

RICE Journal

of Creative Entrepreneurship and Management



RICE

Rattanakosin International College of Creative Entrepreneurship, RMUTR

VOLUME 7 NUMBER 2

MAY - AUGUST 2026

ISSN 2821 - 9074 (Online)

ISSN 2730 - 2601 (Print)

<https://so12.tci-thaijo.org/index.php/RJCM>

ISSN 2821-9074(Online)
ISSN 2730-2601(Print)

RJCM

RICE JOURNAL OF CREATIVE ENTREPRENEURSHIP
AND MANAGEMENT

Rattanakosin International College of Creative Entrepreneurship (RICE)
Rajamangala University of Technology Rattanakosin (RMUTR)

Volume 7, Number 2, May-August 2026

Published by:

Rattanakosin International College of Creative Entrepreneurship (RICE)
Rajamangala University of Technology Rattanakosin (RMUTR)

Editorial Office: Academic Division

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RJCM Vol. 7, No. 2, May-August 2026

RICE Journal of Creative Entrepreneurship and Management (RJCM)
Rattanakosin International College of Creative Entrepreneurship (RICE)
Rajamangala University of Technology Rattanakosin (RMUTR)

About Us

RJCM is an international journal for academics and scholars at the higher education level to communicate and share their viewpoints and academic work with fellow professionals in the areas of creative entrepreneurship and management as practiced in their fields of specializations in social sciences. Currently, it is under the supervision of Thai-Journal Citation Index (TCI).

RJCM publishes three numbers per volume annually and welcomes contributors to submit their manuscript in January, May, and September of each year. We accept both academic and research papers in social sciences from contributors. The papers are double-blind reviewed by three independent reviewers in each volume and published online-plus-print thrice a year.

The length of the unformatted manuscript in WORD can be 15 pages in length including references. The contents of the manuscript should include (1) a title with the author's name, affiliate, email address and telephone contact, (2) an abstract of 150 words with 3-5 keywords, (3) an introduction, (4) a rationale and background of the study, (5) research objectives, (6) research methodology, (7) data collection procedure, (8) data analysis, (9) results and discussion, (10) research limitation (if any), (11) conclusion, (12) acknowledgement(s) (if any), (13) the author's biography of about 50-80 words, (14) references, and (15) an appendix or appendices (if any).

All interested readers and paper contributors please contact Editor-in-Chief 2: Wichai Siriteerawasu, Ed.D., Rattanakosin International College of Creative Entrepreneurship (RICE), Rajamangala University of Technology Rattanakosin (RMUTR), <wichai.sir@rmutr.ac.th>. Please kindly note that website submission will be advised after the first editorial screening.

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RJCM Vol. 7, No. 2, May-August 2026

RICE Journal of Creative Entrepreneurship and Management (RJCM)
 Rattanakosin International College of Creative Entrepreneurship (RICE)
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Note from the Editors of RJCM Volume 7 Number 2

Dear *RJCM* Readers,

Rattanakosin International College of Creative Entrepreneurship (RICE), Rajamangala University of Technology Rattanakosin (RMUTR), Thailand, is pleased to present RICE Journal of Creative Entrepreneurship and Management (RJCM) now steps in the seventh year, Volume 7, Number 2, May-August 2026.

This issue features seven articles that have undergone rigorous peer review by three distinguished experts in relevant fields. Importantly, the reviewers are independent of the authors and the evaluation process was conducted under a double-blind system.

The articles published in this issue reflect a diversity of topics within the journal's academic scope. They contribute valuable theoretical insights that scholars and researchers may further develop, extend into new studies, or employ in the creation of new knowledge.

The Editorial Board extends its sincere gratitude to all authors who submitted their work for publication, to the peer reviewers who generously devoted their time to provide constructive evaluations and recommendations, and to the advisory team whose contributions were vital in bringing this issue to completion.

We hope that RICE Journal of Creative Entrepreneurship and Management (RJCM) will serve as a meaningful academic resource for all readers. The Editorial Board warmly welcomes submissions for future issues, which will undergo thorough review by qualified experts both within and outside the institution. We also welcome suggestions and feedback, which will be carefully considered to further enhance the quality and standards of the journal.

Wichai Siriteerawasu, Ed.D.

Rattanakosin International College of Creative Entrepreneurship (RICE)
Rajamangala University of Technology Rattanakosin (RMUTR), Thailand

Address from RICE Director

Nuttapong Jotikasthira, Ph.D.

Rattanakosin International College of Creative Entrepreneurship (RICE)

Rajamangala University of Technology Rattanakosin (RMUTR), Thailand

Dear *RJCM* Readers,

It is with great pride and anticipation that I present this issue of *RICE Journal of Creative Entrepreneurship and Management (RJCM)*. As the journal continues to grow in scope and influence, it remains steadfast in its mission to serve as a platform for advancing knowledge, fostering innovations, and bridging theories with practices in the fields of entrepreneurship and management.

RJCM is committed to nurturing scholarly dialogue that not only enriches academic discourse but also inspires practical applications for educators, business leaders, and policymakers. Each article published here reflects rigorous peer review, intellectual integrity, and a dedication to excellence—qualities that ensure the journal's contribution to both local and global communities of practice.

I extend my deepest gratitude to the authors for their valuable contributions, to the reviewers for their critical insights, and to the editorial team for their tireless efforts in upholding the journal's standards. Together, we are cultivating a vibrant academic ecosystem that encourages creativity, resilience, and forward-thinking leadership.

It is my sincere hope that this issue of *RJCM* will serve as a source of inspiration and guidance for readers, sparking new ideas and collaborations that advance the frontiers of creative entrepreneurship and management.

Nuttapong Jotikasthira, Ph.D.

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Rajamangala University of Technology Rattanakosin (RMUTR), Thailand

RJCM Vol. 7, No. 2, May-August 2026

e-ISSN 2821-9074

Print-ISSN 2730-2601

RICE Journal of Creative Entrepreneurship and Management, Vol. 7, No.2, pp. 1-12,

May - August 2026

© 2026 Rajamangala University of Technology Rattanakosin, Thailand

doi: 10.14456/rjcm.2026.8

Received 02.03.26/ Revised 21.05.26/ Accepted 28.05.26

Motivation for Pursuing Graduate Studies in Digital Technology and Learning Innovation at the Faculty of Education, Ramkhamhaeng University

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Abstract

This study aimed to: (1) investigate the motivation for pursuing graduate studies in the Digital Technology and Learning Innovation program, Faculty of Education, Ramkhamhaeng University; and (2) compare the factors influencing motivation to enroll in the program.

The population consisted of 35 graduate students in the Digital Technology and Learning Innovation program, Faculty of Education, Ramkhamhaeng University. The sample included 32 graduate students, determined using Krejcie and Morgan's sample size table and selected through purposive sampling. The research instrument was a five-point Likert scale questionnaire. Data were analyzed using descriptive statistics, including frequency, percentage, mean, and standard deviation.

The findings revealed that the most influential motivational factor was faculty members ($\bar{x} = 4.55$, S.D. = 0.71). The highest-rated item under this factor was that faculty members possess knowledge, competence, and expertise in their respective fields ($\bar{x} = 4.69$, S.D. = 0.53). The second most influential factor was personal reasons ($\bar{x} = 4.43$, S.D. = 0.82), with the highest-rated item being the desire to enhance one's knowledge, skills, and abilities ($\bar{x} = 4.63$, S.D. = 0.65). The third factor was curriculum-related factors ($\bar{x} = 4.39$, S.D. = 0.80), particularly the continuous development and improvement of the curriculum and the appropriateness of the program duration ($\bar{x} = 4.44$, S.D. = 0.83). The fourth factor was institutional image ($\bar{x} = 4.34$, S.D. = 0.84), especially the university's educational standards and students' satisfaction with continuing their studies at Ramkhamhaeng University ($\bar{x} = 4.47$, S.D. = 0.83). Finally, the fifth factor was educational expenses ($\bar{x} = 4.33$, S.D. = 0.91), with the highest-rated item indicating that the cost of education is lower compared to other institutions ($\bar{x} = 4.63$, S.D. = 0.82).

Keywords: *Motivation; Graduate Studies; Digital Technology and Learning Innovation*

1. Introduction

In an era characterized by rapid advancements in digital technology, various dimensions of education have been significantly affected and must continuously adapt to ongoing changes. Teaching and learning in the 21st century are no longer confined to traditional instructional approaches; rather, they require the integration of digital technologies and innovative practices to create effective learning processes that respond to the evolving needs of learners. Consequently, the development of human resources equipped with knowledge and competencies in digital technology and learning innovation has become increasingly important, particularly at the graduate level, where emphasis is placed on research, data analysis, and the development of applicable educational concepts.

The graduate program in Digital Technology and Learning Innovation at the Faculty of Education, Ramkhamhaeng University represents a response to contemporary educational demands and the advancement of knowledge in a field that plays a crucial role in modern society. The program aims to develop students' understanding and essential skills in applying technology to teaching and learning, as well as designing innovative solutions that support learning processes. Such preparation is vital in enabling learners to cope with ongoing transformations in educational systems and human resource development.

However, students' decisions to pursue graduate studies in this field are not solely based on academic content. Multiple factors influence their decisions, including opportunities for self-development, career advancement, family expectations, and personal motivation. Examining motivation for pursuing graduate studies in this field is therefore essential, as it reflects the extent to which learners are prepared and committed to developing themselves in areas related to technology and learning innovation. Previous studies have indicated that motivation can be broadly categorized into two main types: intrinsic motivation and extrinsic motivation (Aree Phanmani, 1995). Intrinsic motivation is often associated with personal interest and the desire to enhance technological skills, whereas extrinsic motivation may stem from career opportunities, higher income, or professional recognition. Understanding these two dimensions of motivation enables the Faculty of Education to design curricula and educational management strategies that better align with learners' needs and expectations.

Furthermore, understanding students' motivations for enrolling in the Digital Technology and Learning Innovation program can contribute to the development of effective student recruitment strategies. Identifying the key factors that stimulate interest and influence enrollment decisions can support curriculum promotion efforts and attract individuals with strong potential and genuine interest in this field.

Based on these considerations, the researcher aims to investigate and compare the motivational factors influencing graduate study decisions in the Digital Technology and Learning Innovation program at the Faculty of Education, Ramkhamhaeng University. The findings of this study are expected to provide valuable insights for program development and improvement, enhance understanding of learners' behaviors and needs in the current context, and support curriculum enhancement and marketing strategies that align with societal demands and labor market requirements in the digital era. Ultimately, the study seeks to maximize benefits for both students and Ramkhamhaeng University.

1.1 Research Objectives

1. To examine the motivation for pursuing graduate studies in the Digital Technology and Learning Innovation program, Faculty of Education, Ramkhamhaeng University.

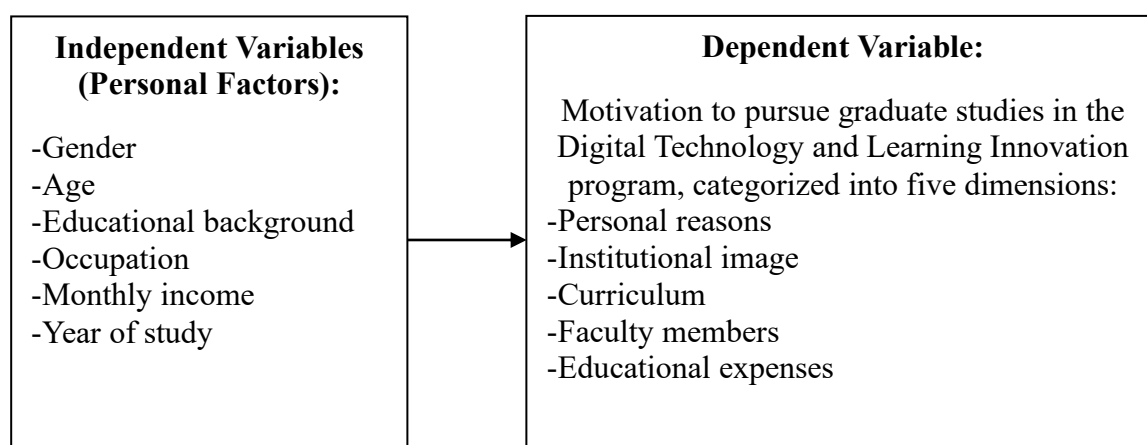
2. To compare the motivational factors influencing the decision to pursue graduate studies in the Digital Technology and Learning Innovation program, Faculty of Education, Ramkhamhaeng University.

1.2 Conceptual Framework

This study aims to investigate and compare the factors influencing motivation to pursue graduate studies in the Digital Technology and Learning Innovation program, Faculty of Education, Ramkhamhaeng University. In this research, personal factors of graduate students are considered potential independent variables that may influence their motivation to enroll in the program. These personal factors may affect the level of motivation across different dimensions. The conceptual framework of the study is illustrated in Figure 1.

The study identifies the following variables:

Figure 1 Conceptual Framework of the Research



2. Research Methodology

This study employed a survey research design. The research procedures were as follows:

2.1 Population, Sample, and Key Informants

The population of this study consisted of 35 graduate students enrolled in the Digital Technology and Learning Innovation Program, Faculty of Education, Ramkhamhaeng University.

The sample comprised graduate students from the same program. The sample size was determined using the formula developed by Krejcie and Morgan (1970). Based on a $\pm 5\%$ margin of error, the calculated sample size was 32 participants. Data were collected through an online questionnaire, and the first 32 complete responses were used for data analysis.

2.2 Research Instrument

The research instrument was a questionnaire designed to investigate motivation for pursuing graduate studies in the Digital Technology and Learning Innovation Program, Faculty of Education, Ramkhamhaeng University. The questionnaire consisted of two parts:

Part 1: General Information of Respondents

This section included six checklist items: gender, age, educational background, occupation, monthly income, and current year of study.

Part 2: Motivation for Pursuing Graduate Studies

This section assessed motivation across five dimensions: Personal reasons, Institutional image

Curriculum, Instructors and Educational expenses

Respondents were asked to evaluate their level of motivation using a five-point Likert scale, consisting of: Highest, High, Moderate, Low, and Lowest.

2.3 Data Collection

The researcher personally conducted all stages of data collection. The procedures were as follows:

2.3.1 The researcher informed course instructors in the Department of Educational Technology, Ramkhamhaeng University, to request permission to collect data from graduate students.

