer trust.

On the business side, companies can further promote sustainable behaviour by fostering consumer engagement. One approach is the use of gamification strategies, such as offering reward points for actions like reusing packaging or sharing eco-friendly behaviours on social media. Recent studies show that gamification mechanisms-such as enjoyment, achievement, and social motivation-significantly increase consumer participation in sustainable behaviours [92-93]. However, as this study demonstrates, generic “green messaging” may be insufficient. Businesses should tailor communication strategies to different consumer segments, using detailed and fact-based messaging for highly eco-conscious consumers and benefit-focused or socially framed messaging for others [87].

Collaborating with influencers or implementing public campaigns can further amplify sustainability messages by leveraging social signals to motivate behavioural change. Systematic reviews demonstrate that influencers play a central role in shaping sustainable consumption decisions [94, 95], while empirical evidence from Vietnam confirms that subjective norms and greenwashing awareness significantly influence Generation Z’s green purchasing intentions [96]. Additionally, social influence-including perceived green value and environmental attitudes-has been shown to play a critical role in sustainable clothing purchase decisions [97].

Rather than relying solely on mainstream influencers, businesses may consider partnering with micro-influencers or community leaders whose values align more closely with the target audience, thereby enhancing message authenticity and trust. This approach aligns with findings that perceived authenticity determines whether influencer collaborations successfully build trust or, conversely, risk backfiring [98].

As this research demonstrates, individuals are more likely to engage in green actions when they observe others doing the same, highlighting the power of social proof as a motivator [38, 49]. Furthermore, green perception-reflecting the degree to which consumers care about environmental issues-plays a key role in shaping responses to green signals such as eco-labels or policy messages. The study therefore underscores the importance of environmental literacy campaigns, particularly for consumers who may be less familiar with the benefits of sustainable packaging. Rather than solely promoting green values, such campaigns should clearly communicate the practical advantages and tangible impacts of green packaging to help overcome scepticism [88, 91]. By combining effective policy measures, business

strategies, and engagement initiatives, stakeholders can create stronger momentum towards sustainable consumption, benefiting both environmental outcomes and long-term business performance.

5.4. Limitations and future research

This study has several limitations that should be acknowledged. First, the survey relied on self-reported data, particularly regarding consumers’ willingness to pay (WTP), which may be prone to hypothetical bias and social desirability effects, potentially inflating stated green behaviours. Specifically, hypothetical bias refers to the tendency of survey respondents to overstate their willingness to pay for green products or behaviours in hypothetical survey scenarios compared to their actual actions in real-market situations. Future studies are encouraged to incorporate behavioural data, such as actual purchase transactions, e-commerce platform analytics, or field experiments, rather than relying solely on self-reported intentions. In addition, experimental designs can help directly measure how different environmental signals, eco-labels, or peer influence affect willingness to pay.

Second, the sample primarily consisted of young, urban Vietnamese consumers, who may exhibit higher environmental awareness than the general population. This demographic bias may also explain why peer influence appeared particularly strong, reflecting the social media-driven behaviours of younger cohorts, while policy signals were less salient due to limited policy awareness within this group. While non-probability sampling methods are useful for reaching targeted or hard-to-access populations, they inherently reduce representativeness, making it challenging to extrapolate results to the entire Vietnamese consumer population. The predominance of respondents from Ho Chi Minh City, where e-commerce infrastructure and environmental awareness are relatively high, introduces potential urban bias; thus, the WTP and perceptions captured here may differ from those in rural regions or lower-income areas with less exposure to green packaging innovations or government campaigns. Additionally, due to the lack of randomisation, non-probability samples preclude the calculation of margins of error and robust statistical inference for the wider population [18, 67]. As such, caution is warranted when applying these insights beyond the study sample. Future research should employ probability-based sampling methods and aim for greater demographic and geographic diversity to enhance the external validity of the findings.

Third, the cross-sectional nature of the study prevents the establishment of causal relationships between variables. Cross-sectional designs provide only a “snapshot” of associations at a single point in time, making it impossible to determine whether changes in perceptions or exposure

to signals precede and cause changes in outcomes such as willingness to pay. Future research could adopt longitudinal or experimental designs to better assess how perceptions and behaviours evolve over time. Moreover, future studies should expand demographic and geographic coverage beyond urban populations and incorporate objective

behavioural data, such as purchase records or participation in green-marketing programmes. These approaches would strengthen the generalisability and practical relevance of future research results.

APPENDICES

Appendix 1. Original variables and modified variables.

Original Variables	Original questions	Modified Variables	Modified Questions	Source
Recycled and Second-hand Attributes	Consumers may attach negative quality values to recycled products.	Recyclable and used attributes of express packaging (RA)	RA1 Consumers may associate negative quality perceptions with recycled express packaging.	[25]
	Consumers think used products may have a shorter lifespan.		RA2 Consumers perceive that second-hand express packaging might possess a reduced longevity.	
	Consumers perceive pollution from second-hand products.		RA3 Consumers recognise the negative environmental effects associated with second-hand express packaging.	
Green Information on Express Package	The provision of green information can improve consumers' perception of product value and their willingness to pay.	Eco-friendly information on packaging (GP)	GP1 Giving consumers access to green information can increase their willingness to pay and their opinion of the value of the product.	[54]
	The provision of green information increases perceived consumer effectiveness (PCE).		GP2 The provision of eco-friendly information increases perceived consumer effectiveness	[58]
	I will read the label before purchasing the product and see if it is a recyclable, low-pollution, environmentally-friendly product.		GP3 Before making a purchase, I will check the product's label to make sure it is recyclable, low-pollution, and ecologically friendly.	[59]
Policy Guidance and Social Norms	Government subsidies have a significant moderating effect on consumers' willingness to buy green products.	Government policies and social norms (PN)	PN1 Government subsidies provide a considerable influence on the willingness of customers to purchase environmentally friendly products.	[60]
	Government policy guidance can improve public awareness of environmental protection and promote social attention to green projects.		PN2 Government policy guidance has the potential to enhance public awareness regarding environmental protection and foster community interest in environmentally friendly projects.	[36]
	Information policies can improve consumers' understanding of recycling behaviour and its environmental benefits and change consumers' attitudes to a certain extent.		PN3 Information policies have the potential to enhance consumers' knowledge of recycling practices and their associated benefits for the environment, as well as to influence consumers' attitudes to some degree.	[23]
Participation of Other Consumers	Consumers appear to trust other consumers and follow their actions.	Consumers' engagement (PC)	PC1 It seems that individuals show a tendency to put their trust in the behaviours and decisions of those around them.	[62]
	The actions of peer consumers in similar purchase situations can affect how people perceive the quality of a product.		PC2 The behaviours showed by peer consumers in similar purchasing situations can influence individuals' perceptions on the quality of a product.	[63]
	Signals stemming from other consumers' opinions and behaviours have a pronounced effect on consumers' quality impressions.		PC3 Signals originating from the opinions and behaviours of other consumers significantly influence the quality perceptions possessed by people.	[85]
Personal Green Values	We are obliged to use recyclable express packaging.	Consumer's green perception (PV)	PV1 We are obliged to use recyclable express packaging.	[64]
	Usage behaviour of recyclable express packaging goes along with my principles of environmental protection.		PV2 The usage behaviours of recyclable express packaging align with my commitment to environmental responsibility.	[65]
	Consumers with high environmental concerns are more inclined to accept green behaviours.		PV3 Individuals with higher levels of environmental concern demonstrate an increased desire to embrace environmentally friendly behaviours.	[39]
Willingness to Pay	It is acceptable for me to pay more money for groceries that are packaged in an environmentally friendly way.	Willingness to pay (WP)	WP1 I find it reasonable to spend extra money for products that are packaged in an environmentally sustainable express packaging.	[66]
	I feel proud to have environmentally friendly packaged products in my house though they are more costly than conventionally packaged products.		WP2 I take pride in having environmentally friendly packaged products in my home, despite their higher cost compared to conventionally packaged alternatives.	
	I would be willing to spend more money in order to buy less environmentally harmful products.		WP3 I would be prepared to spend more money to acquire products that are less harmful to the environment.	

CRediT author statement

Thi Van Trang Tran: Supervision, Writing - Reviewing & Editing; Thi Hoang Linh Ho: Conceptualisation, Methodology, Software, Writing - Original draft preparation; Manh Hung Huynh: Data curation, Writing - Original draft preparation; Thi Hanh Trinh Do, Nhu Hoai Bao Pham: Visualisation, Investigation, Validation, Writing - Reviewing & Editing.

COMPETING INTERESTS

The authors declare that there is no conflict of interest regarding the publication of this article.

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English-language online newspapers in Vietnam's foreign communication: Evidence from 618 articles

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Received 1 April 2025; revised 22 August 2025; accepted 29 August 2025

Abstract:

This article examines the legal framework of foreign communication policies. It employs qualitative analysis and quantitative content analysis of 618 articles published in VietnamPlus and VnExpress International during the 2022-2023 period to evaluate the role of English online newspapers (EONs). The findings indicate that EONs frame information to increase coverage of economics, diplomacy, and heritage topics, directing international public attention while promoting reform achievements, investment potential, and cultural image, thereby strengthening soft power. However, a key challenge identified is that a significant portion of the content remains thematically unclear, which may hinder the effectiveness of foreign communication and the achievement of strategic communication goals. Additionally, critical hurdles include maintaining high-quality translations, upholding rigorous journalistic standards, and complying with relevant regulations. Consequently, capacity-building for journalists, adopting technological innovations for content delivery, and refining editorial oversight are essential to ensure consistent quality. Recommended measures include strengthening editorial management, expanding nuanced coverage of foreign affairs, and upgrading digital infrastructure to broaden global reach. Ultimately, EONs can be a pivotal component of Vietnam's foreign communication strategy, fostering deeper understanding among international stakeholders, solidifying national reputation, and bolstering socio-economic development. By implementing these enhancements, EONs can be better positioned to address emerging global challenges and contribute more effectively to Vietnam's continued integration into the international community.