2.3.2 The researcher coordinated with students to request their cooperation in participating in the study.

2.3.3 Data were collected online from graduate students in the Digital Technology and Learning Innovation Program, Faculty of Education, Ramkhamhaeng University.

2.3.4 The completed questionnaires were checked for completeness and accuracy before proceeding with data analysis.

2.4 Data Analysis

The data were analyzed as follows:

2.4.1 General information of graduate students in the Digital Technology and Learning Innovation Program, Faculty of Education, Ramkhamhaeng University, was analyzed using frequency and percentage.

2.4.2 Motivation for pursuing graduate studies across the five dimensions—personal reasons, institutional image, curriculum, instructors, and educational expenses—was analyzed by calculating the mean ($\bar{x}$) and standard deviation (S.D.) for each dimension and for the overall total.

3. Results

Part 1: General Information of the Respondents

The results of Part 1, concerning the general information of the respondents, revealed the following:

Table 1 General Information of the Respondents

General Information		Respondents (n = 32)	
		Frequency	Percentage
1. Gender	Male	14	43.7
	Female	18	56.3
	LGBTQ+	-	-
	Prefer not to specify	-	-
2. Age	Below 22 years	-	-
	23–33 years	15	46.9
	34–44 years	14	43.7
	45 years and above	3	9.4
3. Educational Level	Bachelor's degree	19	59.4
	Master's degree	13	40.6
	Doctoral degree	-	-
	Government officer	18	56.3

General Information		Respondents (n = 32)	
		Frequency	Percentage
4. Occupation			
	Government employee	11	34.4
	Private company employee	2	6.2
	Self-employed	1	3.1
	Freelance worker	-	-
5. Monthly Income			
	Below 18,000 Baht	4	12.5
	18,001–20,000 Baht	4	12.5
	20,001–25,000 Baht	6	18.7
	25,001–30,000 Baht	11	34.4
	30,001–35,000 Baht	3	9.4
	35,000 Baht and above	4	12.5
6. Current Year of Study			
	First-year graduate student	11	34.4
	Second-year graduate student	8	25.0
	Graduated	13	40.6

From Table 1, the survey results of 32 respondents regarding motivation for pursuing graduate studies in the Digital Technology and Learning Innovation Program, Faculty of Education, Ramkhamhaeng University, revealed the following: The majority of respondents were female (56.3%), while males accounted for 43.7%. Most respondents were aged 23–33 years (46.9%), followed by those aged 34–44 years (43.8%), and the smallest proportion were aged 45 years and above (9.4%). Regarding educational background, the majority held a bachelor's degree (59.4%), while 40.6% held a master's degree. In terms of occupation, the largest group were government officers (56.3%), followed by government employees (34.4%), private company employees (6.2%), and self-employed individuals (3.1%) for monthly income, the largest proportion of respondents earned 25,001–30,000 Baht (34.4%), followed by 20,001–25,000 Baht (18.7%). The categories below 18,000 Baht, 18,001–20,000 Baht, and 35,000 Baht and above each accounted for 12.5%. The lowest percentage was reported in the 30,001–35,000 Baht category (9.4%). Regarding current academic status, the majority had already graduated (40.6%), followed by first-year graduate students (34.4%), and second-year graduate students (25.0%), respectively.

Results (Part 2): Motivation for Pursuing Graduate Studies

The results of Part 2, concerning motivation for pursuing graduate studies in the Digital Technology and Learning Innovation Program, Faculty of Education, Ramkhamhaeng University, are presented as follows:

Table 2 Motivation for Pursuing Graduate Studies in the Digital Technology and Learning Innovation Program, Faculty of Education, Ramkhamhaeng University (n = 32)

Motivation for Pursuing Graduate Studies	$\bar{x}$	S.D.	Interpretation
1. Personal Reasons	4.43	0.82	High
2. Institutional Image	4.34	0.84	High
3. Curriculum	4.39	0.80	High
4. Instructors	4.55	0.71	Very High
5. Educational Expenses Overall	4.33	0.91	High
Personal Reasons	4.41	0.82	High

From Table 2, the analysis of the questionnaire on motivation for pursuing graduate studies in the Digital Technology and Learning Innovation Program, Faculty of Education, Ramkhamhaeng University, indicated that overall motivation was at a high level ($\bar{x}$ = 4.41, S.D. = 0.82). When considering each dimension individually, the findings were as follows: Personal reasons were rated at a high level ($\bar{x}$ = 4.43, S.D. = 0.82). Institutional image was rated at a high level ($\bar{x}$ = 4.34, S.D. = 0.84). Curriculum was rated at a high level ($\bar{x}$ = 4.39, S.D. = 0.80). Instructors received the highest rating, at a very high level ($\bar{x}$ = 4.55, S.D. = 0.71). Educational expenses were rated at a high level ($\bar{x}$ = 4.33, S.D. = 0.91)

Table 3 Motivation for Pursuing Graduate Studies in the Digital Technology and Learning Innovation Program, Faculty of Education, Ramkhamhaeng University, Classified by Dimension (n = 32)**1. Personal Reasons**

Item	$\bar{x}$	SD	Interpretation
1.1 To obtain a higher academic qualification for career advancement	4.53	0.87	Very High
1.2 To serve as a pathway for further study at a higher level	4.31	0.85	High
1.3 To enhance knowledge, skills, and personal competencies	4.63	0.65	Very High
1.4 To build self-confidence and personal pride	4.38	0.86	High
1.5 To gain learning experiences with peers from diverse professions	4.28	0.80	High

Overall – Personal Reasons | 4.43 | 0.82 | High

2. Institutional Image

Item	$\bar{x}$	SD	Interpretation
2.1 The university maintains high educational standards	4.47	0.71	High
2.2 The university has a well-recognized reputation	4.38	0.82	High
2.3 The university provides a supportive learning environment	3.97	0.92	High
2.4 Faculty members are academically competent and recognized	4.41	0.82	High
2.5 Students are satisfied with continuing their studies at the university	4.47	0.83	High

Overall – Institutional Image | 4.34 | 0.84 | High

3. Curriculum

Item	$\bar{x}$	SD	Interpretation
3.1 The curriculum structure meets academic standards	4.41	0.82	High
3.2 The curriculum is continuously developed and improved	4.44	0.83	High
3.3 The curriculum is modern and offers diverse courses	4.31	0.68	High
3.4 The program duration is appropriate	4.44	0.83	High
3.5 The courses offered are interesting	4.38	0.82	High

Overall – Curriculum | 4.39 | 0.80 | High

4. Instructors

Item	$\bar{x}$	SD	Interpretation
4.1 Instructors are knowledgeable and experts in their fields	4.69	0.53	Very High
4.2 Instructors use effective teaching methods and knowledge transfer processes	4.31	0.73	High
4.3 Instructors accept students' opinions and suggestions	4.59	0.65	Very High
4.4 Instructors support students' continuous self-development	4.63	0.78	Very High
4.5 Instructors demonstrate morality, ethics, and serve as role models	4.53	0.79	Very High

Overall – Instructors | 4.55 | 0.71 | Very High

5. Educational Expenses

Item	$\bar{x}$	SD	Interpretation
5.1 Tuition fees are lower than other institutions	4.59	0.82	Very High
5.2 Overall educational expenses are lower compared to other institutions	4.63	0.82	Very High
5.3 Costs of documents and textbooks are lower than other institutions	4.13	0.86	High
5.4 Transportation and commuting costs are lower than other institutions	3.97	0.98	High
5.5 Students' income is sufficient to cover educational expenses	4.31	0.85	High

Overall – Educational Expenses | 4.33 | 0.91 | High

From Table 3, the analysis of motivation for pursuing graduate studies in the Digital Technology and Learning Innovation Program, Faculty of Education, Ramkhamhaeng University, by dimension revealed the following details:

1. Personal Reasons

Overall, motivation in the dimension of personal reasons was at a high level ($\bar{x}$ = 4.43, S.D. = 0.82). The highest-rated item was “To enhance knowledge, skills, and personal competencies” ($\bar{x}$ = 4.63, S.D. = 0.65), which was at a very high level. This was followed by “To obtain a higher academic qualification for career advancement” ($\bar{x}$ = 4.53, S.D. = 0.87), also at a very high level. The third-ranked item was “To build self-confidence and personal pride” ($\bar{x}$ = 4.38, S.D. = 0.86), at a high level. Next was “To serve as a pathway for further study at a higher level” ($\bar{x}$ = 4.31, S.D. = 0.85), at a high level. The lowest-ranked item, though still at a high level, was “To gain learning experiences with peers from diverse professions” ($\bar{x}$ = 4.28, S.D. = 0.80).

2. Institutional Image

Overall motivation related to institutional image was at a high level ($\bar{x}$ = 4.34, S.D. = 0.84). The highest-rated items were “The university maintains high educational standards” and “Students are satisfied with continuing their studies at Ramkhamhaeng University” ($\bar{x}$ = 4.47, S.D. = 0.83), both at a high level. The third-ranked item was

“Faculty members are academically competent and recognized” ($\bar{x}$ = 4.41, S.D. = 0.82), followed by “The university has a well-recognized reputation” ($\bar{x}$ = 4.38, S.D. = 0.82). The lowest-ranked item was “The university provides a supportive learning environment” ($\bar{x}$ = 3.97, S.D. = 0.92), although it remained at a high level.

3. Curriculum

Overall motivation in the curriculum dimension was at a high level ($\bar{x}$ = 4.39, S.D. = 0.80). The highest-rated items were “The curriculum is continuously developed and improved” and “The program duration is appropriate” ($\bar{x}$ = 4.44, S.D. = 0.83), both at a high level. This was followed by “The curriculum structure meets academic standards” ($\bar{x}$ = 4.41, S.D. = 0.82). The fourth-ranked item was “The courses offered are interesting” ($\bar{x}$ = 4.38, S.D. = 0.82). The lowest-ranked item was “The curriculum is modern and offers diverse courses” ($\bar{x}$ = 4.31, S.D. = 0.68), though still at a high level.

4. Instructors

Overall, motivation related to instructors was at a very high level ($\bar{x}$ = 4.55, S.D. = 0.71). The highest-rated item was “Instructors are knowledgeable and experts in their fields” ($\bar{x}$ = 4.69, SD = 0.53), at a very high level. This was followed by “Instructors support students’ continuous self-development” ($\bar{x}$ = 4.63, S.D. = 0.78), and “Instructors accept students’ opinions and suggestions” ($\bar{x}$ = 4.59, SD = 0.65), both at a very high level. The fourth-ranked item was “Instructors demonstrate morality, ethics, and serve as role models” ($\bar{x}$ = 4.53, S.D. = 0.79), also at a very high level. The lowest-ranked item in this dimension was “Instructors use effective teaching methods and knowledge transfer processes” ($\bar{x}$ = 4.31, S.D. = 0.73), though still at a high level.

5. Educational Expenses

Overall motivation regarding educational expenses was at a high level ($\bar{x}$ = 4.33, S.D. = 0.91). The highest-rated item was “Overall educational expenses are lower compared to other institutions” ($\bar{x}$ = 4.63, SD = 0.82), at a very high level. This was followed by “Tuition fees are lower than other institutions” ($\bar{x}$ = 4.59, S.D. = 0.82), also at a very high level. The third-ranked item was “Students’ income is sufficient to cover educational expenses” ($\bar{x}$ = 4.31, S.D. = 0.85), at a high level. Next was “Costs of documents and textbooks are lower than other institutions” ($\bar{x}$ = 4.13, S.D. = 0.86), at a high level. The lowest-ranked item was “Transportation and commuting costs are lower than other institutions” ($\bar{x}$ = 3.97, S.D. = 0.98), although it remained at a high level.

4. Discussion

The findings regarding motivation for pursuing graduate studies in the Digital Technology and Learning Innovation Program, Faculty of Education, Ramkhamhaeng University, are discussed as follows:

4.1 Personal Reasons

The finding that the primary personal motivation was “to enhance knowledge, skills, and personal competencies” is consistent with the study by Anothai Phuengthonglor (2000), which examined motivation for pursuing a master’s degree in Development Communication Arts at Chulalongkorn University. The study found that self-expectation, particularly the desire to acquire new and different knowledge, was the highest-rated motivational factor.

The researcher interprets this result as indicating that when learners are determined to develop themselves and increase their competencies, such commitment significantly influences their decision to pursue further study in a program that responds to their specific personal needs.

4.2 Institutional Image

The findings that Ramkhamhaeng University maintains educational standards and that students are satisfied with continuing their studies at the university are consistent with the study by Sangduan Yomin (2020), which investigated motivation for pursuing a master's degree in the Visionary Leaders (Twilight Program), MBA Program at Ramkhamhaeng University. That study reported that institutional factors were rated at the highest level of motivation, with educational standards and quality being the most influential aspects.

The researcher believes that a positive institutional image enhances learners' confidence in the quality of education and assures them that their expectations will be met during their studies.

4.3 Curriculum

The findings that the curriculum is continuously developed and improved, and that the program duration is appropriate, are consistent with the research of Jittima Wongratchanan (2021), which examined factors influencing Chinese students' decisions to pursue a Master of Business Administration (Chinese Program) in Thailand. The study found that curriculum quality and appropriate program duration received the highest mean scores.

The researcher suggests that a flexible curriculum aligned with learners' needs increases confidence in their decision to pursue further study. The Digital Technology and Learning Innovation Program at Ramkhamhaeng University has undergone continuous revision and improvement. The current program is the 2022 revised curriculum, with a study duration of two years.

4.4 Instructors

The finding that instructors' knowledge, competence, and expertise in their respective fields were the strongest motivating factors is consistent with the study by Waraporn Chuayprakong (2019), which examined decision-making in pursuing graduate studies at the Faculty of Political Science and Law, Burapha University. The study found that faculty-related factors were rated at the highest decision-making level, particularly instructors' professional ethics and subject-matter expertise.

The researcher interprets this as reflecting learners' belief that instructors' expertise ensures high-quality knowledge and guidance, enabling students to extend their existing knowledge and apply it effectively in both academic and professional contexts.

4.5 Educational Expenses

The finding that educational expenses are lower compared to other institutions aligns with the study by Sangduan Yomin (2020), which reported that cost-related factors were rated at a high level, particularly the perception that educational expenses were worthwhile relative to the program's quality. The researcher believes that reasonable tuition and associated costs reduce financial barriers and facilitate students' decisions to pursue further education.

Overall, the five motivational factors are interconnected and collectively support students' decision-making processes. The results of this study indicate that instructor-related factors serve as the primary driving force behind the decision to pursue graduate studies. Meanwhile, personal reasons, institutional image, curriculum quality, and educational expenses function as supporting factors that reinforce students' confidence that studying at Ramkhamhaeng University will meet their needs and expectations appropriately.

5. New Knowledge Contribution

This study generates new knowledge regarding motivation for pursuing graduate studies in the Digital Technology and Learning Innovation Program, Faculty of Education, Ramkhamhaeng University. The findings indicate that instructor-related factors constitute the most influential source of motivation among graduate students. Instructors play a pivotal role in shaping students' decisions to pursue further study, particularly through their knowledge, competence, and expertise in their respective fields, as well as their continuous support for students' self-development. Furthermore, instructors who are open to students' opinions, demonstrate professional ethics, and employ clear and effective teaching methods significantly enhance students' motivation at the highest level. Personal factors—such as the desire to enhance knowledge and skills, obtain higher academic qualifications for career advancement, and build self-confidence—also serve as important driving forces in students' decisions to pursue graduate studies. In terms of institutional image, Ramkhamhaeng University is perceived as maintaining recognized educational standards and a reputable academic standing, reinforced by satisfaction among graduates. Reasonable tuition fees and overall educational expenses, which are lower compared to other institutions, contribute to students' perceptions of value and cost-effectiveness. Additionally, the curriculum's continuous development, standardized course structure, and appropriate program duration further strengthen students' confidence and perceived value in enrolling in the graduate program. In conclusion, the factors influencing students' decisions to pursue graduate studies extend beyond instructional quality alone. They encompass interconnected environmental and institutional factors, including faculty support, institutional image, and reasonable educational costs. Therefore, ongoing curriculum development and responsive university services aligned with students' needs are essential to enhance program attractiveness and meet learners' expectations in the digital era.

6. Conclusion

Graduate students demonstrated an overall high level of motivation to pursue graduate studies in the Digital Technology and Learning Innovation Program, Faculty of Education, Ramkhamhaeng University. Among the five dimensions examined, instructor-related factors ranked highest, with motivation at the very high level, particularly regarding instructors' knowledge, competence, and expertise in their respective fields. The second-ranked factor was personal reasons, with the strongest motivation being the desire to enhance knowledge, skills, and personal competencies. The third-ranked factor was curriculum, with high levels of motivation associated with the standardized curriculum structure, continuous curriculum development and improvement, and appropriate program duration. The fourth-ranked factor was institutional image, where high levels of motivation were linked to the university's educational standards and students' satisfaction in continuing their studies at Ramkhamhaeng University. Finally, educational expenses ranked fifth, with very high motivation specifically related to the perception that overall educational costs are lower compared to other institutions. Overall, the findings indicate that while instructor quality serves as the primary motivating factor, personal aspirations, curriculum quality, institutional reputation, and reasonable educational costs collectively contribute to students' decisions to pursue graduate studies.

7. Recommendations

7.1 Recommendations Based on the Findings

7.1.1 The university should continuously promote the professional development of faculty members to maintain teaching quality and strengthen student motivation. Emphasis should be placed on enhancing both pedagogical competencies and research expertise in specialized fields.

7.1.2 The curriculum should be regularly updated to ensure alignment with labor market demands in the digital era. This may include incorporating more practice-oriented content and emerging technologies to enhance students' professional competitiveness.

7.1.3 The university should actively promote its institutional image, including educational standards and a supportive learning environment, to strengthen public confidence and attract prospective students. Diverse communication channels and the presentation of outstanding achievements should be utilized to increase interest and enrollment decisions.

7.1.4 The university should expand scholarship opportunities to support financially disadvantaged students, thereby reducing financial barriers and promoting equitable access to education.

7.2 Recommendations for Future Research

7.2.1 Future studies should explore motivation in greater depth, particularly the influence of intrinsic and extrinsic motivational factors, to gain a more comprehensive understanding of decision-making behaviors in pursuing graduate studies. The findings may inform marketing strategies and curriculum development within the program.

7.2.2 Comparative studies should be conducted across other programs within the Faculty of Education to identify differences in motivational factors and develop context-specific improvement strategies.

7.2.3 Future research should develop research instruments that incorporate technological, cultural, and social contextual factors to enhance the validity, comprehensiveness, and potential for generating new insights.

7.2.4 Further studies should investigate strategies for sustaining student motivation after enrollment, focusing on satisfaction outcomes and skill development, in order to improve long-term teaching and learning processes.

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RJCM Vol. 7, No. 2, May-August 2026

e-ISSN 2821-9074

Print-ISSN 2730-2601

RICE Journal of Creative Entrepreneurship and Management, Vol. 7, No.2, pp. 13-25,
May-August 2026

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doi: 10.14456/rjcm.2026.9

Received 15.01.26/ Revised 28.05.26/ Accepted 28.05.26

Potential applications of AI-generated doll imagery for unique agricultural products

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Abstract

Faced with the rapid advancement of AI-generated image technology (AIGIT) and its ability to lower learning barriers, traditional design-education still has numerous challenges, such as limited time, varying artistic abilities, and creative bottlenecks. The authors tried to explore the application of AIGIT (specifically using the Stable Diffusion (SD) platform) in doll design education and the promotion of Taiwanese agricultural products (guava). A three-hour AI image generation training (prompt design to optimization) was assessed for its impact on boosting student creativity and efficiency. The final doll designs further were evaluated by industry experts across five dimensions: visual appeal, character characteristics, emotional expression, consistency, and functionality. Questionnaire results, visualized via R-programmed radar charts, revealed AI-assisted design fostered culturally resonant, visually appealing mascots, with iterative prompt refinement boosting success rates. AI emerged as both a creative and pedagogical tool, enhancing innovation and cultural branding. Besides, practical implications include strengthening local agricultural products through character design, while educational implications highlight AI's role in lowering barriers to creative expression. The originality of this study lies in its integration of AI-generated doll imagery with agricultural product promotion, offering a novel model for design education and regional agricultural cultural development.

Keywords: *Artificial intelligence generated image technology; Doll design; Agricultural special products*

1. Introduction

With the rapid advancement of deep learning and large-scale computing resources, artificial intelligence-generated image technology has evolved from early generative adversarial networks (GANs) to diffusion models and text-to-image systems such as DALL-E and Stable Diffusion, which can automatically generate diverse, high-resolution visual content based on natural language prompts (Guo & Shin, 2025; Ho et al., 2020). These technologies have not only revolutionized designers' creative processes but have also had a profound impact on fields such as industrial design, visual communication, and entertainment, bringing unprecedented teaching and learning tools to design education. However, at the current stage, design education in the classroom still faces challenges such as time-consuming teacher demonstrations, uneven artistic skills among students, and/or creative bottlenecks (Jeng, 2019). Therefore, how to integrate emerging technologies into limited classroom time and resources to improve teaching efficiency and learning outcomes has become a challenge that educators urgently need to address. But whether artificial intelligence-generated image technology (AIGIT) can truly enhance students' creative thinking abilities and learning motivation still requires systematic evaluation to verify its effectiveness.

2. Research Objectives

The purpose of this study was to evaluate the design quality of dolls following the implementation of a 3-hour AI-generated Taiwanese agricultural product (guava) doll-design training program in the classroom using a free AI stable diffusion (SD) platform. Based on students' learning outcomes in AI-generated design, the findings will be used as a model by educators to enhance their future teaching methods.

3. Literature Review

3.1 The Relationship between Doll Design and the Promotion of Taiwanese Agricultural Products

Doll design, as a comprehensive design form encompassing visual communication, character creation, and cultural narrative, has seen its definition and functions evolve alongside shifts in era and medium. Traditionally, dolls were viewed as children's toys, emphasizing anthropomorphic design and emotional projection functions (Calvert, 1999). However, in the 21st century, doll design has gradually transformed into a core element of brand identity, cultural symbols, and cross-media narratives, encompassing multiple aspects such as character design, IP development, cultural and creative products, and local marketing (Jenkins, 2006).

From a perspective of design theory, dolls are not merely sculptural objects but also symbolic carriers. Barthes (1977) noted that the form, color, and structure of design objects

all carry specific cultural connotations and narrative functions (Barthes, 1977). Doll design achieves this through character design, emotional attachment, and narrative context, making them recognizable, memorable, and interactive cultural symbols. Yano (2013) used Hello Kitty as an example to illustrate how “soft character design” can establish a global character brand through simplified design and emotional appeal (Yano, 2013). In Taiwan, character design is gradually being incorporated into the promotion of agricultural products and the construction of local brands, becoming an important strategy for cultural marketing and industrial innovation. Local governments and agricultural associations are strengthening the cultural narrative and brand identity of agricultural products by designing characters with local characteristics. For example, Yao and Wu (2021) designed a doll for the Tientoushui community in Changhua County located in central Taiwan. This doll combined the imagery of local agricultural products with a friendly design, successfully attracting the attention of young people and tourists. Such design strategies not only enhance product recognition but also promote the reproduction of local culture and emotional connections (Yao & Wu, 2023). Through the storytelling packaging of doll characters, agricultural products are no longer just functional commodities but narrative carriers that embody local memories and cultural values.

3.2 Artificial Intelligence (AI)

Artificial intelligence (AI) refers to a machine's or computer's ability to simulate human thought processes, first introduced by McCarthy et al. (1956) and later developed through various schools of thought like bionics and cybernetics (Gong & Jiang, 2020; McCarthy et al., 2006). Today, AI is defined as a system's capacity to understand external data, learn from it, and adapt to achieve specific goals (Haenlein & Kaplan, 2019). Artificial Intelligence Generated Content (AIGC) focuses on processing visual data, such as images and videos, with several applications in graphic design: A) Automated Design: AI can create initial design sketches that can be modified by designers, improving efficiency and allowing non-professionals to produce quality work. B) Format Conversion: Using Neural Style Transfer (NST) technology, AI can convert designs into different styles, giving designers flexibility. C) Material Generation: AI employs techniques like Variational Autoencoders (VAEs) and Generative Adversarial Networks (GANs) to generate new design materials in various styles. D) Image Enhancement and Repair: AI can improve low-quality images and repair damaged ones, offering more usable resources for designers. E) Prediction and Optimization: AI can predict design reception and optimize it for better user outcomes, enabling designers to create more user-centered work (Chen, 2018; Gatys et al., 2015; Liang et al., 2018; Rocca, 2019; Yao et al., 2025; Zou et al., 2021).

3.3 The Needs and Challenges of Design Education

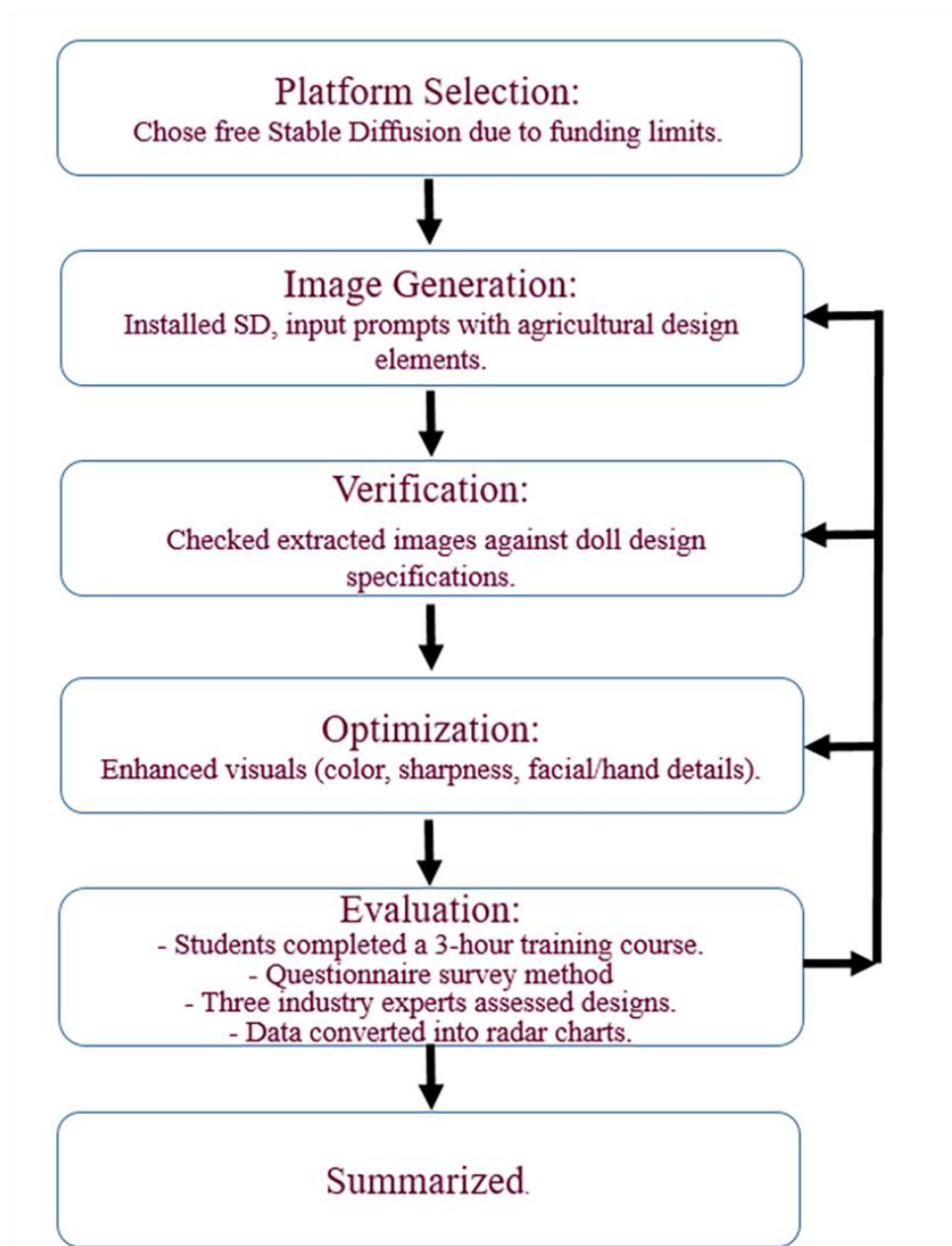
In traditional design classrooms, teachers often have to draw examples themselves or rely on students' hand-drawn sketches to guide them in understanding abstract

composition, color coordination, and visual storytelling concepts. However, this process is time-consuming and requires a high level of artistic foundation from both teachers and students, which can lead to insufficient classroom interaction or a loss of creative motivation. Currently, the application of artificial intelligence (AI) technology in education has gradually become a global trend, especially in design education, where AI has not only changed the creative process but also redefined teaching methods and learning models. Design education emphasizes creativity, visual expression, and critical thinking, and the introduction of AI technology has provided new possibilities for cultivating these core competencies.