Keywords: digital diplomacy, English-language online newspapers, foreign communication, media framing, Vietnam.

Classification numbers: 5.1, 5.2, 7

1. Introduction

Journalism and communication play a crucial role in the development of a nation. Journalism serves not only as a medium of information but also as an essential tool for implementing communication strategies that directly influence the public's thoughts, perceptions, attitudes, and behaviours, thereby contributing to the orientation of public opinion towards positive and progressive values [1]. In the context of globalisation and the Fourth Industrial Revolution, EONs have increasingly become a preferred mode of communication for a large public segment, owing to their prominent advantages of speed, high interactivity, and multimedia integration in message delivery. With their distinctive characteristics, EONs encapsulate the advantages of various forms of journalism while employing modern technologies and digital techniques to effectively communicate journalistic messages in general and foreign communication messages in particular. According to Decision No. 2434/QĐ-TTg dated 13 December

2016, from the Government regarding the "Plan for the Foreign Journalism System until 2020, with a vision towards 2030", the term Foreign Journalism (BCDN) was officially utilised in Vietnam. Specifically, "*foreign journalism is one of the crucial forces in foreign information work, forming a part of the propaganda and ideological work of the Party*" [2].

English online newspapers represent a specialised section of electronic news portals. These EONs are affiliated with various countries and disseminate information regarding domestic and international events and topics, facilitating access for the general public within and globally. Numerous online newspaper outlets in Vietnam have established dedicated English sections to convey the nation's foreign information. This platform is recognised as a significant communication channel, enhancing and promoting awareness among the international audience about Vietnam-related information. In the context of Vietnam, EONs can be defined as a specialised segment of electronic news

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platforms that report on issues and fields concerning Vietnam and the world using English. From the perspective of disseminating external information, EONs can be categorised into two levels:

Level 1: EONs provide information across various fields and diverse issues in regions and countries worldwide, addressing international affairs. The audience for foreign communication at this level includes the global public, representing a broad global spectrum.

Level 2: EONs supply information regarding domestic issues within the confines of a specific country. The audience impacted by foreign communication at this level includes the country's public (irrespective of location: citizens residing domestically or living, studying, and working abroad) and international individuals.

In recent years, Vietnam has significantly enhanced its international standing and reputation by undertaking essential responsibilities, such as serving as a non-permanent member of the United Nations Security Council for the term 2020-2021, chairing ASEAN in 2020, successfully hosting the United States-North Korea Summit in 2019, and actively participating in major multilateral forums such as ASEAN, APEC, and ASEM. In this context of extensive integration, foreign communication through EONs has become increasingly crucial, particularly in promoting and positioning the national image and brand. Notably, given the current landscape characterised by increasing global volatility, complex geopolitical circumstances, and the prevalence of distorted and misleading information in cyberspace, it is imperative for official Vietnamese media outlets to provide objective information promptly and accurately in English. This aids in positively directing international public opinion on critical issues related to national interests.

Affirming the role of the press in promoting foreign affairs, both the Party and the Government have issued decisions and resolutions related to defining the tasks of the media, including foreign affairs responsibilities. These include Decision No. 79/2020/QĐ-TTg dated 30 October 2010, regarding the "Regulations on State Management of Foreign Information"; Decision No. 2434/QĐ-TTg dated 13 December 2016, concerning the "Plan for the Foreign Press System through 2020, with a vision towards 2030"; Decision No. 1191/QĐ-TTg in 2020 approving the "Objectives, Tasks, and Solutions to Innovate and Enhance the Capacity of Information Propaganda and Foreign Information Work to Contribute to Building Peaceful, Friendly, Cooperative, and Development-oriented Borders"; and

Decree No. 72/2015/ND-CP dated 7 September 2015, on the "Management of Foreign Information Activities". Thus, foreign newspapers, in general, and EONs, in particular, play a significant role, becoming one of the core components for disseminating information and advancing the nation's foreign affairs, especially in the current complex global context.

Research questions: i) How do EONs in Vietnam frame foreign communication messages for the international public?; ii) What roles do EONs play in promoting Vietnam's national image and safeguarding national interests?; iii) What challenges and opportunities do EONs face after the national press streamlining plan?

2. Literature review

Recent scholarship has reconceptualised traditional public and media diplomacy through integrating digital technologies, coalescing under the umbrella of digital media diplomacy. H. Saliu (2022) [3] argues that digital media diplomacy transcends one-way broadcasting by fostering interactive, networked exchanges between state actors and foreign publics, thereby blending information dissemination, persuasion, and co-creation of narratives. C. Bjola, et al. (2019) [4] expand on this by demonstrating how foreign ministries and diplomatic missions leverage social platforms such as Twitter and Facebook not only for announcements but also to manage reputational crises and monitor global sentiment in real-time. S. Barman (2024) [5] further shows that algorithmic targeting and data analytics enable diplomatic services to tailor messages to segmented audiences ranging from diaspora communities to international investors, thus magnifying persuasive impact and aligning content with foreign policy objectives.

In Vietnam, EONs have transitioned from peripheral translation services to strategic state and private-public diplomacy instruments. Following Prime Minister Decision 1976/QĐ-TTg on 24 November 2020, the Vietnam News Agency's portal, VietnamPlus, was mandated to adopt multimedia storytelling, live updates, and social media integration. L.T. Trieu, et al. (2024) [6] document that these reforms nearly doubled VietnamPlus's monthly multimedia outputs and yielded a 35% increase in unique international pageviews between 2021 and 2023. Complementing this state-led model, VnExpress International, launched in 2013, publishes over 150 English-language articles weekly, mixing investigative regulatory reports with analyses for investors and diplomats [6]. T. Duong (2019) [7] finds that 68% of surveyed foreign business leaders regularly consult VnExpress International

for investment-climate insights, a reliance linked to a 20% uptick in inquiries to the Ministry of Planning and Investment in 2018. Further cohesion emerged when Government Decree No. 46 (12 March 2025) unified Voice of Vietnam's print and electronic English services, standardising a diplomatic glossary co-developed with the Ministry of Foreign Affairs. This measure improved terminological consistency across over 230 weekly English publications [7].

These domestic developments are framed within broader theoretical constructs emphasising dialogue, narrative framing, and institutional capacity. G. Cowan, et al. (2008) [8] propose that digital news outlets must evolve from monologic broadcasts to platforms for dialogue and collaborative engagement, while N.J. Cull (2008) [9] positions them as “narrative-framing” agents capable of shaping real-time diplomatic discourse. D. Oloo's (2021) [10] systematic review finds that ministries with dedicated digital diplomacy units staffed and resourced for analytics and rapid response achieve greater online engagement and message coherence. In Vietnam's context, T.N. Nguyen (2024) [11] highlights opportunities in using e-government portals and mobile apps to enhance transparency and reach but also warns of audience fragmentation if content is not tailored for diverse foreign constituencies. V. Lam (2022) [12] further demonstrates how interactive formats such as live Q&A sessions and multimedia explainers on English platforms can mitigate these challenges by fostering two-way dialogue and deepening foreign engagement.

This body of work affirms that EONs in Vietnam have become indispensable to the country's foreign communication architecture. Institutional mandates, private-sector agility, and interagency coordination have converged to position these platforms as frontline digital diplomacy tools capable of projecting national soft power while enabling genuine exchange with global stakeholders.

3. Theoretical framework and application

A robust theoretical framework is vital for understanding how EONs in Vietnam influence international perceptions and contribute to the nation's foreign communication strategy. This study employs three interrelated theories, including agenda-setting, framing, and constructivism, not only to provide conceptual grounding but also to actively shape the approach to data analysis. Each theory is discussed below regarding its core ideas, methodological application, and explanatory power concerning the influence of EONs (Fig. 1).

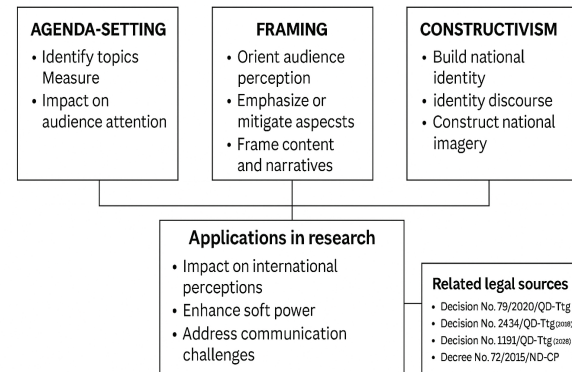


Fig. 1. Theoretical framework for studying EONs. Source: Author's work.

Agenda-setting theory, formulated by M.E. McCombs, et al. (1972) [13], posits that media outlets do not simply reflect reality; instead, they play a key role in determining which issues receive public attention and are perceived as significant. The media guide “*what to think about*” by selecting, emphasising, and repeatedly presenting specific topics, thus shaping the public and policy agenda. In the context of EONs, this theory explains how editorial choices about topic selection, headline prominence, and news frequency can drive international audiences to focus on specific aspects of Vietnam's foreign affairs, such as economic achievements, diplomatic activities, or policy reforms. To operationalise agenda-setting in this research, the analysis systematically quantifies the presence and prominence of different topics within EON content. Headlines, lead stories, and article placement are coded to reveal patterns in topic prioritisation during key events. By measuring the frequency and visibility of each theme, the study uncovers how Vietnamese EONs attempt to shape the international conversation, foregrounding issues that support national interests and diplomatic objectives.