However, it has also raised a series of challenges in terms of education, ethics, and technology. First, the application of AI in design education can be divided into three main areas: creative assistance, personalized learning, and teaching automation. AI-generated image tools such as DALL-E, Midjourney, and Stable Diffusion can help students quickly produce visual sketches during the conceptualization phase, lowering the barrier to entry for creation and enhancing creative fluency and visual expression. These tools not only accelerate the design process but also promote students' understanding and application of design language. Secondly, AI technology also promotes the development of personalized learning. Through learning analytics and adaptive recommendation systems, teachers can provide customized teaching materials and feedback based on students' learning behaviors and work styles (Yao et al., 2025). This data-driven teaching model helps enhance learning motivation and effectiveness, particularly in multicultural and interdisciplinary design courses, where it can effectively address students' diverse backgrounds and learning needs.

4. Research Methods

The study trained 12 students (all digital design students, 2 women and 10 men, aged 19 to 22) to design agricultural product mascots using the free Stable Diffusion AI platform. After attending a three-hour lecture on prompts for AI-generated images, they generated doll images via prompts, refined visuals, and optimized details. Final designs were evaluated through expert-reviewed questionnaires and then converted into radar charts by using R programming, focusing on visual appeal, characteristics, emotional expression, coherence, and functionality. The research frameshift was as follows:

Figure 1 Flowchart for Completing the Three-Hour AI-Generated Doll Design Course

4.1 Practical Operation and Procedures

Many artificial intelligence (AI) platforms are available on the Internet today that can help designers create works. Some of the more well-known platforms are Stable Diffusion, Leonardo (<https://leonardo.ai/>), Midjourney network (<https://www.midjourney.com/>), and dreamlike.art (<https://dreamlike.art/>). However, due to limited project funding in this study, the authors attempted to teach students to use the free AI-SD platform, directly inputting prompts to design and generate brand doll designs.

4.2 AI Operational Steps

The operational steps that AIGC technology presented were as follows. 1) Use AI to create images: The SD platform should be installed first. 2) To have the AI produce the

anticipated visuals of commercial dolls, provide prompts that incorporate design code elements taken from agricultural specialty products. 3) Re-evaluation and verification of design symbol elements: Once the required images and graphics have been extracted, assess the design to make sure it satisfies doll design specifications. 4) Image optimization and enhancement: To improve image quality, make use of platform capabilities or additional graphic design applications. By changing colors, sharpening photographs, and fine-tuning hand and facial details, the overall visual impact was presented in the most suitable manner.

4.3 Final AI-Generated Image Design Evaluation

4.3.1 Expert Assessment

To evaluate the quality of agricultural product mascots designed by students after completing a three-hour AI-generated image for training course (Table 1), the author referenced the questionnaire survey method described in previous report (Chen et al., 2025). Three industry experts with extensive professional experience (including one woman with experience in graphic design and two men with extensive experience in advertising design who are proficient in AI-generated image technology) were then invited to conduct the assessment. Data collected from the questionnaire was converted into radar charts to provide a quick overview of image quality. The evaluation of mascot design quality was based on five core dimensions: visual appeal, character traits, emotional expression, consistency and coherence, and character functionality.

Table 1 Ai-Generated Image Training Course (3 hours)

Topic	Operations	Time(min)
Understanding Stable Diffusion and Generative Models	Model Principles, Platform Introduction, Application Scenarios	30
Prompt Design and Semantic Control	Prompt Structure, Style Control, Semantic Fine-Tuning	60
Implementation: Image Generation and Parameter Adjustment	Image Generation, CFG, Number of Steps, Resolution, and Other Parameter Operations	60
Advanced Applications and Creative Experiments	Multi-Prompt Fusion, Style CONversion, Cross-Module creation	30

4.3.2 Data Analysis

In data analysis, radar charts typically visualize multiple dimensions simultaneously, enabling rapid identification of overall performance strengths. Therefore, after expert evaluation of the data, the author utilized the fmsb package in the R programming (R version 4.5.2) to generate radar charts, allowing readers to quickly grasp the dimensional characteristics of AI-generated imagery doll design.

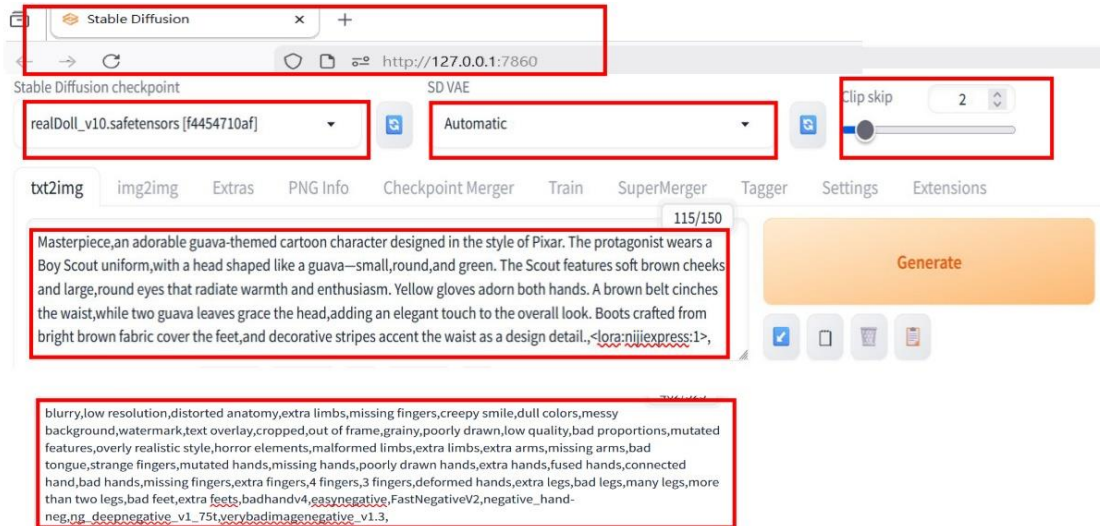
5. Results and Discussion

5.1 Browse the Stable Diffusion Platform and Prompts Training

An effective open-source AI tool for creating images is Stable Diffusion platform. Although the setup and installation process is rather easy, it does require some basic computer knowledge. The basic steps are as follows: Make sure your computer has an NVIDIA graphics card first (at least 8GB of VRAM is recommended). Then opened your browser after the software had started, and typed in <http://127.0.0.1:7860> to access the graphical user interface and started producing (Figure 2). Students were able to design their puppet characters during a three-hour training session by completing assigned tasks and adjusting parameters such as prompt phrases, number of steps, and resolution.

The keywords employed in the model training process have a direct impact on the prompt selection, and various models may employ quite different prompts. The model might not recognize certain keywords, producing results that fall short of expectations. It is advised to consult the Civitai platform's specialized pages for each model, take examples from them, and modify them as necessary. The models (checkpoints) used in this output demonstration were `realDoll_v10` and `disneyPixarCartoon_v10`. These aimed to generate images with two distinct textures: one for the protagonist and another for supporting characters. The primary function of Variational Autoencoders (VAE) was to determine color tones and another details, with the purpose of increasing image saturation and reducing grayscale, thereby adding more color to the image. For VAE, it was recommended to select the automatic option. Next, set the parameter option for Clip (Contrast Language-Image Pre-training) to the number 2 to generate more aesthetically pleasing or creative compositions (Figure 2). By inputting text prompts describing the characteristics of the doll into the SD platform, images of the main character and other characters could be quickly generated, as shown in Figures 4 to 6.

Figure 2 Stable Diffusion Platform Website. Red box showed the URL (topmost). Other parameters demonstrated the checkpoint model as readDoll_v10 (second row, left), VAE (second row, center), Clip model (second row, right), positive prompt input (third row), and negative prompt input (bottom).



Briefly, the prompt structure of Stable Diffusion can be roughly divided into five items (Figure 3), including subject, appearance and action, accessories and clothing, background and composition, style and mood, etc.

For example, the prompts including “guava-themed cartoon character”, “designed in the style of Pixar, protagonist” and “adorable and cheerful” were core characters or objects that define the image, and these keywords belong to the subject category. The authors believed that this classification would help us learn and adjust prompt words more clearly or apply them to different image generation needs. Briefly, the quality of AI-generated images depended directly on how the text prompt was written. By carefully combining descriptive keywords, attributes, and styles within these categories, users can minimize misunderstandings regarding the subject and style of the generated images.

Figure 3 Prompt syntax for Stable Diffusion platform.



5.2 AI-Generated Image Creation Works

After three-hour training, two male and female doll characters, supporting characters, and scene designs that were most popular among students were selected

respectively from the AI-generated doll images, as shown in Figures 4-6. During the AI design and creation training process, students gradually discovered that the results of the drawings were closely related to the prompts they entered, including gender, style, clothing, and scenes.

Briefly, the quality of the AI-generated image on the Stable Diffusion platform is directly influenced by the text prompt's composition. While weighted syntax (e.g., (subject):1.5) highlights significant aspects, the model can concentrate on prominent elements by precisely mixing descriptive keywords, attributes, and stylistic directives—separated by commas. Sharper details and more cohesive compositions are the consequence of reducing token waste and ambiguity through clarity, conciseness, and relevancy (Popovic, 2023). In addition, during the training period, due to the students' unfamiliarity with the prompt words, the initial success rate of generating images was approximately 1/200 to 1/350. However, after continuous training and prompt refinement, the success rate of image generation was improved to between 1 in 100 and 1 in 150, and could even be better. Apart from prompts affecting the quality of AI-generated images, the using of the different checkpoint models also had direct impact.

Figure 4 Character design for the dolls: male protagonist (left) and female protagonist (right), by using the disneyPixarCartoon_v10.



Figure 5 Character design for dolls: male supporting character (left) and female supporting character (right), by using the realDoll_v10 model.



Figure 6 Doll Scene Design, home (left) and school (right), by using the realDoll_v10 model.

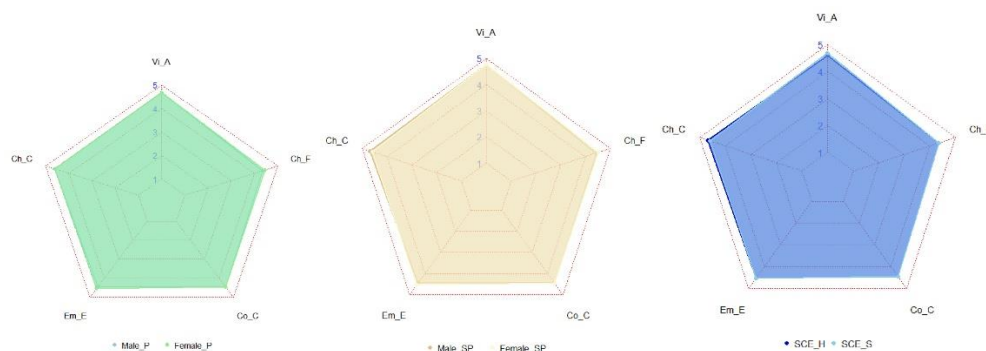
5.3 AI-Generated Doll Work Evaluation

Subsequently, three industry experts were invited to participate in the questionnaire evaluation, with an average professional experience of approximately 17.7 years. Although their average age was 40.3 years old, they were all seasoned designers who had started their own businesses and should be representative of the opinions of artistic creators. The evaluation covered five aspects: 1) visual appeal, 2) character traits, 3) emotional expression, 4) consistency and coherence, and 5) character functionality. The analysis results were then shown in the radar chart (Figure 7). Overall, regarding the creative dolls featuring an agricultural theme (guava), the three design experts unanimously agreed that the main character, supporting characters, and scene settings demonstrated exceptional suitability and creativity, with no significant discrepancies in their evaluations.

However, scores for certain dimensions (such as character functionality) were slightly lower than those for the visual appeal dimension (Figure 7). The authors tentatively proposed the following two possible reasons: 1) The “visual appeal” dimension was intended to assess whether an image features a harmonious color scheme, clear composition, and pleasing visual effects. However, after three hours of training, the instructor had guided students to use variational autoencoders (VAEs) to enhance image saturation, reduce grayscale, and establish color schemes. 2) “Character functionality” should not be limited to a mere pretty picture. In the cited questionnaire items, this dimension was defined as follows: whether the design is suitable for a specific application scenario; whether the character’s actions and poses meet functional requirements; and whether the design meets practical usage needs, such as facilitating the production of derivative merchandise (Chen et al., 2025).

If training sessions were extended to allow participating students greater familiarity with the SD platform's operations, there would be potential for even more creative and unexpected outcomes.

Figure 7 Evaluation of AI-generated Doll design. Y-axis value: mean, Left: Male and Female characters, Center: Supporting role (MS: male supporting, FS: female supporting), Right: Scene modeling (Home and School scene), Vi_A: visual appeal, Ch_C: character characteristics Em_E: emotional expression, Co_C: consistency and coherence, and Ch_F: Character function. (Radar plot prepared by using R version 4.5.2 programming)



6. Conclusion, Implication and Future Research

This study demonstrates that artificial intelligence-generated image technology, particularly Stable Diffusion, can effectively support doll design education while promoting Taiwanese agricultural products. Through a three-hour structured training program, the students successfully created a series of mascots that blend cultural stories with visual appeal, overcoming the traditional challenges of limited artistic skills and insufficient class time, and demonstrating a learning process that effectively stimulates student creativity. Expert evaluations confirmed that the AI-generated dolls exhibited strong coherence, emotional resonance, and functional qualities, highlighting the importance of prompt refinement and iterative practice. The data indicated that AI-generated image technology is not only a valuable tool for assisting human creativity but can also serve as an educational tool to enhance students' learning efficiency, motivation, and innovative capabilities in design classes. If the agricultural theme was further incorporated into mascot design, we can also highlight the potential of AI in strengthening local brand identity and cultural identity through design.

To further deepen these research findings, future comparative studies are recommended to explore more specific directions. For example, how do AI-generated mascot designs differ from those created by human professionals in terms of brand image building and market acceptance? At the same time, the long-term impact of AI-generated image technology (AIGIT) on students' creative thinking will be further evaluated by extending the duration of training.

7. Acknowledges

The authors would like to thank Shiuping University of Science and Technology for providing financial support for the Project No. 113-16-B004.

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RJCM Vol. 7, No. 2, May-August 2026

e-ISSN 2821-9074

Print-ISSN 2730-2601

RICE Journal of Creative Entrepreneurship and Management, Vol. 7, No.2, pp. 26-35,
May - August 2026

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doi: 10.14456/rjcm.2026.11

Received 27.01.26/ Revised 30.05.26/ Accepted 30.05.26

Sustainable Lean Management Practices: Net Zero Win-Win Green Value Stream: A Case Study of Metal Product Manufacturing Supply Chain Performance

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Abstract

This study investigates the application of Sustainable Lean Management in Taiwanese small and medium-sized metal product manufacturing enterprises to support the net-zero carbon emissions goal by 2050. Using production value stream mapping, pain point analysis, and seven green waste management principles, combined with professional coaching, on-site improvement tools, and Quality Control Circle (QCC) strategies, the study evaluates changes in delivery performance, operational efficiency, product quality, inventory management, and green value creation before and after implementation. In parallel, a cradle-to-gate carbon footprint assessment of a representative metal hand tool product was conducted following ISO 14067 and ISO 14044 standards. The life cycle assessment covers raw material acquisition, manufacturing, transportation, and packaging, with data quality ensured through Data Quality Rating and defined truncation criteria. Results indicate that manufacturing processes—particularly outsourced forging, heat treatment, and electroplating—account for over 90% of total emissions. The findings demonstrate that integrating Lean and Green practices can simultaneously reduce environmental impact, improve operational performance, and support ESG-oriented industrial transformation.

Keywords: *Sustainable Lean Management; Net-Zero Carbon Reduction; Green Value Stream; Manufacturing Performance; Supply Chain Improvement*

1. Introduction

The urgency of addressing climate change has driven industries worldwide to adopt carbon footprint assessments and integrate sustainability into business practices. International frameworks such as the Paris Agreement and the UN Sustainable Development Goals (SDGs) emphasize the need for net-zero pathways by 2050. At COP26, governments reinforced commitments to decarbonization, while the European Union launched the Carbon Border Adjustment Mechanism (CBAM), directly affecting export-oriented economies such as Taiwan.

Environmental, Social, and Governance (ESG) frameworks have become central to corporate reporting. Standards like the EU CSRD, GRI, SASB, and the ISSB's IFRS S1 and S2 provide guidelines for transparency. ESG ratings by MSCI and Sustainalytics influence investment decisions, making sustainability performance integral to financial

competitiveness. Despite significant research in electronics, automotive, and chemical industries, carbon footprint studies in the hand tool sector remain scarce, creating a research gap.

This study addresses these gaps by conducting a carbon footprint assessment of a representative hand tool product, integrating it with a case study on Sustainable Lean Management applied to five SMEs in central Taiwan. The objective is to identify emission hotspots, propose mitigation strategies, and situate these findings within the ESG discourse to provide both academic and policy contributions.

Carbon footprinting of industrial products has become a critical aspect of sustainable manufacturing and climate change mitigation. Life cycle assessment (LCA) offers a robust methodology to quantify the greenhouse gas (GHG) emissions associated with products across their life cycle stages. Metal hand tools, such as wrenches, are widely used in automotive, construction, and maintenance industries, yet their environmental impacts have been sparsely reported in peer-reviewed literature. This study aims to quantify the cradle-to-gate carbon footprint of a forged alloy steel wrench manufactured in Taiwan, providing insights for emission reduction strategies and supporting eco-design and procurement decisions.

Research Objectives

The primary objective is to establish a systematic approach to measure, analyze, and reduce carbon emissions at both the product and organizational levels. This includes identifying emission hotspots, applying Lean & Green methods, and validating improvements using standardized metrics.

2.Literature Review

ESG frameworks, disclosure, and performance

ESG has evolved from voluntary disclosure toward globally harmonized, decision-useful information that links sustainability outcomes with enterprise value. At the framework level, the International Sustainability Standards Board (ISSB) issued IFRS S1 (general sustainability-related disclosures) and IFRS S2 (climate-related disclosures) consolidating prior initiatives (e.g., TCFD) into a global baseline for capital markets reporting (IFRS Foundation, 2023). The EU's Corporate Sustainability Reporting Directive (CSRD) expands scope and prescriptiveness for European and large non-EU entities, emphasizing double materiality and value-chain coverage (European Commission, 2023). The GRI Standards remain the leading impact-oriented framework for multi-stakeholder reporting (GRI, 2021), while SASB Standards provide industry-specific metrics aligned with financial materiality (SASB, 2018). Together, these frameworks foster consistency, comparability, and assurance readiness (WEF, 2021; OECD, 2020).

Empirical work links ESG integration to organizational processes and performance. Eccles, Ioannou, and Serafeim (2014) show that firms with high sustainability policies outperform peers on both stock market and accounting metrics, mediated by improved stakeholder management and long-term orientation. A large meta-study (Friede, Busch, & Bassen, 2015) aggregating >2,000 studies finds the ESG–financial performance relationship is non-negative in the vast majority of cases and positive on average. More recent reviews (Whelan, Atz, & Clark, 2021) conclude that ESG integration can lower downside risk, strengthen innovation capacity, and support resilience—effects particularly salient in energy-intensive manufacturing.

For manufacturing supply chains, ESG drives upstream engagement (supplier screening, audits, Scope 3 data requests) and investment in low-carbon processes (renewables, electrification, circular inputs). Evidence from “lean-and-green” scholarship

suggests operational excellence programs can reduce environmental impacts while sustaining cost and quality advantages (King & Lenox, 2001; Garza-Reyes, 2015; Piercy & Rich, 2015). However, disclosure quality and data granularity—especially for Scope 3 categories—remain uneven across SMEs, indicating a persistent “ESG data gap” that complicates investor use and policy oversight (OECD, 2020).

Product carbon footprints for metal products (LCA/CFP)

Product-level carbon footprints quantify cradle-to-gate or cradle-to-grave climate impacts according to ISO 14067 and the ISO 14040/44 life-cycle assessment family (ISO, 2018; ISO, 2006). For metal products, the literature consistently identifies energy-intensive transformation steps (e.g., primary steelmaking, forging, heat treatment, electroplating) as CF hotspots, while logistics and packaging are typically minor contributors on a per-unit basis (Song et al., 2021; Zhang et al., 2022). Integration of recycled content in steel and aluminum substantially reduces embodied carbon—often the single most effective lever at the material stage (Yuan et al., 2020). Region-specific electricity mixes and plant-level heat sources (e.g., natural gas vs. electrified heat) materially change results, underscoring the importance of geographic representativeness in inventory data (Guinée et al., 2018).

Studies focusing on East Asian manufacturing find that outsourcing to specialized processors can shift but not eliminate hotspots: energy-intensive subprocesses remain dominant in cradle-to-gate CF even when conducted off-site (Chen et al., 2022). Waste-input–output hybrid approaches improve completeness for upstream processes with limited primary data (Nakamura & Kondo, 2019). Methodological rigor hinges on transparent data quality assessment, often using Data Quality Rating (DQR) schemes covering temporal, geographic, and technological representativeness (Kjaer et al., 2018). Truncation rules (e.g., <1% per unit process, <5% in total) and allocation choices (mass vs. economic) require justification to mitigate bias (ISO, 2006; ISO, 2018).

Policy drivers increasingly intersect with product CF. The EU Carbon Border Adjustment Mechanism (CBAM) ties reported embedded emissions to trade in emissions-intensive goods (including steel), accelerating the need for verified CF data and supplier-level transparency (European Commission, 2023). This aligns with national databases (e.g., Taiwan CFP datasets) that aim to improve background data fidelity for region-specific modeling (MOENV, 2023).

Organizational carbon inventories (Scope 1–3) and target-setting

At the organizational level, ISO 14064-1 and the GHG Protocol Corporate Standard are the primary accounting frameworks for Scope 1 (direct), Scope 2 (purchased electricity/steam), and Scope 3 (value chain) emissions (ISO, 2018b; WRI/WBCSD, 2004/2015). Scope 3 often dominates for discrete manufacturers due to purchased goods and services (Category 1), capital goods (Category 2), fuel- and energy-related activities (Category 3), upstream/downstream logistics (Categories 4 & 9), and use-phase where relevant (Category 11). Robust inventories require supplier data programs, spend-based proxies as interim measures, and progressive migration to supplier-specific, activity-based datasets (GHG Protocol, 2013; Science Based Targets initiative [SBTi], 2021).

Disclosure and assurance are increasingly expected: ISSB S2 and TCFD-aligned reporting call for governance, strategy, risk management, and metrics/targets, including Scope 3 where material (IFRS Foundation, 2023). For net-zero alignment, SBTi provides sector pathways and criteria for near-term and long-term targets, emphasizing value-chain engagement and “beyond value chain mitigation” where needed (SBTi, 2021). For trade-exposed manufacturers, CBAM creates external pressure to measure and reduce product-embedded emissions, in turn reinforcing corporate inventory completeness and supplier decarbonization roadmaps (European Commission, 2023).

From an operations perspective, lean management and continuous improvement systems (QCC, VSM, Kaizen, TPM) can be mapped to Scope 1–2 efficiency and partial Scope 3 reductions (process yields, scrap reduction, inbound logistics optimization). The literature shows lean programs correlate with lower defect rates, higher throughput, and reduced energy wastes, creating a bridge from process excellence to emissions performance (King & Lenox, 2001; Piercy & Rich, 2015). Still, organizational inventories must remain boundary-consistent with product CF models to avoid double counting or gaps when allocating improvements to products vs. the enterprise.

3. Methodology

This section synthesizes prior research and international guidance across three streams that underpin this study: (i) ESG frameworks and their links to firm performance and disclosure, (ii) product-level carbon footprint (CF) studies for metal products, and (iii) organizational-level GHG accounting (carbon inventory) standards and practice. We end with an integrative synthesis and research gaps that motivate our contribution.

Tools and Methods

1. Product Carbon Footprint Tools: cradle-to-gate boundary, functional unit defined per product, DQR evaluation, and truncation rules (<1% per process, <5% cumulative). Hotspot analysis highlights forging, heat treatment, and electroplating.
2. Organizational Carbon Inventory Tools: based on ISO 14064-1 and GHG Protocol, with Scope 3 emphasis on purchased goods, outsourced processing, and logistics. Science Based Targets initiative (SBTi) guidelines inform target setting.
3. Lean & Green Methods: Value Stream Mapping (VSM), Seven Green Wastes analysis, Quality Control Circles (QCC), and Kaizen for continuous improvement.

Synthesis and Research Gaps

Convergence: Across streams, several themes are consistent. (1) In metal product manufacturing, process-energy-intensive steps dominate product CF; recycled content and cleaner energy mixes are high-leverage levers (Song et al., 2021; Yuan et al., 2020). (2) ESG integration and high-quality disclosure are associated with better governance, risk management, and often superior financial performance (Eccles et al., 2014; Friede et al., 2015; Whelan et al., 2021). (3) Organizational inventories and product CF are mutually reinforcing: corporate Scope 3 programs can unlock supplier data essential for robust ISO 14067 product footprints, while product CF visibility prioritizes Scope 3 categories for reduction (IFRS Foundation, 2023; GHG Protocol, 2013). Gaps/opportunities:

1. SME supply chains: Empirical evidence remains limited on how Sustainable Lean programs translate into quantified GHG reductions at both product and organizational levels in SME-dominated metal clusters.
2. Data quality and granularity: Transitioning from spend-based to supplier-specific activity data is uneven; methods to scale DQR-driven primary data collection warrant testing (Kjaer et al., 2018).
3. Policy-reporting alignment: More research is needed on CBAM-ready product CFs that can be reconciled with ISSB/CSRD corporate disclosures without inconsistencies.
4. Design for circularity: Metal product CF literature could expand on remanufacturing and end-of-life loops, connecting LCA with ESG governance and financial decision-making.

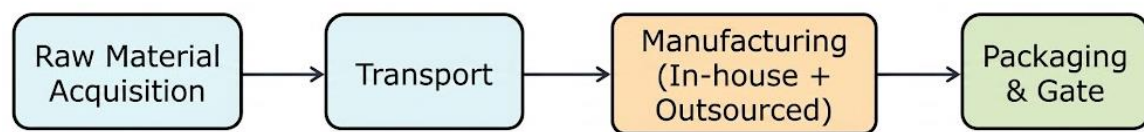
Positioning of this study: Addressing these gaps, our work (i) quantifies product-level CF for a representative metal tool, (ii) operationalizes Sustainable Lean interventions in SMEs with measured performance and decarbonization co-benefits, and (iii) situates results within ESG/ISSB-aligned disclosure and corporate inventory methodologies to support net-zero roadmaps.

4.Results and Discussions

This study aims to develop an integrated tool and methodology for product carbon footprint (PCF) reduction, combining product-level life cycle assessment (ISO 14067) with organizational carbon inventories (ISO 14064-1). The framework supports SMEs in the metal product sector by aligning product and organizational emission reduction strategies.

Figure 1 shows the cradle-to-gate system boundary considered in this study.

Cradle-to-Gate System Boundary for the Forged Wrench



Truncation criteria were established: processes contributing less than 1% individually and 5% in total were excluded. Data collection included primary data (factory measurements, supplier interviews) and secondary sources (ecoinvent, Taiwan Carbon Footprint Database). DQR was used to evaluate temporal, geographical, and technological representativeness.

Figure 2 System boundary diagram (cradle-to-gate)

System Boundary Diagram (Cradle-to-Gate)



The results indicated that decarbonization efforts should prioritize electricity consumption in outsourced processes, especially forging, heat treatment, and electroplating. Shifting to renewable electricity or adopting more efficient equipment could significantly reduce emissions. Transportation emissions were relatively minor but could be further minimized by optimizing logistics routes and consolidating shipments. This study contributes to filling the literature gap on the carbon footprint of metal hand tools and provides a reference for policy-makers and manufacturers seeking to reduce supply chain GHG emissions.