Framing theory explores not just what issues are presented by the media but *how* these issues are constructed and communicated. Frames provide context and narrative structure, highlighting certain aspects of a story while omitting or downplaying others. Through framing, media outlets can guide interpretation, influence opinions, and shape emotional responses. In the case of Vietnamese EONs, framing theory is crucial for understanding how messages about Vietnam, its policies, international relations, or societal challenges are crafted to project particular images or values to global audiences. In practical terms, this study applies framing theory by qualitatively analysing the language, metaphors, and recurring themes of EON articles. Frames such as “*Vietnam as a responsible international partner*”, “*dynamic economic reformer*”, or “*protector*

of cultural heritage" are identified and tracked across different issues and periods. Special attention is given to the framing of sensitive topics, such as maritime disputes, human rights, or environmental challenges, to assess how EONs manage Vietnam's image, address reputational risks, and reinforce positive associations. Comparative analysis across platforms and news cycles helps reveal shifts in dominant frames and their strategic deployment.

Constructivism, as developed by A. Wendt (1999) [14] and others, posits that media are not passive conveyors of information but active agents in constructing social reality and national identity. Through repeated narratives, symbolic language, and the ongoing articulation of collective values, media shape how a nation is perceived externally and internally. In the Vietnamese context, constructivist theory provides a lens to examine how EONs contribute to the formation of Vietnam's desired image in the international arena, embedding concepts such as "*Bamboo Diplomacy*", "*proactive international integration*", or "*resilience*" into the public discourse. This study operationalises constructivist theory through discourse analysis, which identifies, traces, and interprets key narratives, metaphors, and identity markers in EON coverage. By examining the persistence and evolution of particular storylines, the research demonstrates how EONs not only transmit information but also, as "identity entrepreneurs", shape perceptions of Vietnam among foreign audiences. Case studies of major diplomatic campaigns or national branding efforts illustrate the dynamic process by which EONs negotiate and institutionalise Vietnam's strategic identity.

These three theories are not merely cited but embedded in every stage of the research process. Topic selection and coding categories are informed by agenda-setting; qualitative analysis is structured around identifying and interpreting frames; and discourse analysis draws on constructivist insights to understand identity construction. By integrating these theories, the research moves beyond descriptive reporting and systematically explains how EONs influence international perceptions, advance Vietnam's soft power, and address communication challenges in the digital era.

The study also employs documentary analysis of administrative and normative legal texts, such as Decision No. 79/2020/QĐ-TTg of 30 October 2010 on the "Regulation on state management of external information"; Decision No. 2434/QĐ-TTg of 13 December 2016 on the "Master plan for the foreign press system to 2020, with orientation to 2030"; Decision No. 1191/QĐ-TTg (2020) approving the "Objectives, tasks, and solutions for renewing and

enhancing the capacity of information, propaganda, and foreign communication work contributing to building peaceful, friendly, cooperative, and developmental borders"; and Decree No. 72/2015/ND-CP of 7 September 2015 on the "Management of external information activities" across national sectors [16].

4. Methods

This study employs a content analysis methodology that integrates quantitative and qualitative approaches to ensure a comprehensive evaluation of the quantity and depth of meaning of messages in EONs in Vietnam. The research is conducted in two phases:

First, a quantitative analysis was performed by identifying and coding pre-established themes across a sample set of 618 articles. Subsequently, the frequency of occurrence for each theme is statistically analysed, thereby clarifying the prevalence and prioritisation of various content groups and identifying the dominant trends in foreign communication during the survey period. The criteria for selecting news articles for the research sample include:

- (1) The article must be an original piece published in the English section of VietnamPlus or VnExpress International, not an automatic translation or a republished compilation from international sources.
- (2) The article's content must focus on foreign affairs, national image, international integration, diplomatic cooperation, investment promotion, cultural and tourism promotion, or issues influencing the global perception of Vietnam.
- (3) The article must have a clear structure.
- (4) The publication date must fall between January 2022 and the end of December 2023.

The sampling process was conducted using systematic random sampling with a random start. First, all articles meeting the above criteria were listed separately for VietnamPlus and VnExpress International and assigned sequential numbers according to their publication time. The sampling frame consisted of 1,907 eligible articles from VietnamPlus and 1,808 from VnExpress International, giving a total of 3,715 articles. Based on the intended sample sizes of 320 articles for VietnamPlus and 317 articles for VnExpress International, the interval was calculated using the formula $K=N/S$, where K is the sampling interval, N is the population size, and S is the projected sample size determined in Step 1.

Step 1. Determining the projected sample size: The projected sample size was calculated and verified using the SurveyMonkey sample size calculator (<https://www.surveymonkey.com>). The population size was defined as

the total number of articles published by each selected news outlet during the two-year study period. A 95% confidence level and a 5% margin of error were adopted, consistent with standard practice in scientific research.

Step 2. Calculating the sampling interval: Based on the projected sample size, a sampling interval was calculated separately for the two news outlets. The sampling interval for VietnamPlus English was denoted as K_1 , while that for VnExpress International was denoted as K_2 . The interval was calculated using the formula $K=N/S$, where K is the sampling interval, N is the population size, and S is the projected sample size determined in Step 1. The calculation yielded a sampling interval of six ($K=6$) for both datasets.

Step 3. Selecting the sample using systematic random sampling: Systematic random sampling was employed using the calculated sampling interval. For each news outlet, a random starting point was first identified within the initial sampling interval. Subsequently, every sixth article was selected until the required sample size was achieved. The same procedure was applied to both VietnamPlus English ($K_1=6$) and VnExpress International ($K_2=6$), ensuring a consistent and unbiased sampling process across the two datasets. This resulted in a sampling interval of 6 for both newspapers. A random starting point was then selected for each list, after which every sixth article was included in the sample. If a sampled article was found to contain duplicated content, no longer met the selection criteria, or had been removed from the platform, the next eligible article on the list was selected as a replacement. As shown in Table 1, after screening and replacement where possible, the final sample consisted of 317 articles from VietnamPlus and 301 articles from VnExpress International, yielding a total of 618 articles.

Table 1. Sampling frame, intended sample size, sampling interval, and final sample size. Source: Author's work.

Criteria	VietnamPlus	VnExpress International	Total
Population size	1,907	1,808	3,715
Intended sample size	320	317	637
Sampling interval (K)	6	6	–
Final sample size	317	301	618

After the sample collection, a qualitative thematic analysis was conducted following the framework established by V. Braun, et al. (2006) [17] for the coded theme groups. In this study, content analysis was employed as the primary methodological approach to systematically examine the sampled articles. Each article constituted a unit of analysis and was coded into thematic categories developed based on the research objectives and the analytical framework of the study. The coding process focused on identifying

dominant topics, message orientations, and patterns of foreign communication across the dataset. On this basis, qualitative thematic analysis was subsequently conducted to explore in greater depth the underlying meanings, interpretative structures, and recurring patterns within each thematic group. In this phase, the content within each theme group is meticulously read and deeply analysed regarding the presentation of messages, the construction of informational frameworks, and the identification of characteristics, strengths, and weaknesses in foreign communication strategies. The qualitative analysis facilitates the exploration of layers of meaning, nuances of expression, and salient issues that quantitative statistical data may not fully capture. These codes were then grouped into broader themes as seen in Fig. 2.

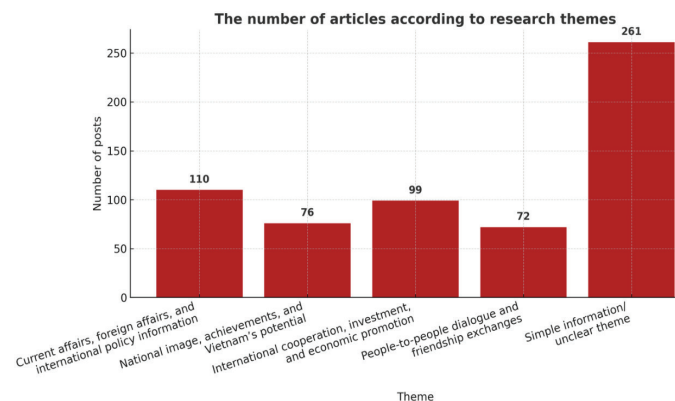


Fig. 2. Distribution of sampled articles by research theme. Source: Author's work.

This process allowed the study to confirm both the content and the communicative strategies used by EONs in Vietnam to transmit foreign affairs messages to an international audience. The use of thematic analysis ensures a systematic and transparent evaluation, following current standards in qualitative research.

5. Findings

5.1. Provision of current affairs, foreign affairs, and international policy information

Firstly, foreign communication via EONs serves as a bridge, providing information and fostering understanding among the public (particularly foreign audiences) regarding the national strategy, the principles and policies of the Party, as well as the laws and regulations of the Vietnamese State. Events such as partnership signing ceremonies, Vietnam's representatives' presence at international gatherings, and regulations across various sectors (including cooperation with other countries) distinctly illustrate the Vietnamese Government's foreign information content. Expressly, in Decree 72/2015/ND-CP, the Government affirms that Vietnam's foreign information comprises [16]:

(1) Official information about Vietnam: Information about the policies and directives of the Party; the laws and regulations of the State; the status of various fields (economy, culture, society, history, etc.); and other relevant information about Vietnam.

(2) Information promoting Vietnam's image: Information regarding the nation, its people, history, and cultural heritage of the Vietnamese ethnic community.

(3) Information on global developments concerning Vietnam: Information concerning global conditions across diverse fields, including insights into the relationships between Vietnam and other countries, aimed at fostering cooperative relationships that support the nation's socio-economic development and facilitate Vietnam's international integration.