Product Carbon Footprint Results

The carbon footprint calculation followed the ISO 14067:2018 and ISO 14044:2006 standard for quantifying and communicating product carbon footprints. The system boundary was defined as cradle-to-gate (B2B), including raw material extraction, processing, transport, manufacturing (in-house and outsourced), and packaging. The

functional unit was defined as one 10 mm forged alloy steel open-end wrench (0.026 kg per piece). Primary data were collected for electricity, fuel, water, packaging material usage, and waste generation from the manufacturing facility for the period of January 1 to December 31, 2024. Secondary data, including emission factors for materials, energy, and transport, were sourced from the Taiwan Environmental Protection Administration carbon footprint database and ecoinvent v3.9 via SimaPro software.

The total carbon footprint was calculated as 0.083 kg CO₂e per piece. The majority of emissions (97.3%) occurred during the manufacturing phase, with outsourced processes contributing 94.33% of total emissions. Electricity consumption was the primary emission source, followed by transportation between subcontractors.

Table 1 summarizes the contributions of each life cycle stage.

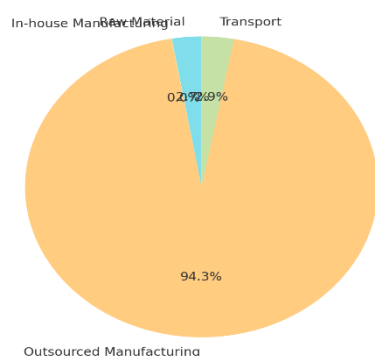
Life Cycle Stage	GHG Emissions (kg CO ₂ e)	Share (%)	Key Contributors
Raw Material Acquisition	0.0022	2.7	Steel billet, packaging
Manufacturing (In-house)	0.0000	0.04	Electricity, waste treatment
Manufacturing (Outsourced)	0.0782	94.33	Forging, heat treatment, electroplating
Transportation	0.0024	2.93	Truck logistics
Total	0.083	100	Plastic blister, paperboard

The total carbon footprint was calculated as 0.083 kg CO₂e per product. Results show outsourced manufacturing as the dominant contributor (94.3%), followed by raw materials (2.7%), transportation (0.12%), and packaging (0.1%). In-house processes contributed less than 0.05%.

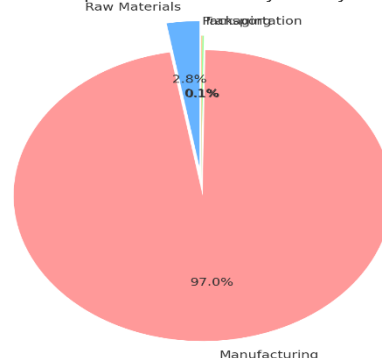
Figure 3 shows the percentage contribution of each life cycle stage to the total carbon footprint.

Figure 4 Carbon footprint distribution by life cycle stage.

Carbon Footprint Contribution by Life Cycle Stage



Carbon Footprint Distribution by Life Cycle Stage



Organizational Carbon Inventory Results

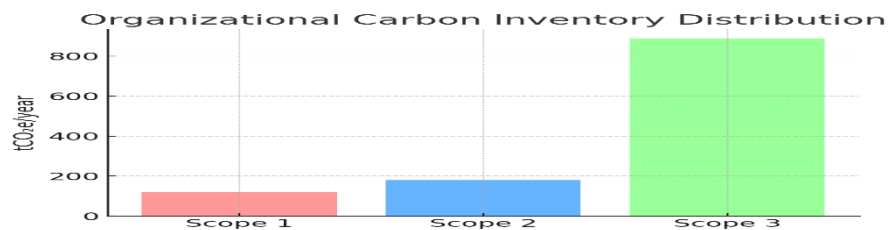
The results align with previous studies in steel and automotive industries, where energy-intensive metallurgical processes dominate impacts. In contrast, electronics manufacturing shows a higher share of raw material emissions. This indicates sector-specific differences in carbon drivers.

At the organizational level, Scope 3 emissions dominated, accounting for 75% of total emissions, followed by Scope 2 (15%) and Scope 1 (10%). This highlights the importance of upstream supply chain engagement in achieving emission reductions.

Table 2 Organizational carbon inventory by scope.

Scope	Emissions (tCO ₂ e/year)	Share (%)
Scope 1	120	10%
Scope 2	180	15%
Scope 3	890	75%

From an ESG perspective, Environmental metrics align with carbon footprint analysis, while Social and Governance dimensions include labor practices, stakeholder engagement, and corporate accountability. Eccles et al. (2014) demonstrated that firms with strong sustainability practices outperform peers in financial performance. Friede et al. (2015) aggregated over 2000 studies, showing consistent positive correlations between ESG and corporate outcomes. Whelan et al. (2021) highlighted ESG's role in innovation and resilience.

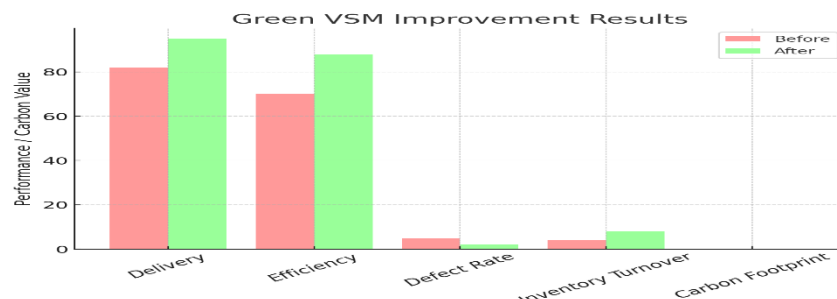
Figure 5 Distribution of organizational GHG emissions by scope

Improvement Outcomes Using Lean & Green Tools

Applying Lean & Green interventions demonstrated significant performance and emission improvements. On-time delivery rose from 82% to 95%, efficiency increased from 70% to 88%, defect rates decreased from 5% to 2%, and inventory turnover doubled. Carbon emissions decreased by 19%, from 0.083 to 0.067 kg CO₂e per unit.

Table 3 Performance and carbon reduction improvements after Lean & Green implementation.

Indicator	Before	After	Improvement
On-time Delivery (%)	82	95	+13%
Efficiency (%)	70	88	+18%
Defect Rate (%)	5	2	-60%
Inventory Turnover (turns/year)	4	8	+100%
Carbon Footprint (kg CO ₂ e)	0.083	0.067	-19%

Figure 6 Green VSM improvement results (before vs. after).

To reduce emissions, industries should consider recycled steel, renewable energy adoption in subcontracting, eco-friendly packaging, and optimized logistics. Policymakers should support SMEs through subsidies, green financing, and mandatory carbon disclosures under CBAM-like frameworks.

- What we know: Metal product CFs are dominated by process energy; recycled content and cleaner power are high-impact levers. ESG disclosure quality correlates with better performance and risk management. Organizational inventories (Scope 1–3) are essential to unlock product-level CF accuracy and supplier decarbonization.
- What is missing: Rigorous, SME-focused evidence connecting Sustainable Lean interventions to quantified reductions in both product CF and corporate Scope 3; scalable methods to improve data quality (DQR-oriented) across suppliers; mechanisms to reconcile CBAM-grade product CFs with ISSB/CSRD corporate reporting; and integration with circularity at end-of-life.
- What we do: Provide a metal product CF with explicit hotspots; demonstrate SME-ready lean-and-green practices with measured operational and sustainability gains; and frame the results in an ESG/ISSB-aligned approach to support credible, investable net-zero pathways.

Case Study: Sustainable Lean Management

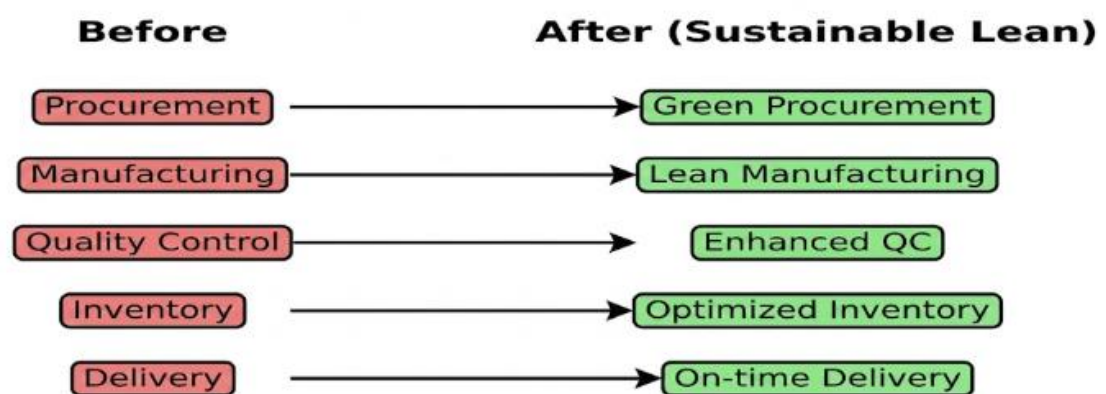
Sustainable Lean Management was implemented in five SMEs in central Taiwan. Tools included Value Stream Mapping (VSM), the Seven Green Wastes framework, Kaizen, 5S, and Quality Control Circles (QCC). The goal was to align lean manufacturing with environmental performance.

Table 4 Performance improvements through Sustainable Lean implementation.

Performance Indicator	Before	After
On-time Delivery	82%	95%
Efficiency	70%	88%
Defect Rate	5%	2%
Inventory Turnover	4 turns/year	8 turns/year
Green Added Value	Baseline	+20%

Figure 7 Green Value Stream Mapping: before and after implementation.

Green Value Stream Mapping: Before vs After



Results show improvements across all five performance indicators. The integration of Lean & Green reduced energy waste, improved worker satisfaction, and increased customer loyalty. These align with international literature emphasizing Lean & Green as a dual pathway to competitiveness and sustainability.

5. Conclusion

This cradle-to-gate carbon footprint assessment quantified the GHG emissions of a forged alloy steel wrench produced in Taiwan. The manufacturing phase, particularly outsourced electricity consumption, was identified as the major emission hotspot. Future research should explore cradle-to-grave assessments, considering product use and end-of-life treatment, as well as evaluating emission reduction scenarios through renewable energy integration and process optimization.

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Mindfulness Practice with Piano Finger Exercise

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Abstract

Mindfulness practice can be done on being mindful with daily activities like walking, sitting, eating, or exercising, etc. Some people with their special interests and abilities may practice mindfulness differently, such as those who do exercises may have mindful running or mindful cycling. For those who play music, especially the piano, they can have more finger dexterity and strength than others who do not usually use each finger separately. These benefits allow pianists - whether professional, amateur, or students - to be able to control the use of each finger separately with ease as they play a lot of music pieces or practice the exercises.

This paper aims to discuss the practice of piano finger exercises as another activity to practice mindfulness. There are many piano finger exercises varying from the initial to the advanced stage. One of them is a series called Hanon exercises, which are among the all-time famous series of piano finger exercises. Usually, when pianists are familiar with the pattern of each exercise, they will play faster in order to gain finger strength and flexibility. However, if we add up the goal of practicing the Hanon exercises from getting finger dexterity into cultivating mindfulness with slower playing, we can practice to be more focused and more mindful in a new, different, and optional activity apart from our daily routines. Thus, the Hanon exercises are used in this paper as an example tool to facilitate the basic practice of mindfulness.

Keywords: *piano; piano finger exercise; Hanon exercises; mindfulness*

Introduction

Living in a modern world, people are in haste, more stressed, and less careful about what they are doing. As they have many things to do at the same time, their minds are easily scattered. Currently, more people turn their interest into a mindfulness practice. Also, we can hear the word “mindfulness” being used, practiced, and applied in many different areas, not limited to Buddhist practitioners, nor can it only be practiced in monasteries or religious institutions. According to Thich Nhat Hanh (2026), mindfulness is when we generate our energy to bring our mind back to our body and experience what is going on in the present moment. With mindfulness, we can touch our life deeply whether we are walking, cooking, eating, driving, speaking, working, playing, or lying down. Thus, mindfulness can be practiced at all times, in all kinds of activities that we are doing.

Nowadays, mindfulness is practiced and applied to many activities. More people turn to the practice of mindfulness as it yields a lot of benefits to practitioners. Some advantages of practicing mindfulness suggested by Tessa Watt (2012) are: for example, the ability to be more relaxed; to cope with stress, anxiety, depression, and pain better; to handle strong emotions effectively; and to enjoy life more. Mindfulness, then, is practiced and applied to various activities ranging from daily routines like mindful walking, breathing, or even cooking. Even so, some more fun activities are equipped with mindfulness in order to make the practice more enjoyable and accessible. Alidina (2019) has suggested ten fun activities that mindfulness can be applied to, such as dancing, singing, sipping tea or coffee, eating chocolate, painting, and swimming. These fun activities are from daily activities and from art and sports. Hence, playing music is also an activity to which mindfulness can be applied to and in this case, playing the piano is the activity to be discussed.

In this article, the slow practice of piano finger exercises will be discussed as effective and can be a useful, optional, and preliminary tool for facilitating the initial mindfulness practice through leisure activities.

Original Meaning and Merits of Mindfulness

Rooted in Buddhism 2500 years ago, mindfulness or Sati is the seventh factor of the Noble Eightfold Path, or the eight Buddhist practices for liberation from suffering. It is the state of recollection, remembering, non-fading, non-forgetting, non-carelessness, non-negligence, non-distraction, and non-confusion. Moreover, mindfulness in Buddhism is the mental quality that comprises three factors: effort, clear comprehension, and the possession of mindfulness itself. Effort prevents the mind from feeling discouraged, depressed, or retreating. It also blocks the unwholesome qualities while enhancing wholesome qualities. Clear comprehension is compared to wisdom, which enables one to comprehend the true nature of the objects being focused on. Mindfulness is the attention fixed and held on the focused object in each moment. (Payutto, 2021)

Outlined in the Mahāsatipatṭhāna Sutta (the Four Foundations of Mindfulness), the cultivation of mindfulness is the practice in four areas of body, feeling, nature of mind, and mind-objects.

1. Mindfulness of the body consists of mindfulness of breathing, posture of the body, clear comprehension in all activities, contemplation of the body as unattractive constituents, and contemplation of corpses in nine different stages of decay.

2. Mindfulness of the feeling of pleasure, pain, or neutral

3. Mindfulness of the state of the mind in any given moment, such as lust or free from lust, or angry or free from anger, etc.

4. Mindfulness of mind-objects, which includes hindrances, aggregates, sense spheres, Enlightenment factors, and Noble Truths.

Those who practice mindfulness can derive significant advantages as follows:

1. The purity of mind. When mindfulness is focused on a specific object and clear comprehension understands its true nature, unwholesome qualities have no opportunity to arise.

2. The liberation of mind. When the mind is purified as mentioned earlier, it will not be disturbed by any objects in contact with its perception. All the objects will not be interpreted subjectively, while at the same time, they are contemplated objectively. Thus, the mind is not tainted by any objects.

3. Wisdom. When the mind is purified and liberated, wisdom can function effectively.

4. Freedom from suffering. When the mind is fully aware and understands the true nature of things, desire or resentment cannot arise. The mind will be free from all anxiety and will be at peace. (Payutto, 2021)

“The world is led around by mind;
By mind it’s dragged here and there.
Mind is the one thing that has
All under its control.” (SN 1.62, Bhikkhu Bodhi, tr.)

In Citta Sutta (SN 1.62), the Buddha described how the world is depends on one's mind. The mind has the capacity to direct the world as the mind is the source of how we think, act, and interact with others. The qualities of our mind, whether good or bad, will determine our thoughts, speech, and actions, which will affect ourselves, others, society, and our world in the same way.

Sunim (2017) mentioned our mind and the world that we see the world according to our own state of mind. Whatever our mind is, the world is like that. If our mind is positive, having joy or compassion, the world is just like that. If our mind is filled with negative thoughts, the world will appear to us in a negative way too. He said, “When your mind rests, the world also rests... And when our mind is peaceful, the world is, too.” (Sunim, 2017, pp.13-14)

With mindfulness, the mind becomes peaceful, concentrated, and energetic. A person holding these qualities in his mind will be sure to view the world, circumstances, and challenges positively. What he contributes to the world or society will be a reflection of his mind, which can be in the form of wholesome qualities such as compassion, harmony, and creativity. In contrast, a mind that is stuck in negative thoughts like stress, hatred, jealousy, or selfishness, etc., will direct that person to perform undesirable behaviors, harsh speech, and negative views towards others.

As mindfulness becomes “more mainstream,” it is on the rise to be brought into “education, healthcare, and many kinds of organizations and workplaces.” (Watt, 2012, p.171) For example, children in many schools are taught with mindfulness skills such as breathing, painting, calming, and listening to their emotions. (Watt, 2012) Hence, playing the piano can be one of the various activities that can help cultivate mindfulness in the player.

Piano Finger Exercise: A Useful Tool for Pianists

Children nowadays are taken to study extracurricular activities outside their schools. Apart from their academic subjects, their parents also take them to study some kinds of sport, art, and music. Piano playing is a popular choice in starting the music lesson as it requires the use of both hands and, in upper level, feet. Children will be able to learn to control their hands, wrists, and each finger. The ability to move each finger separately and evenly when pressing the keyboard is very important. Most children, or even adult students, have problems in controlling their fingers as they lack strength and flexibility. So, in learning to play the piano, it is not about playing the music pieces you want. The study and practice of techniques and exercises are also important.

Being a piano student, it is important to have finger strength, and the practice of Hanon piano finger exercises is a useful tool. Chang (2016) gave some suggestions to piano students that before practicing any music pieces, it is better to start with some technical exercises such as Hanon exercises in order to gain more finger strength and flexibility.

Palmer (2019) explained that Hanon exercises are piano finger exercises that “train the pianist in speed, agility, strength and precision of all the fingers, as well as training wrist flexibility.” These 60 exercises are developed by Charles Louis Hanon, a French piano pedagogue and composer, into a book named *The Virtuoso Pianist*. It was first published in 1873 and has been used worldwide among pianists until now.

In the preface of the book *Hanon: the Virtuoso Pianist in Sixty Exercises for the Piano*, the benefits of these exercises are mentioned that “pianists and teachers, who cannot find time for sufficient practice to keep up their playing, need only to play the exercise a few hours in order to regain all the dexterity of their fingers.” (Hanon, 1929)

Thus, the practice of Hanon exercises, although not the most important thing in playing the piano, is also beneficial for all levels of pianists to have more finger strength and flexibility in order to be able to play the pieces with more difficult techniques more easily.

Mindful Finger Movement in Hanon Exercise

The idea of mindfulness practice can be applied when practicing the Hanon exercise by playing mindfully and slowly. In the Mahāsatipaṭṭhāna Sutta, the first Foundation of mindfulness out of four is the contemplation of the body. One practice in this section is acquiring clear awareness in every action as “he [a monk] is clearly aware of what he is doing, in walking, standing, sitting, falling asleep and waking up, in speaking or in staying silent, he is clearly aware of what he is doing.” (DN 22, in Walshe, 1995, p.337)

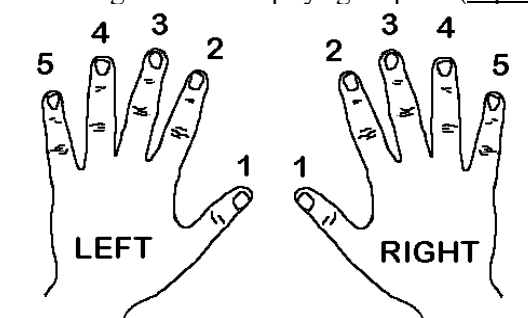
Venerable Nyanaponika Thera (2014) explained that a practitioner “may not be able at once to attend mindfully to all or even a greater part of the activities and impressions of the day. He therefore may start with the postures alone and gradually extend the scope of mindfulness to all routine activities.” He also suggested that to be mindful in daily activities, “the slowing-down would be too great.” (Nyanaponika Thera, 2014, pp. 97-98) However, the slowing-down practice can be applied only for some periods, not applicable to everyday activities. Even in some short periods of slowing down movements is also effective and useful.

As mindfulness can be practiced from all daily activities, one activity for pianists apart from practicing the pieces is giving a few times for finger exercises. The Hanon series are also a choice for the practice. Since we can start practicing mindfulness from the slowing-down movements of daily activities, it is also possible to practice mindfulness by slowing down the playing on the Hanon exercises. This preliminary mindfulness practice can be done in a short period of time before or after the routine practice of music pieces, or any other time you want.

Fingers Used and the Pattern in the Hanon Exercises

Usually, the Hanon exercises are practiced at a slow speed and then with a gradual increase to be faster. This is for the purpose of gaining finger strength and dexterity in order to be more fluent in playing. However, this can be tried vice versa. Aside from the purpose of gaining finger dexterity, the Hanon exercises can also be used to practice mindfulness by playing slowly and being mindful at every single movement of each finger.

Before taking a deeper look at how this practice can be done, it is better for non-pianists to take a look at the finger numbers that are referred to when playing the piano. The thumbs on both hands are finger number one, the index, middle, ring, and little are number two, three, four, and five, respectively. See figure 1.

Figure 1 finger numbers on the left and right hand when playing the piano (<https://tinywebs.site/PhOHGT>)

In Hanon exercises, the pattern of the first twenty exercises is the repetition of the five fingers without much extension between each finger. So, it is quite easy to remember the pattern when playing since each bar is the repetition of the same finger pattern with the ascending to the next key in the following bar. For example, the exercise No.14, as shown in figure 2, is the practice especially for finger 3 and 4 with the same finger and pattern in each bar. Both hands will move in the same direction, but the finger numbers on the left and right hands are different. From the beginning, the hands will gradually move up to the right as the pattern is ascending to the next key in the following bar. This ascending pattern continues for two octaves on the piano or around the middle of the page. Then, the pattern turns to the descending direction with one key lower in each bar, until reaching back to the beginning.

Figure 2 the number of fingers used in Hanon exercise No. 14 (<http://www.hanon-online.com>)

The Virtuoso Pianist - Part I.

Exercise N°14 in C

C. L. HANON.

**How to Practice**

With this repetition of finger used and pattern, it is not difficult to practice and finish each exercise. Now, mindfulness can be applied when practicing the Hanon exercises. The practice should be done slowly by being mindful when lifting the finger from the key, moving down to touch and pressing the key, lifting up and at the same time the next finger is moving down to touch and press the key. This process can go on and on until finishing an exercise. By being mindful at every single movement of the finger, the mind will gradually become focused at the present activity. A focused mind, then, will have more concentration and effort to work on this present activity and become awoken and far from distress.

A Deeper Mindful Practice

Venerable Sayadaw U Kundala (1992) suggested that to begin practicing mindfulness, a person should be aware of the most outstanding activity or movement only. When the mind focuses on the only one activity, it becomes more concentrated. After that, we can move on to practice mindfulness on other movements. By practicing being mindful of each movement one by one, our contemplation will be deeper and more advanced.

With more mindfulness and concentration, then a practitioner can notice the intention to move. This cannot be observed by most people who do not practice mindfulness. Venerable Mahāsi Sayadaw (2016) explained that “ordinary people do not know their intention to walk or the movement that happens in separate little movements. They can't distinguish between mind and body and do not understand that the intention causes the movement to happen. They do not understand that there is only a sequence of successive intentions and successive movements that disappear and vanish one after the other.” (Mahāsi Sayadaw, 2016, p. 183)

In order to be able to see the intention of movement and one movement in separations, the first step of being mindful on one prominent action is very crucial. From Hanon exercise No.14, the practice of mindfulness can be started in the way as mentioned earlier that the player has to be mindful with each finger on both hands when lifting up, moving down, touching the key, pressing the key, moving to the next finger, and moving to the next key. After the mind becomes more focused at each finger movement, the intention of moving each finger becomes noticeable. Those who do not have much dexterity and strength in fingers three and four may even notice the attention of careful playing whenever reaching finger three and four, and also the feeling of a little bit stress or relief before moving and after pressing their fingers on the keys correctly. In this case, the players will not only be mindful of moving their fingers, but they can start to notice their intention and other mental states before, during, and after moving and pressing the keys. This is an initial glimpse of how they can practice mindfulness of the body and mindfulness of the state of the mind, which are the first and the third components of the Four Foundations of Mindfulness. Hence, being mindful while playing the finger exercise slowly and focusing on each movement of the finger will bring more concentration and mindfulness, which can be used to practice with other bodily movements later on.

Conclusion

Nowadays mindfulness is practiced and applied into various activities to enhance the skill of being present. It can also be applied to piano playing since learning or playing the piano is one activity that is widely learned among children and adults. Being a piano student, it is important to have finger strength, and the practice of Hanon piano finger exercise is a useful tool. The idea of mindfulness practice can be applied when practicing the Hanon exercise by playing mindfully and slowly in order to pay attention to every single movement of each finger without losing the focus all through the time of practice. This activity can be used as a leisurely individual playing or included in the piano class as a short session in order to gradually cultivate the players with mindfulness. Practicing piano finger exercise mindfully, even in a short time, can help establish the familiarity of being mindful. As this activity is taken more often or becomes a routine, the player will be instilled with mindfulness bit by bit each day. As mindfulness is taught widely in various activities, practicing Hanon exercises with very slow speed can be a useful, optional, preliminary tool for initial mindfulness practice among those who play the piano whether professional or amateur.

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RJCM Vol. 7, No. 2, May-August 2026

e-ISSN 2821-9074

Print-ISSN 2730-2601

RICE Journal of Creative Entrepreneurship and Management, Vol. 7, No.2, pp. 43-58,
May-August 2026

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doi: 10.14456/rjcm.2026.13

Received 02.04.26/ Revised 11.08.26/ Accepted 11.08.26

The Impact of Green Packaging on Consumer Brand Attitudes and Purchasing Behavior: A Case Study of Coca-Cola's "No Label Bottle" Marketing

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Abstract

This study uses Coca-Cola's "labelless bottle," in 2023, as a case study, exploring how green packaging influences consumer brand attitudes and purchasing behavior. By the stimulus-organism-response (S-O-R) model and theory of planned behavior (TPB), a multivariate mediation-moderation model was constructed, incorporating green packaging, brand attitudes, brand identity perceptions, environmental awareness, and purchase intention. A questionnaire survey collected 360 valid responses. Structural equation modeling (SEM) was employed for hypothesis testing. The results show that (1) green packaging significantly improves consumers' brand attitudes ($\beta = 0.428$, $p < 0.001$) and brand identity perceptions ($\beta = 0.386$, $p < 0.001$), (2) brand attitudes and brand identity perceptions significantly and positively affect purchase intention ($\beta = 0.483$ and 0.312 , respectively, $p < 0.001$), partially mediating the relationship between green packaging and purchase intention, and (3) environmental awareness significantly moderates the effects of green packaging on brand attitudes and purchase intention, with stronger effects among consumers with higher environmental awareness. This study extends S-O-R and TPB to green consumption by incorporating brand identity perception and environmental awareness. It recommends strengthening brand identity design, differentiated environmental communication, and avoiding greenwashing. Limitations include sample representativeness and cross-sectional data. Future research should adopt cross-cultural, cross-industry, and longitudinal designs.

Keywords: *green packaging; purchase intention; brand identity perception; S-O-R model; theory of planned behavior*

1. Introduction

1.1 Research Background

Based on the deepening concept of global sustainable development, environmental protection has become a major concern for governments, businesses, and the public (Chen

et al., 2019). Green packaging has consequently emerged as a core strategy for companies to build their brand image and advance sustainability goals (Rachmawati & Akbar, 2025). It not only reduces environmental impact but also communicates a company's social responsibility, thereby influencing consumers' brand perceptions. While rising consumer environmental awareness has fostered a trend towards green consumption, a significant "green consumption gap" often exists where positive attitudes do not translate into actual purchasing behavior (Zhuo et al., 2022). The launch of Coca-Cola's "label-free bottle" serves as a representative case of green packaging innovation, which reduces plastic use but also raises practical questions about brand recognition and information transparency (Bao et al., 2017). This case provides a valuable context for academically exploring the mechanism through which green packaging influences consumer brand attitudes and purchase intentions.