As one of the forces responsible for conducting foreign information dissemination, the EONs portal of Vietnam serves as a specialised platform that provides a diverse range of comprehensive information regarding the three primary aspects of national foreign information as outlined in Decree 72/2015/ND-CP in a timely, flexible, and audience-specific manner. Consequently, the public is equipped with essential and significant knowledge about foreign affairs, contributing to an expansion of public understanding and an enhancement of awareness concerning the international positioning and roles of the nation.

Before every major foreign affairs event, such as visits, multilateral signings, activities at the United Nations, APEC, or bilateral meetings with major countries, EONs constantly update developments, publish leaders' speeches, and analyse the context and consequences. A typical example: *"Prime Minister Pham Minh Chinh has instructed all ministries and sectors to proactively participate in multilateral mechanisms and promote the country's external relations, aiming for stronger integration and international cooperation"* (VietnamPlus, January 2023). Through this, international readers, investors, researchers, and foreign reporters can grasp Vietnam's foreign policy strategy, commitment to integration, and stance on regional and global issues.

Secondly, foreign communication through the EONs portal alleviates the public's inquiries, questions, and concerns regarding foreign affairs by disseminating accurate, objective, authentic, and reliable information about relevant foreign events in which the public is interested. In August 2023, VietnamPlus published an article titled *"Foreigners pleased as Vietnam extends e-visa validity to 90 days"*. This article provides specific information regarding the extension of Vietnam's electronic visa validity, enumerating the new benefits for foreign tourists and investors: *"Vietnam has extended*

its electronic visa validity to 90 days, a move welcomed by both tourists and foreign investors. The new policy allows for multiple entries and has been praised as a significant step in supporting international mobility". Below the article, numerous international readers left comments about the visa application process, methods for online procedures, and reflecting on the obstacles they encountered during entry. The commentary section also became a "feedback channel", where the foreign public expressed opinions or posed questions regarding Vietnam's visa policies. As a result, the editorial team can collect feedback promptly and continue gathering information from official sources for further clarification. In many cases, when public inquiries are of a specialised nature (for example, concerning length of stay or visa renewal procedures), the editorial office contacts the relevant authorities to subsequently update details in the "Q&A" section or publish additional articles. Through this approach, the EONs portal not only serves as a conduit for one-way information dissemination but also fulfils the role of a bridge, helping the international public gain a clearer understanding of Vietnam's legal framework and foreign policy directions, thereby positively and appropriately guiding public opinion in alignment with current realities.

5.2. Promotion of national image, achievements, and Vietnam's potential

Promoting Vietnam's national image, notable achievements, and future potential is a core component of the country's foreign communication strategy. EONs serve as principal instruments in this endeavour, functioning as official channels that inform and shape international audiences' perceptions. Through systematic coverage and careful content selection, these media outlets contribute significantly to constructing and disseminating a multifaceted image of Vietnam on the global stage.

A central approach employed by EONs involves highlighting Vietnam's economic accomplishments, supported by credible data and international assessments. Reporting on foreign direct investment and investor confidence is frequently anchored in concrete statistics and expert commentary. One notable example is the coverage of Japanese business sentiment: *"Up to 70 percent of Japanese businesses have announced that they want to expand operations in Vietnam, and as many as 65.3 percent of the 787 Japanese companies recorded high profits in Vietnam in 2018"* (VietnamPlus, February 2019). By foregrounding such figures, EONs do not merely inform; they actively construct a narrative of Vietnam as a stable and promising investment environment. This strategic use of quantitative evidence not only enhances the credibility of the reports but also aligns with the expectations of international readers for transparent, data-driven analysis.

Cultural diplomacy is equally prominent in the content strategies of EONs. The media regularly document the recognition of Vietnamese heritage by international organisations, the growing reputation of Vietnamese cuisine, and the country's achievements in arts and education. *"Vietnamese beef Pho is on the list of 20 best watery dishes in the world, according to CNN Travel. The country's cuisine continues to receive international recognition, strengthening Vietnam's reputation as a top culinary destination"* (VnExpress International, January 2024). The presentation of such achievements is not incidental but instead forms part of a broader communication effort to enhance Vietnam's soft power and promote cultural understanding.

The corrective function of EONs is also notable. When misconceptions or negative narratives about Vietnam arise in international discourse, these media outlets provide factual, balanced perspectives that help counteract bias. By referencing Vietnam's policy commitments and recent progress in environmental sustainability, social equity, and public health, the newspapers offer a more nuanced and comprehensive understanding of the country's development trajectory and willingness to contribute to global solutions. The cumulative impact of these communication activities is observable in Vietnam's improving performance on various international rankings related to business environment, tourism, and cultural influence. EONs regularly cite such indicators as a reflection of the country's achievements and as a persuasive element in shaping further international engagement.

The English online newspaper serves as a vital platform across multiple sectors in Vietnam, such as the economy, culture, education, and science, continuously offering opportunities to strengthen the nation's reputation and build trust among the global community. In turn, this facilitates smoother diplomatic endeavours, both bilateral and multilateral, and streamlines trade promotion, supporting the cultivation of mutually advantageous connections with many countries. Furthermore, this goal aligns with the broader strategy for comprehensive international integration currently pursued by the Vietnamese Party and State.

5.3. Facilitation of international cooperation, investment, and economic promotion

The advancement of international cooperation, investment attraction, and economic promotion remains a cornerstone of Vietnam's foreign communication strategy. EONs play an essential role in this context, serving as primary channels for disseminating information about economic policies, investment opportunities, and collaboration with global partners.

These newspapers provide systematic coverage

of major policy reforms, the signing of bilateral and multilateral agreements, and significant foreign investment projects. Reporting is distinguished by its transparency, accuracy, and the frequent inclusion of official data or authoritative statements. For instance, VietnamPlus reported: *"The Asian Development Bank (ADB) signed a 25 million USD loan agreement with Tien Phong Bank to finance women-led small and medium-sized enterprises (WSMEs), accompanied by a 750,000 USD technical assistance grant to help TPB better meet the needs of WSMEs"* (VietnamPlus, March 2022). Rather than simply noting the occurrence of such events, articles typically place them within the broader context of national development strategies and international cooperation goals. In this example, particular attention is given to Vietnam's efforts to support gender equality and enhance the growth of small and medium-sized enterprises in line with global development priorities.

English online newspapers also devote considerable attention to trade delegations, investment forums, and economic diplomacy activities. Detailed reporting on the participation of Vietnamese businesses in international exhibitions or missions demonstrates the country's proactive integration and highlights priority sectors for cooperation. For example: *"A delegation of Vietnamese enterprises visited Germany to seek new investment opportunities in the fields of renewable energy and digital transformation, underscoring Vietnam's commitment to sustainable growth and international collaboration"* (VnExpress International, July 2023). Such information clarifies Vietnam's orientation towards innovation, openness to high-value partnerships, and readiness to collaborate on key sustainable development issues.

A further aspect is the timely communication of regulatory changes and investment incentives. EONs are often among the first to update international audiences on amendments to investment law, sector liberalisation, and improvements in the domestic business climate. This prompt and detailed reporting is vital in reducing uncertainty, supporting transparency, and strengthening investor confidence, which are crucial for sustainable foreign investment and deeper economic linkages. Additionally, reporting frequently includes the perspectives of international experts, business associations, and institutions such as the World Bank or the International Monetary Fund. These views provide authoritative context and comparative benchmarks, enabling international readers to assess Vietnam's market potential and the effectiveness of its economic policies.

English online newspapers support Vietnam's economic diplomacy and international integration.

Through comprehensive, timely, and well-sourced reporting, they inform international stakeholders and reinforce the country's image as a reliable and forward-looking partner in global economic relations. Their contribution is integral to the promotion of investment, the facilitation of trade, and the advancement of economic cooperation between Vietnam and its international partners.

5.4. Promotion of people-to-people dialogue and international friendship exchanges

Within Vietnam's foreign communication, EONs are increasingly prominent in promoting people-to-people dialogue, fostering international friendship, and protecting national interests. These functions are closely interrelated and together help to project a positive image of Vietnam while safeguarding its sovereignty and identity in an era of rapid global information exchange. This work's theoretical and policy foundation is established in Resolution No. 8 of the XIII Party Central Committee, which affirms safeguarding national and ethnic interests as the highest priority in national strategy. This is reflected in the directive to "ensure the highest national and ethnic interests, based on the fundamental principles of the United Nations Charter and international law" [20]. In practical terms, this commitment requires foreign communication, particularly through official channels such as EONs, to maintain vigilance and proactivity in shaping Vietnam's international reputation.

A primary mechanism by which EONs fulfil this mandate is through rigorous fact-checking and promptly correcting misinformation. In an environment where social media platforms (Meta, YouTube, TikTok, etc.) allow for unregulated and often unchecked content spread, EONs set themselves apart by adhering to strict editorial standards. EONs consistently provide authoritative updates and legal perspectives when tensions arise in the East Sea. An article from VietnamPlus in July 2023 clearly outlined Vietnam's stance: "*Vietnam resolutely and persistently safeguards its sovereignty, sovereign rights, and jurisdiction in the East Sea by peaceful means and in line with international law, including the 1982 United Nations Convention on the Law of the Sea (UNCLOS 1982)*". By doing so, EONs not only inform the international community but also help to prevent the escalation of conflicting narratives that hostile actors may exploit.

The function of EONs as protectors of national interests is further illustrated in their response to digital misinformation and cyberattacks. Following coordinated misinformation campaigns targeting Vietnamese institutions, VnExpress International published an in-depth analysis quoting cybersecurity experts:

"Vietnamese authorities have identified and taken action against coordinated misinformation campaigns targeting key infrastructure. Experts emphasise the importance of public vigilance and the government's commitment to transparent communication" (VnExpress International, October 2023). This demonstrates EONs' essential role in disseminating the state's official response and reassuring international and domestic audiences of Vietnam's capacity to manage complex information threats.

Interconnected with this protective function is the active promotion of people-to-people dialogue and international friendship. EONs frequently highlight events and activities that strengthen cultural ties and mutual understanding between Vietnam and other countries. For instance, coverage of the Vietnam-Japan Festival in Ho Chi Minh City focused on both the celebration of cultural heritage and the spirit of bilateral cooperation: "*The Vietnam-Japan Festival 2023 not only showcases the rich cultural traditions of both countries but also demonstrates the deep bond and mutual respect shared by the Vietnamese and Japanese peoples*" (VietnamPlus, March 2023). Similarly, EON reports on the achievements of the Vietnamese diaspora, such as contributions to scientific research recognised by the World Health Organization: "*Vietnamese scientists have played a pivotal role in international COVID-19 vaccine research, with the World Health Organization acknowledging their significant contributions to global health*" (VnExpress International, May 2022). These stories generate international goodwill and build pride and cohesion within Vietnamese communities worldwide.

It is important to note that these efforts align with Vietnam's unique diplomatic philosophy, commonly called "Vietnamese Bamboo Diplomacy". As officially articulated at the National Foreign Affairs Conference 2021, bamboo diplomacy embodies the spirit of strong roots, a resilient trunk, and flexible branches, representing a steadfast commitment to core principles and adaptability in response to external changes. EONs play a central role in interpreting and communicating this philosophy. This diplomatic doctrine is not only reflected in high-level statements but is also vividly present in the way EONs report on international affairs. When covering sensitive regional disputes, EONs consistently underscore Vietnam's reliance on international law, peaceful negotiation, and multilateral engagement, which are fundamental attributes of bamboo diplomacy. The coverage of maritime issues in the East Sea demonstrates Vietnam's legal determination and preference for dialogue and constructive cooperation. Similarly, reporting on Vietnam's leadership in ASEAN, participation in United Nations initiatives, and proactive

role in climate change negotiations consistently frames the country as reliable and adaptable, a nation that stands firm on principle but remains open to partnership and consensus. Bamboo diplomacy is further expressed in EONs' extensive coverage of people-to-people exchanges, cultural festivals, and bilateral celebrations, such as the Vietnam-Japan Festival or international New Year greetings. These stories showcase Vietnam's openness, inclusiveness, and ability to forge deep, lasting friendships, key elements of soft power that the bamboo metaphor encapsulates.

These communication activities are conducted within the policy and legal framework set by Decree 72/2015/ND-CP, ensuring that Vietnam's information is consistent, factual, and aligned with national interests. The integration of bamboo diplomacy into high-level policy and daily news coverage affirms the essential role of EONs in shaping Vietnam's image and the practice of Vietnamese foreign policy itself. EONs are indispensable in expressing and actualising the spirit of bamboo diplomacy. Through balanced, authoritative, and context-rich reporting, they contribute to safeguarding national interests, advancing international friendship, and positioning Vietnam as a resilient, adaptive, and trustworthy partner in the global arena.

6. Discussion and recommendations

Alongside the positive roles that EONs play in Vietnam's foreign communication, this research has revealed several persistent challenges that limit the effectiveness of these platforms in today's era of globalisation and rapid technological change.

First, in a world marked by increasing global integration, rapid advances in communication technology, and complex shifts in international politics, Vietnam faces the ongoing challenge of effectively conveying its foreign policy messages across various domains, especially politics, economics, and social stability. EONs serve as important channels for sharing information about Vietnam with the global community, but they also help shape perceptions, promote the country's image, foster cooperation, and support national unity. However, EONs are confronted with strong competition from global social media platforms such as Facebook, YouTube, X (Twitter), and TikTok. These platforms enable information to spread instantly, encourage broad public engagement, and offer various perspectives on Vietnam. In contrast, EONs follow formal editorial processes and policy guidelines, which can slow their updates and make attracting young or international audiences who expect fast, diverse, and interactive content more challenging. The findings indicate that many popular topics related to Vietnam

first emerge on social media before being addressed and analysed by official news outlets, sometimes diminishing the role of EONs in guiding international public opinion.

Second, documents from the 13th National Congress of the Communist Party highlight the urgent need to “*renew the content, methods, and effectiveness of foreign communication*”. This sets high expectations for news organisations, especially EONs, to continuously improve content quality, diversify topics, and adopt engaging presentation styles to build trust and expand their international audience. Nevertheless, there remains an ongoing challenge in balancing official policy objectives with the need to make content more appealing, diverse, and engaging for international readers. Most EONs focus primarily on promoting and safeguarding national interests in line with the Party and State directions, leading to a strong emphasis on positive news and limited coverage of sensitive or controversial topics. While this approach ensures a consistent and stable foreign communication message, it may reduce the dynamism and appeal of EONs compared to global social media, where trending topics are openly discussed and can quickly shape public perception.

Particularly, the results of the quantitative analysis indicate a concerning issue regarding the overwhelming proportion of articles categorised as “*Simple information/unclear theme*” (42.2% of the total survey sample). This finding serves as a significant warning concerning the effectiveness of foreign communication in EONs in Vietnam. Articles within this category often merely provide isolated event information, list data, or quote statements, lacking analysis, commentary, or connection to national strategic messages. The article “*Vietnam's major cities push ahead with electric bus revolution*”, published on VnExpress International on 11 June 2023, summarises the situation in Hanoi by stating: “*Five routes have been converted to electric operation, and the total number of electric buses in the city has risen to 225*”. The article merely enumerates the newly implemented electric bus routes and the number of vehicles. It lacks any commentary or analysis regarding the implications of electric bus development for environmental policy, tourism benefits, or social impacts on the populace, particularly concerning international tourists or expatriates residing in Vietnam. This represents a form of reporting that remains at the level of mere events, devoid of depth in understanding or strategic message connectivity.

Furthermore, some articles simply relay international information without providing evaluation, discussion, or connection to the perspectives and interests of Vietnam.

The article “*US pledges to enhance cooperation with Vietnam in coping with climate change*”, published on VietnamPlus on 7 September 2022, primarily reports on the meeting between Prime Minister Pham Minh Chinh and US Special Presidential Envoy John Kerry, with excerpts such as: “*Prime Minister Pham Minh Chinh had a meeting with US Special Presidential Envoy for Climate John Kerry on September 7*” - “*Kerry said the US wants to strengthen cooperation with Vietnam in coping with climate change, developing renewable energy, and achieving net zero emissions by 2050*”. The article merely lists statements and information regarding the commitment to cooperation, without analysing Vietnam’s actual role and contributions to these global issues, nor does it provide any commentary on the significance of the event for the country’s image or foreign communication strategy. This situation may stem from the pressure to produce news rapidly and a lack of clear thematic direction. If this trend persists, enhancing soft power and positioning the national brand through foreign communication will be challenging to achieve substantively. Lessons learned indicate that reforming foreign communication requires not only diversifying themes and formats but also necessitates a fundamental shift in content development thinking, transitioning from merely updating events to guiding perceptions with clear, in-depth themes closely aligned with national strategic objectives.

Third, translation quality stands out as a significant barrier to the effectiveness of EONs. The primary audience for these platforms consists of foreigners, researchers, international journalists, investors, and overseas Vietnamese, all of whom expect accurate and natural English and consistency in specialised terms, particularly in diplomacy, politics, defence, and culture. In practice, many editors still rely heavily on machine translation, have limited exposure to international audiences, and may not fully understand the expectations of their diverse readers. As a result, translation errors, awkward language, or misinterpretations can occur, especially with technical terms, names, historical events, or sensitive diplomatic content, potentially making articles less persuasive or leading to misunderstandings. Editorial teams are often small, with limited resources for thorough review or consultation with native speakers, and there is a lack of unified terminology across news organisations. The pressure to publish quickly and the increasing complexity of topics such as digital transformation, climate change, and modern international cooperation further shorten the time for careful editing. All these factors can undermine the credibility, appeal, and impact of Vietnam’s foreign communication. They may even harm the country’s image, the reputation of its

media organisations, and international perceptions of Vietnam.

The aforementioned practical challenges impact the operational effectiveness of EONs in Vietnam and influence the communication mechanisms outlined within the study’s theoretical framework. The rapid development of social media, with its capacity to disseminate information and generate multifaceted discussions, has significantly altered the media landscape, thereby affecting the agenda-setting role of EONs. In many instances, the public first accesses prominent topics and information through social media, necessitating that EONs adjust their approaches to maintain their agenda-setting role and provide accurate, timely information. Furthermore, certain limitations regarding the quality of translation and the presence of simplistic articles lacking clear themes may adversely affect the framing function of foreign journalism. In articles introducing economic achievements, if the information is limited to mere data or events without an analysis of their significance, the message portraying “*Vietnam as dynamic, innovative, and integrated*” may not truly stand out or persuade international readers.

Additionally, minor translation errors can diminish accuracy, resulting in incomplete message transmission. When messages regarding national image are not clearly articulated or fail to convey the necessary nuances, establishing a positive and consistent perception of Vietnam in the eyes of international audiences may encounter certain obstacles. Moreover, these factors also influence the construction and reinforcement of national identity within foreign media. The dissemination of distinctive values, such as the diplomatic image of bamboo, necessitates that journalistic content be coherent, profound, and focused on identity elements. If the content primarily serves an informational purpose, lacking connections to identity or strategic values, the ability to create a unique imprint and build the national image on the international stage will be somewhat constrained.

Therefore, this research proposes several recommendations aimed at enhancing the role of EONs in the current foreign communication efforts of Vietnam, as follows:

Adherence to legal regulations and official guidelines is a central requirement in producing foreign communication content for EONs in Vietnam. In practice, editorial departments regularly consult Decree No. 72/2015/ND-CP [15] and Directive No. 05/CT-TTG to verify the accuracy and appropriateness of information before publication, particularly for topics with potential diplomatic or political sensitivity. Editorial workflows are structured so that content relating to

foreign affairs undergoes legal and policy review by designated editors or legal consultants. Regular training sessions and internal briefings keep staff updated on changes in legislation and official directives. Content audits and compliance checks are periodically conducted to identify risks or breaches, ensuring that published material remains within the bounds of regulatory requirements. In cases involving contested narratives or sensitive information, editorial boards coordinate with relevant authorities to clarify facts and provide corrective reporting when necessary. This approach supports providing accurate, comprehensive information and a timely response to misinformation or unfounded claims in the international information environment.

Improving the effectiveness of EONs in foreign communication depends on editorial expertise and technological capacity. Editorial teams benefit from the participation of journalists and editors with backgrounds in international relations, foreign languages, and multimedia reporting. Opportunities for professional development, including workshops on digital storytelling, data journalism, and the coverage of complex foreign affairs topics, contribute to improved content quality. Collaboration with universities and training centres is a practical approach to strengthening staff skills through joint courses and internships. Applying digital tools and new content formats, such as interactive graphics and multimedia explainers, supports broader audience engagement and timely information delivery. Using analytics to monitor article reach and reader feedback enables editorial teams to adjust content strategies based on evidence rather than assumptions. Regular reviews of published content and technological processes help identify gaps and areas for improvement. In this way, investments in human resources and technology support the long-term enhancement of Vietnam's foreign communication efforts through EONs.

One of the most persistent challenges facing EONs in Vietnam is ensuring the consistent quality of English translations. High-quality translations are fundamental for conveying foreign communication messages accurately and enhancing Vietnam's international image. To address this, news organisations should focus on building specialised translation teams that combine strong English proficiency with subject-matter expertise in international relations and journalism. A multi-step review process involving subject experts and native English editors is recommended to minimise errors and ensure clarity. Collaboration with universities, professional associations, and external consultants can help reinforce these efforts (Fig. 3).

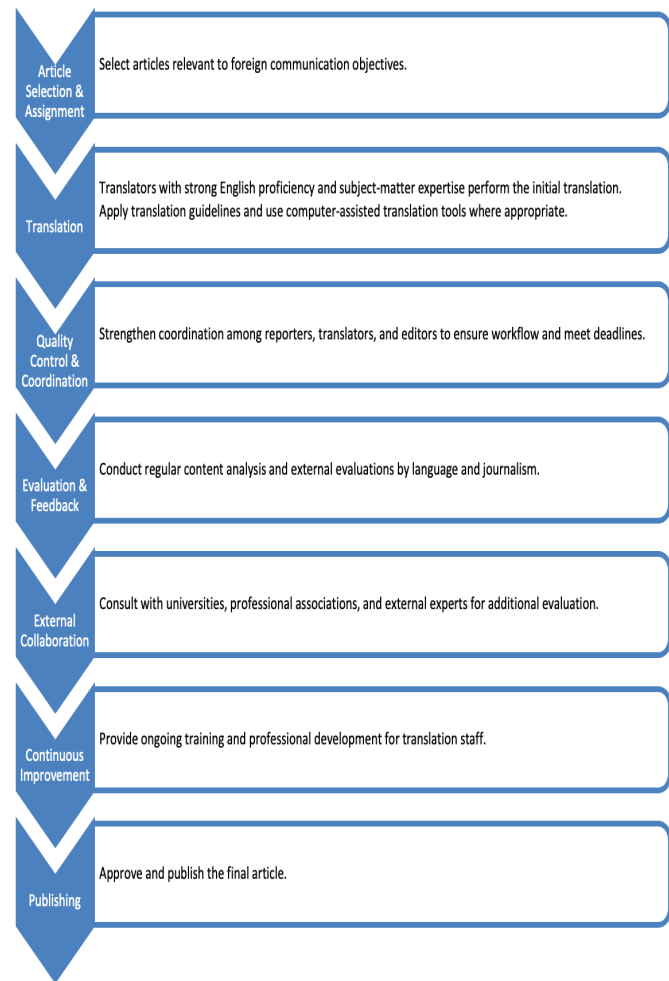


Fig. 3. Proposed workflow for translating and publishing English-language online news articles. Source: Author's work.

In addition, newsrooms should adopt clear translation guidelines, apply computer-assisted tools where appropriate, and strengthen coordination among reporters, translators, and editors to meet tight deadlines without compromising quality. Regular content analysis and external evaluation by language and journalism experts are essential for ongoing quality assessment. Feedback from international readers should also be solicited to further improve readability and credibility. Continuous training and professional development for translation staff will ensure that EONs maintain high standards, supporting the effectiveness of Vietnam's foreign communication strategy.

7. Conclusions

EONs in Vietnam serve as proactive, swift, and credible foreign communication channels with a wide-ranging impact on diverse public audiences. The primary target group significantly influenced by EONs in Vietnam comprises foreign audiences

both within Vietnam and globally. Consequently, the online journalism in English represents a medium that facilitates public access to information and alters perceptions regarding Vietnam's foreign activities. This, in turn, enhances the quality and effectiveness of disseminating information and the Vietnamese State's policies, guidelines, and legal frameworks regarding foreign relations in the contemporary context. Furthermore, the English online newspaper contributes to establishing Vietnam's brand and credibility on the global stage, safeguarding national interests in international endeavours, and addressing media crises while correcting misinformation. Based on these functions, the study proposes three recommendations. First, foreign communication through EONs should continue to adhere strictly to legal regulations and official guidelines so that information remains accurate, consistent, and appropriate, particularly in relation to politically or diplomatically sensitive issues. Second, greater investment should be directed towards both human and material resources, especially through improving technological infrastructure, enhancing digital production capacity, and strengthening the professional expertise of journalists, editors, and translators involved in foreign communication. Third, the development of English content should be treated as a substantive strategic priority rather than a merely technical task. This includes improving translation quality, ensuring terminological consistency, increasing thematic depth and analytical value, and adopting more suitable multimedia and digital formats to expand international reach and audience engagement. These recommendations are intended to address the limitations identified in current foreign communication practices and to further strengthen the role of EONs in Vietnam's contemporary foreign communication efforts.

COMPETING INTERESTS

The author declares that there is no conflict of interest regarding the publication of this article.

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Cognitive culture of the river environment as reflected in place names in Can Tho City

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Received 4 September 2024; revised 11 November 2024; accepted 25 June 2025

Abstract:

The natural environment of the Mekong delta in general, and Can Tho in particular, plays an important role in shaping the living environment for its inhabitants, contributing to the formation of a distinctive river culture for both Can Tho and the Southwest region. The expansion of land reclamation and agricultural production activities in the Southwest region generally, and Can Tho specifically, since the 17th century, has fundamentally altered the natural landscape. This transformation is clearly reflected in the place names of Can Tho. The character of the natural environment is encoded in these place names and partly reflects accumulated knowledge of river and canal systems, as well as an awareness of aquatic animals and local waterway traffic. Using data collection, statistical and classification methods, fieldwork, and in-depth interviews, combined with interdisciplinary approaches and grounded in cultural region theory, particularly with reference to the natural characteristics of Can Tho, this article focuses on understanding the manifestations of cognitive culture related to the river environment through place names. It thereby contributing to documenting indigenous knowledge of the local people.

Keywords: Can Tho, cognitive culture, place names, river environment.

Classification numbers: 9.3, 10

1. Introduction

Humans exist and develop within the natural environment; therefore, the relationship between humans and nature is a fundamental aspect of cultural life. This relationship is multidimensional, involving both adaptation to the living conditions imposed by nature and the transformation of nature through techniques, experience, and other means to enable it to serve human needs. Through this process, humans form lifestyles, behavioural principles, and cognitive attitudes appropriate to the natural conditions surrounding them.

To adapt, exploit advantages, and cope with the difficulties and challenges posed by nature, specifically the river environment, the people of the Southwest in general, and those of Can Tho in particular, must possess a wealth of experience and a considerable body of knowledge about the cultural space in which they exist. Consequently, awareness of the river environment constitutes one of the essential and vital needs of the residents here.

According to N.T. Tran, et al. (2018) [1], “*in the process of existence and development, the human community - the cultural subject - always has the need to learn, and thus has accumulated a rich treasure of experience and knowledge about the universe and humans themselves - these are two microsystems of the cognitive cultural subsystem*”. In their history of interacting with the natural environment, especially the river environment, they have “both applied their existing knowledge to take advantage of and deal with the environment, and accumulated a lot of new knowledge based on the experience gained through this process”.

2. Research objects, scope, and methods

2.1. Research object and scope

This article examines place names that reflect the cognitive culture of the river environment among the people of Can Tho, focusing specifically on those that convey awareness of river and canal systems, as well as aquatic animals and local waterway traffic.

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Content scope: The study surveys written documents and field investigation materials, including existing place names as well as those that have since disappeared but still retain valuable cultural elements.

Spatial scope: The primary focus is on Can Tho city. To gain a deeper and more comprehensive understanding of the formation and transmission of cultural capital, the research extends to include place names within Can Tho province.

Time scope: The survey encompasses place names recorded from the establishment of the Tran Giang headquarters in 1739 up to 2021.

2.2. Research methods

Based on the article's approach grounded in the theory of cultural regions, interdisciplinary methods are employed, including analysis and synthesis, statistics and classification, with particular emphasis on data collection.

Data collection method: This method enables the author to obtain a rich and authentic source of documents, facilitating effective research on the topic. It comprises:

- **Primary data collection:** Combined with field investigation and interview methods, the author gathers data on the meanings and origins of folk place names that currently exist primarily in the consciousness or daily lives of the people and are rarely found in publications or administrative records.

- **Secondary data collection:** Documents related to the topic are selected from various sources, including books, journals, theses, dissertations, and websites. Official lists of place names in Can Tho city associated with cultural awareness of the river environment are obtained from state agencies (Statistics Department, relevant departments, branches, and sectors). Additionally, documents from authors researching place names in Can Tho city are consulted. Folk place name records that appear only in publications but not in administrative documents are drawn from sources such as the Party History of Can Tho province (historical), Party Histories of districts, Mekong delta folk literature, Can Tho folk literature, local documents published during the French colonial period and the Republic of Vietnam era, old geographical records of Can Tho province, and current local historical references. These official, published sources are highly reliable. The diversity and richness of these data provide significant advantages for analysis, evaluation, and understanding of the subject matter.

Statistical and classification method: From the collected data, statistical analyses are conducted on the number of place names related to the cognitive culture of the river and canal environment currently existing in Can Tho city. These are then classified into three fundamental groups: place names reflecting cognitive culture of river and canal systems, those reflecting awareness of aquatic animals, and those relating to waterway traffic. The results form the basis for systematically and comprehensively decoding place names containing elements of cognitive culture related to the river and canal environment.

Synthesis and analysis method: Building on the classified data, the author analyses the origins, meanings, and cultural values of the cognitive culture of the river and canal environment as expressed in place names in Can Tho city, verifying findings against relevant sources. The results serve as key evidence for comparison, evaluation, synthesis, and commentary throughout the research period and underpin the article's findings.

The results obtained through these methods provide the author with a comprehensive and diverse documentary base in terms of both the quantity of place names and the objectivity and thoroughness with which the cultural elements of river environment awareness embedded in Can Tho's place names can be decoded.

3. Findings

Through field surveys combined with statistical analysis of place names in Can Tho city, the author recorded 499 place names associated with the cognitive culture of the river environment. The research results are shown in Table 1.

Table 1. Place names reflecting cognitive culture of the river environment in Can Tho city.

No.	Types of place names	Number
1	Place names reflecting cognitive culture of river and canal systems	433
2	Place names reflecting cognitive culture of aquatic animals	34
3	Place names reflecting cognitive culture of waterway traffic	32
Total		499

Source: Survey results, 2021.

3.1. Place names reflecting the cognitive culture of river and canal systems

The survey results are shown in Table 2.

Table 2. Statistical table of place names related to river and canal systems.

No.	Types of place names	Number
1	Place names associated with the element Lang	9
2	Place names associated with the element Lung	7
3	Place names associated with the element Rach	132
4	Place names associated with the element Xeo	43
5	Place names associated with the element Tac (Tat)	10
6	Place names associated with the element Vam	26
7	Place names associated with the element Song	8
8	Place names associated with the element Kenh (Kinh)	116
9	Place names associated with the element Cai	82
Total		433

Source: Survey results, 2021.

Place names related to water elements in Can Tho illustrate the dense network of waterways in the ancient land of Tran Giang, present-day Can Tho. As the capital of the Southwest region since the French colonial period, Can Tho is situated on the right bank of the Hau river in the Mekong delta. It is an urban river area characterised by a dense system of rivers and canals, renowned for numerous fruit gardens along the Cai Rang, Ba Lang, Vam Xang, and Phong Dien routes, extending extensively to the Binh Thuy canal. The Cai Rang floating market is also a notable attraction for both domestic and international tourists. Since its formation, the land of Tran Giang - Can Tho has been entirely composed of alluvial deposits regularly laid down by the Mekong river through the Hau river.

Tran Giang Dao - the original name of the Can Tho land - is one of the four Daos established by Mac Thien Tich in 1739. In "Gia Dinh Thanh Thong Chi", T.H. Duc (1999) [2] wrote: "The headquarters of Tran Giang Dao is located on the West bank of Hau river upstream from the East of Nam Vang citadel flowing down to Chau Doc, Can Dang, to the south to Cuong Oai, Lap Vo mountain, then to Tran Giang, through Tran Di Dao, to Ba Thac seaport...". With favourable terrain adjacent to the great river, Tran Giang Dao became a key strategic position on

the waterway and a strong rear base for Ha Tien in its defence against the frequently harassing Siamese and Khmer armies. The name Tran Giang means "to guard the river", which can be broadly understood as referring to a river region.

The Hau river (also known as the Bassac river, Tonle Bassac, or Ba Thac) is a branch of the Mekong river, approximately 220-250 km in length, with the section flowing through Can Tho spanning about 65 km. The "Dai Nam Nhat Thong Chi" of the National History Institute of the Nguyen Dynasty (1997) states that [3]:

The Hau Giang river is located 8 miles northwest of Tay Xuyen district. It originates as the Tien Giang river, reaches Nam Vang district of Cambodia, and splits into a branch to the southwest to become the Hau Giang river. The east of the river are the districts of Dong Xuyen, Vinh An, and An Xuyen. To the west are the districts of Tay Xuyen, Phong Phu, Vinh Dinh, and Phong Thinh. The river is in the middle of the province.

Thus, the territory of Tran Giang - Can Tho, from the time of Lord Nguyen Phuc Khoat (Tran Giang) to that of King Gia Long (Vinh Dinh district) and King Minh Mang (Phong Phu district), was situated on the west bank of the Hau river. Today, the Hau river flows through the districts of Thot Not, O Mon, Binh Thuy, Ninh Kieu, and Cai Rang, depositing fertile alluvium that contributes to the prosperity of the local economy. Moreover, the Hau river has lent its name to several localities, including Hau river road, Hau river 3 area (Ninh Kieu), Rach Sung - Hau river road (O Mon), Nam Hau river urban area, and Nam Hau river road (Cai Rang).

Between the Hau Giang section and the Can Tho river basin, hundreds of large and small canals flow into the city. Among these, place names containing the element Rach constitute the largest group, with 132 instances. According to H. Phe, et al. (2009) [4], the original Khmer term for rach is prek (prek, preak), meaning "a path leading water from the river to the fields, where boats can travel". Examples include Rach Cam river, Rach Cam Nho river, Rach Ranh bridge, Rach Mieu bridge (Binh Thuy), Rach Gap road (O Mon), Rach Ruong market, Rach Rich market (Thot Not), Vam Rach Tre bridge, Rach Nha Tho bridge (Phong Dien), and Rach Chiec bridge (Cai Rang), among others.

In addition, canals are recorded in 116 place names. These are defined as "water conduits dug and built on the ground, serving irrigation and transportation" [4]. These canals not only facilitate convenient water travel but also aid in draining acidity and washing away alum from the soil. Typical place names associated with this

water element include Kênh Cho canal, Xeo Kinh bridge, Kinh Giua bridge (Phong Dien), Kênh Cut estuary, Kênh So 10 intersection (Thot Not), Kênh Xang bridge, Cau Kênh road (O Mon), Kinh Ngang bridge, and Kinh Chuoi bridge (Thoi Lai), among others.

Xeo is defined as a “small creek in the South” [4]. It represents a typical riverine landform in the Southwest region generally, and in Can Tho specifically, and is reflected in 43 place names. Place names containing the element Xeo in Can Tho often include names of plants that grow abundantly in the area, such as Xeo Quyt canal, Xeo Lua canal, Xeo Lua bridge, Xeo Khe canal, Xeo De canal (O Mon), Xeo La canal, Xeo La bridge (Cai Rang), Xeo Cao bridge, Xeo Khe bridge (Binh Thuy), Xeo Tram bridge (Thot Not), Xeo Tre bridge, Xeo Tram bridge (Co Do), Xeo De canal, Xeo De bridge, Xeo Cui canal, Xeo Cui bridge, Xeo Tre canal, and Xeo Tre bridge (Phong Dien).

Vam, of Khmer origin *piam* (pam, peam, piem), means “river mouth, where a canal flows into a river or a small river flows into a larger river” [4]. In Phong Dien district, there is a place called Vam Xang, named after the dredgers who began excavating the Xang Xa No canal from the Can Tho river section, approximately three kilometres from Phong Dien market. Consequently, the place name Vam Xang, along with Vam Xang market and Vam Xang ferry, originated from this. Other place names containing this element include Hai Vam bridge, Vam Can Duoc bridge (Thot Not), Vam Nhon bridge (Thoi Lai), and Vam Rach Tre bridge (Phong Dien).

Place names containing the element Cai have been classified by the author as reflecting the cultural perception of the river environment in Can Tho city. According to L.T. Hoa (2002) [5], “Cai is a noun meaning a river branch or a canal... With the understanding that Cai denotes a river branch or canal, it is possible to explain more than 90 percent of place names containing the common element ‘Cai’ in the South”. In Can Tho, there are 82 place names featuring this element, most of which are associated with plants, such as Cai Chanh canal, Cai Cui river, Cai San estuary, Cai Chanh market (Cai Rang), Cai Khe canal, Cai Son canal, Cai Khe ward (Ninh Kieu), Cai Chom canal, Cai Son area, Cai Chom Rach bridge (O Mon), Cai Son Tren road, and Cai San Vam road (Thot Not), among others.

Additionally, place names in Can Tho record various terrain types, such as Lang Sen canal, Lang Sen market, Lang Chim district road (Vinh Thanh), Ba Lang river, Ba Lang ward (Cai Rang); lung: Lung Au canal (Vinh Thanh), Lung Sau bridge (Phong Dien), Lung Tuong bridge

(O Mon); and tat (tac): Cai Tac canal, Cai Tac bridge, Cai Tac intersection (Cai Rang), Nga Tac canal, Nga Tac bridge (Thot Not), among others.

It is evident that 433 place names associated with typical elements such as “rach”, “vam”, “kênh” (kinh), “cai”, and “xeo” in Can Tho collectively demonstrate the people’s cognitive culture regarding the rich and favourable natural river environment. This environment offers substantial economic potential, fostering the development of rice farming, gardening, aquatic resource exploitation, and stabilisation of livelihoods.

3.2. Place names reflecting cognitive culture of aquatic animals

The river environment, characterised by a dense network of rivers and canals, provides a significant source of aquatic products for the people of Can Tho. Since its formation, the capital of Tran Giang - Can Tho - has been home to numerous dense forests, sedges, and reeds. These conditions are favourable for mosquito breeding. Larvae hatched from mosquito eggs, along with floating animal carcasses, serve as an ideal food source for the cultivation of shrimp and fish. There are 29 place names recording aquatic species present in the riverbeds of Can Tho, as well as craft villages related to aquatic exploitation activities. Some well-known place names include Du Tho canal and Cai Ho canal (O Mon district), Can Tho canal, and Ca Ho canal (Thot Not district). Additionally, otters have been recorded in the area, as reflected in the place name Phe canal (O Mon district).

To capitalise on the local fishery resources, many residents have made a living by fishing in rivers, canals, and estuaries, gradually forming craft villages associated with these activities, such as fishing village (Cai Rang district), cau village, fishing village (Thot Not district), luoi village (Binh Thuy district), day village (Ninh Kieu district), and Du Tho village, which specialises in weaving traps for catching fish, shrimp, and prawns.

Although the river environment is rich and economically beneficial, it is also harsh and poses many potential dangers. When road transport was limited, boat travel along rivers and canals was an effective means of transportation. However, the widespread presence of crocodiles constituted a major threat to the people of Can Tho. Tran Giang was replete with swamps and mudflats, creating ideal breeding grounds for crocodiles. Six place names record the local anxieties concerning this dangerous animal, which persist to this day. Examples include Lung Sau and Lung Sau bridge (Phong Dien district), Dau Sau canal, Dau Sau bridge, Dau Sau estuary, and Dau Sau intersection (Ninh Kieu district).

3.3. Place names reflecting cognitive culture of waterway traffic

The survey results are shown in Table 3.

Table 3. Statistical table of place names reflecting waterway traffic.

Numerical order	Types of place names	Number
1	Place names reflecting perceptions of the nature of water in waterway traffic	23
2	Place names reflecting the laws of waterway traffic	9
Total		32

Source: Author's field survey and documentary database, 2021.

There are 32 place names associated with the cognitive culture of waterway transportation among the people of Can Tho. Residents living along rivers, canals, islands, swamps, and islets often own boats or small canoes for convenient travel, trade, daily life, and in urgent situations such as illness, to ensure prompt transportation. According to S. Nam (2017) [6], boats and canoes function like "legs"; people use them to visit villages, buy tea and cakes, attend weddings and funerals, and to transport midwives and doctors. Even thieves and robbers exploit rivers and canals to arrive unexpectedly and escape swiftly.

Furthermore, except during the heavy rains of the monsoon season, water flows smoothly throughout the year, facilitating convenient boat travel. As noted by the Provincial Party Committee and People's Committee of Can Tho province (2002) [7], "Here, the river is the main traffic artery, and boats and canoes become so important that they are essential". Consequently, awareness of water movement patterns is a vital and urgent necessity for local people to organise their personal lives efficiently and maintain economic productivity.

Waterway traffic, as well as the daily life of the people in the Mekong Delta generally and Tran Giang - Can Tho specifically, is greatly influenced by the ebb and flow of the tide. Although there are deep water channels, the water surface remains calm, without large waves or strong winds, as exemplified by the Binh Thuy Channel (Binh Thuy district). According to H. Minh (2001) [8], an anecdote recounts that in the fifth year of Emperor Tu Duc's reign (Nham Ty 1852), Governor Huynh Man Dat was on a boat tour when he encountered a severe storm upon reaching Linh islet. He discovered a channel with calm waters where the boat could safely shelter from the wind. Secretly praising the terrain as resembling a "lying dragon", he named it Binh Thuy. Since then, many

place names in the area have incorporated Binh Thuy, such as Binh Thuy river, Binh Thuy bridge, Binh Thuy district, and Binh Thuy market. As noted by the Provincial Party Committee and People's Committee of Can Tho province (2002) [7], "In Binh Thuy village, as its name suggests, the river water is gentler and calmer; therefore, people settled early, quickly developed, and it became the homeland of the Can Tho people, a heritage of which later generations are proud". Similar place names appear elsewhere in the southwest region, including Binh Thuy commune (An Giang) and Binh Thuy hamlet (Vinh Long).

However, this area has long contained estuaries and three- or four-way river intersections with whirlpools, posing dangers to boats and canoes passing through. Consequently, experience in navigating rivers and canals is vital. Place names such as Nuoc Van estuary, Nuoc Van bridge, Nuoc Van junction, Bung Binh canal, and Bung Binh bridge (Cai Rang district) reflect the awareness of the river environment by the people of Tran Giang. Nuoc Van Junction, the river estuary in front of Thuong Thanh communal house, has existed for centuries. At low tide, water flows rapidly, creating circular whirlpools (vortices) that make it easy for boats and canoes to capsize. Historically, a large stretch of river existed at the start of the estuary. To avoid danger, boats often slowed for safety or turned back towards Can Tho or downstream to Soc Trang, hence the name Bung Binh canal. The place name Bung Binh also occurs in Tra Vinh province (Bung Binh bridge) and Ca Mau province (Bung Binh hamlet). Furthermore, the depth of rivers and canals is also recorded by local residents through place names such as Cai Sau river, Cai Sau bridge (Cai Rang district), Xeo Sau canal, and Rach Sau Nho bridge (Phong Dien district).

When the people of the Ngu Quang region migrated southward along the East coast to new lands, sailing boats were no longer suitable. The ancients therefore developed small boats capable of easily entering dense forests and weaving through canals to explore the locality. The need for effective transportation in this new terrain necessitated the establishment of conventions and consensus regarding movement. As canal traffic became heavy, numerous dangerous incidents occurred. In addition to relying on experience to respond, people also established rules to ensure convenient travel and to avoid losses and disputes. According to T.H. Duc (1999) [2], at that time, the "Nghi Biếu hầu", who commanded the garrison, issued the following regulations for travelling on waterways:

All boats, regardless of whether the wind or current is favourable or unfavourable, when they come close to each other, they all shout “bat” (commonly called “cay” for going to the left, “bat” for going to the right), then our boat goes to the right, the other person’s boat also goes to the right, following the flow to steer... if they want to avoid each other, the steersman just shouts “bat”... As for shouting “Cay” when the boat reaches the dock, encounters the wind and runs aground, or has an accident, then they shout like that.

Thus, Bat - Cay (cay) refers to the custom of travelling by boat on rivers and canals dating back to the time of King Gia Long. Numerous place names in Can Tho still reflect this custom, including Nga Bat canal, Nga Bat street, Nga Bat bridge (Cai Rang district), Nga Bat canal, Nga Bat bridge, Nga Bat street, Nga Cay canal, and Nga Cay bridge (O Mon district), among others. To this day, the custom is preserved through the folk song:

*“You go to the right and row straight
I turn left and pry the bow of the boat”*

In the southwest region, this custom is frequently reflected in place names, including Nga Bat canal (Kien Giang), Cai Bat Giua canal (Ca Mau), Nga Bat canal and Nga Bat river (Vinh Long), Nga Bat river (Hau Giang), Nga Cay canal (Hau Giang), and Nga Cay canal and Nga Cay river (Vinh Long), among others.

From the primitive river laws of the pioneering period, certain elements were inherited and formed the basis for modern inland waterway traffic regulations. These include rules such as: When two vessels travelling in opposite directions face a risk of collision, the captain or driver must signal to give way; and the vessel travelling upstream must yield to the vessel travelling downstream, among others.

4. Conclusions

The natural environment of the Mekong delta in general, and Can Tho in particular, plays a crucial role in shaping the living environment for its inhabitants,

contributing to the formation of a distinctive river culture for both Can Tho and the broader Southwest region. To survive, develop, explore, and master nature, people have had to accumulate extensive experience and knowledge regarding the laws and characteristics of the rivers in their homeland. The cultural capital embodied in the awareness of the river environment - expressed through 499 place names in Can Tho city - partly demonstrates the sensitivity and adaptability of the local people. This awareness has enabled them both to cope with the challenges posed by the river environment and to harness its advantages for survival and development over nearly three centuries.

COMPETING INTERESTS

The author declares that there is no conflict of interest regarding the publication of this article.

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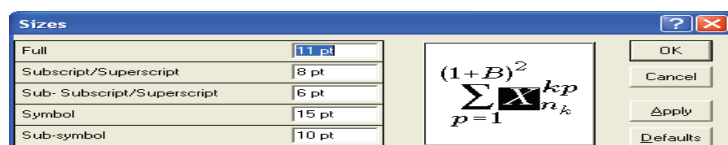


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PUBLICATION LICENCE

No. 459/GP-BTTTT 20th July 2021

No. 50/GP-BTTTT 1st February 2023