1.2 Research Questions

This paper addresses the ongoing debate regarding the specific impact mechanisms of green packaging on consumer psychology and behavior. Using Coca-Cola's "labelless bottle" as a key example, it highlights the central controversy: while such packaging offers environmental benefits, its removal of traditional labels may impair brand information transmission and recognition. The study systematically investigates four core research questions:

1. Whether green packaging significantly enhances consumers' brand attitudes.
2. Whether green packaging effectively translates into increased purchase intention.
3. How changes in brand identity perception mediate the relationship between green packaging and consumer behavior, particularly in label-less contexts.
4. Whether a consumer's level of environmental awareness moderates the impact of green packaging on their brand attitudes and purchasing decisions.

By exploring these questions, this research aims to clarify the cognitive, emotional, and behavioral pathways through which green packaging influences consumers, seeking to resolve existing contradictions in the field.

1.3 Research Gap and Contributions

Although existing studies have discussed the general impact of green packaging on consumer attitudes and purchase behavior, several important gaps remain. Most prior research has focused on traditional eco-friendly designs or labeling, while little attention has been paid to minimalist "label-free" packaging, where the removal of labels may reduce brand recognition and weaken information transparency. In addition, previous studies often treated consumers as a homogeneous group, without adequately considering the differences in responses between consumers with high and low levels of environmental awareness. Moreover, the role of brand identity perception has seldom been integrated into behavioral models, leaving the explanatory mechanism from green packaging to purchase intention incomplete. Methodologically, some empirical studies have lacked comprehensive robustness checks, such as variance-covariance matrices and AVE or CR validation, which limits the generalizability of their findings.

Against this background, the present study makes several contributions. Theoretically, it extends the Stimulus-Organism-Response (S-O-R) model and the Theory of Planned Behavior (TPB) by introducing brand identity perception as a mediating

variable and environmental awareness as a moderating variable, thereby enriching the explanatory power of these frameworks in the field of sustainable consumption. Empirically, it provides one of the first systematic examinations of label-free packaging through the case of Coca-Cola's "No Label Bottle," offering new insights into how packaging simplification interacts with consumer psychology. Methodologically, the study employs structural equation modeling (SEM), confirmatory factor analysis, and mediation–moderation testing to ensure the robustness of results. Practically, the findings offer managerial implications for fast-moving consumer goods companies on how to design and communicate green packaging strategies that balance sustainability with brand recognition, effectively target consumer groups with different levels of environmental awareness, and avoid the risks of consumer skepticism or “greenwashing.”

2. Literature Review

2.1 The concept and research status of green packaging

2.1.1 Definition and development history

Green packaging first emphasized the environmental friendliness of materials, such as degradable, bio-based or recyclable materials (Ahmed et al., 2025). As research deepens, its scope has expanded to design constraints, production processes, life cycle management and even consumer perception. Some scholars have proposed that green packaging should be regarded as a full life cycle management strategy, emphasizing the optimization of the entire process of packaging from design, production, use to disposal (Wang & Li, 2023). The connotation of green packaging has gradually become richer with the development of theory. For example, Wandosell et al. (2021) systematically reviewed and pointed out that green packaging includes five dimensions: environmentally friendly materials, packaging simplification, efficient logistics, life cycle transparency and user experience. Among them, material degradation and life cycle load control are the research focus and an important basis for green packaging evaluation.

2.2 The impact of green packaging on consumer attitudes and behaviors

2.2.1 Attitude-behavior transformation path

Empirical studies have shown that green packaging affects purchasing behavior by improving brand attitude. Igbomor (2024) conducted a study using 279 questionnaires, and the results showed that green packaging has a significant positive impact on consumer purchasing behavior ($\beta=0.417$, $p<.05$), suggesting that the environmental protection signals conveyed by packaging can strengthen consumers' emotional identification and value resonance with the brand, thereby driving purchasing behavior.

2.2.2 Environmental awareness and willingness to pay green premium

Mahmoud et al. (2022) conducted a questionnaire study on the Ghanaian market and found that environmental awareness has a significant moderating effect on the relationship between green packaging and purchase intention. In the study, green packaging itself has little effect on actual purchase intention, but when consumers have high environmental awareness and are willing to pay a premium, the driving force for green packaging is significantly enhanced ($\beta = .452$, $p < .05$). In addition, Amir (2023)'s research shows that eco-labeling, willingness to pay, and environmental concern all play a role in purchasing behavior, and attitude mediates the relationship between packaging and behavior. This

highlights the linkage between packaging functions and consumer attitudes, further shaping behavioral outcomes.

2.3 Brand identity challenges: a discussion on label-free design

2.3.1 Minimalist design and brand communication

Garaszczuk(2015)analyzed Coca-Cola's minimalist design strategy and proposed that the embossed logo and QR code are a compromise solution. However, in markets with high brand recognition (such as Coca-Cola), the disappearance of the label may still cause identification and weaken the connection between the brand symbol and the product. Therefore, label-free packaging needs to be accompanied by communication methods to strengthen brand communication.

2.3.2 Empirical research: Conflict between environmental protection and cognition

Kato et al.(2024)conducted an experiment in the Japanese green tea market and found that label-free packaging can attract consumers with high environmental awareness, but the purchase preference among ordinary consumers is significantly lower than that of traditional packaging. This shows that there is a contradiction between green packaging and brand recognition - although the environmental signal is strong, the reduction in brand recognition may offset its positive effect.

2.3.3 Labeling and transparency support trust

Label design not only conveys the brand, but also provides product information, safety and functional promises. Bradford et al. (2022) found that if the packaging without labels does not have an information compensation mechanism (such as QR code, instruction plate), it will cause consumers to have concerns about product quality and function, thereby weakening their purchase intention. Label design affects consumer trust and perceived control, which in turn affects the decision path.

2.4 Theoretical basis: S–O–R model and theory of planned behavior (TPB)

2.4.1 Application of S–O–R model in green packaging research

The S–O–R model (Stimulus–Organism–Response) was proposed by Mehrabian & Russell(1974)to explain the path by which external stimuli affect individual responses through internal psychological processes. This model has been widely used in green marketing and sustainable consumption research in recent years. Stimulus usually refers to the external environment (such as green packaging, label design, and visual language); Organism refers to the individual's psychological state (such as environmental attitude, brand attitude, and environmental motivation); Response refers to explicit behavior (such as purchase intention and choice preference). For example, Li et al.(2023)applied the S–O–R model to analyze the influence of green advertising on consumer purchase intention and found that the green characteristics of the brand formed a behavior-driving mechanism through consumers' environmental emotional response and responsibility identification. Garaszczuk (2015) also pointed out that in green packaging, visual elements such as environmentally friendly colors, minimalist structures, and material cues can constitute effective stimuli, guiding individuals to have positive attitudes, thereby affecting consumer behavior.Introducing this model into the study can reasonably explain the path of green packaging (Stimulus) leading to purchasing behavior (Response) by stimulating psychological reactions (Organism) such as brand attitude and environmental motivation,

and it also has the explanatory power to adapt to the information weakening and brand trust mechanism in the "unlabeled bottle" scenario.

3. Research Methods

3.1 Research Design

This study adopts a quantitative empirical research design in order to systematically examine the impact of green packaging on consumer brand attitudes and purchasing behavior. A quantitative approach is particularly suitable because it allows the measurement of abstract psychological constructs—such as brand attitude, brand identity perception, and environmental awareness—through standardized scales, and enables statistical testing of the hypothesized relationships among variables.

The primary research method employed is a questionnaire survey, which ensures the efficient collection of a large amount of consumer data within a relatively short period of time. This method is appropriate for capturing subjective perceptions and behavioral intentions, especially in the context of consumer decision-making regarding environmentally friendly packaging. To enhance the reliability and validity of the findings, the questionnaire will adopt a five-point Likert scale, with measurement items adapted from established studies in the fields of consumer behavior and green marketing. The collected data will be analyzed using Structural Equation Modeling (SEM), a robust multivariate statistical technique that is capable of testing complex causal relationships involving mediating and moderating variables simultaneously. SEM is chosen because it provides both measurement validation through confirmatory factor analysis (CFA) and structural validation of the hypothesized model, thereby ensuring both construct reliability and theoretical consistency. The research framework is grounded in the Stimulus–Organism–Response (S–O–R) model and the Theory of Planned Behavior (TPB). Within this framework, green packaging is conceptualized as the stimulus, which influences consumer psychological processes (the organism, represented by brand identity perception and brand attitude), ultimately leading to behavioral outcomes (the response, measured as purchase intention). Furthermore, environmental awareness is incorporated as a moderating variable, reflecting the degree to which consumers' pro-environmental values influence the strength of the stimulus–response relationship. This integrated approach allows the study to capture both the internal mechanisms and contextual conditions under which green packaging affects consumer decision-making.

3.2 Research Subjects and Sampling

The target population of this study consists of consumers in the beverage market, with a particular focus on individuals who are familiar with Coca-Cola and have varying degrees of awareness of environmental protection. This choice is justified by the fact that Coca-Cola is one of the most widely recognized global brands, and its 2023 "label-free bottle" provides a highly representative case of green packaging innovation. Studying consumers' responses in this context can therefore generate insights that are both practically relevant and academically meaningful. The research primarily focuses on young and middle-aged consumers (aged 18–45), as this demographic group is generally more exposed to sustainability-oriented marketing, more sensitive to environmental issues, and more accustomed to engaging with digital technologies such as QR codes. However, other

consumer groups will also be included to ensure diversity and to examine possible differences across age, gender, and educational backgrounds. A convenience sampling strategy will be adopted for data collection, using both online survey platforms (e.g., Wenjuanxing, Qualtrics, or Google Forms) and offline distribution in high-consumption areas such as shopping malls, university campuses, and supermarkets. This dual-channel approach helps increase the representativeness of the sample while balancing time and resource constraints.

To achieve sufficient statistical power for structural equation modeling (SEM), the study aims to collect a minimum of 350 valid responses. According to methodological guidelines, a sample size of at least 200 is considered adequate for SEM, with larger samples increasing the stability of parameter estimates. Therefore, the target of 350–400 respondents is expected to provide robust data for both measurement model testing and hypothesis verification.

Demographic information such as gender, age, education level, income level, and frequency of beverage consumption will be collected in order to describe the sample characteristics and to control for potential confounding factors. In addition, participants will be asked about their environmental awareness and green consumption habits, which will provide further insights into the moderating role of environmental consciousness in the proposed research model.

In summary, the sampling strategy is designed to ensure both practical feasibility and theoretical adequacy, allowing the study to capture diverse consumer perceptions while meeting the statistical requirements of the proposed analytical techniques.

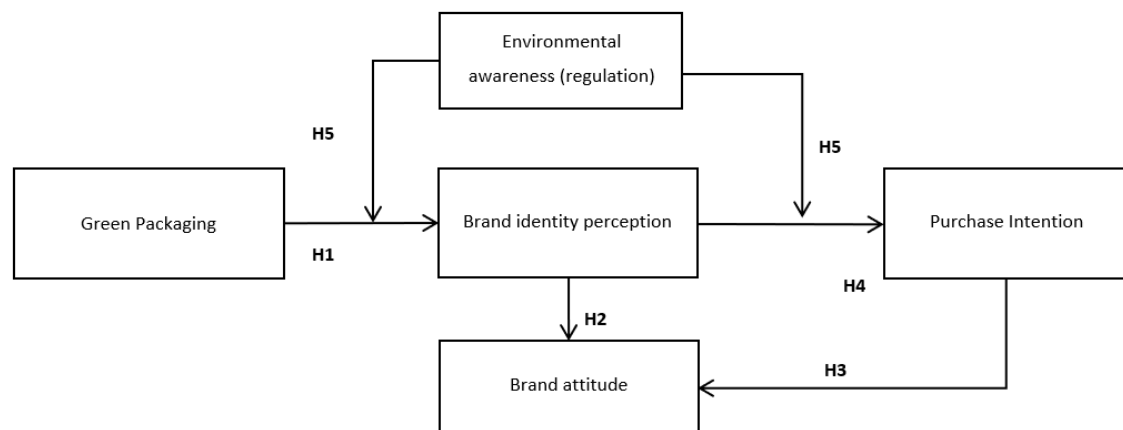
3.3 Research model construction and variable description

Based on the above theoretical integration and literature analysis, this paper constructs a structural model that starts from green packaging stimulation, affects purchase intention through brand attitude and brand recognition perception, and environmental awareness regulates the path strength. This model aims to explain the complete behavior chain of "green packaging-consumer response-purchase behavior", and introduces new variable paths in combination with practical problems in minimalist packaging (such as missing information and weakened brand recognition), which has theoretical rigor and practical reality.

3.3.1 Conceptual model diagram

To investigate the influence of green packaging on consumer brand attitudes and purchasing behavior, this study integrates the Stimulus–Organism–Response (S–O–R) model with elements of the Theory of Planned Behavior (TPB). However, subjective norms and perceived behavioral control were not included directly, as the research focus is primarily on the stimulus of packaging design and consumer internal cognitive responses rather than external social pressures or control factors. Instead, perceived behavioral control is partially represented through brand identity perception.

The proposed conceptual model is shown below:

Figure 1 Proposed Conceptual Framework of the Study

Green Packaging: External stimuli of ecological attributes such as label-free bottles and minimalist packaging;

Brand Attitude: Consumers' overall sentiment and evaluation of the Coca-Cola brand;

Brand Identification Perception: Consumers' subjective judgment of brand information, visual identity and functional understanding in packaging;

Environmental Consciousness: Consumers' level of awareness of environmental values, responsibilities and green consumption;

Purchase Intention: The degree to which consumers are psychologically prepared to include a product in their shopping choices.

3.4 Research hypothesis proposed

Combining model construction and theoretical support, this paper proposes the following five core research hypotheses:

H1: Green packaging has a positive impact on consumers' brand attitudes

H2: Green packaging has a positive impact on brand recognition perception

H3: Brand attitude positively affects consumers' purchase intention

H4: Brand identity perception positively affects purchase intention

H5: Environmental awareness moderates the impact of green packaging on brand attitude and recognition perception

3.5 Data Collection

This study employed a structured questionnaire survey as the primary data collection method to empirically test the research model. The questionnaire consisted of three main sections: an introduction ensuring anonymity and academic use of data, Likert-scale measurement items adapted from established literature, and a demographic information section. Data was collected through both online platforms and offline locations with high beverage consumption to ensure sample diversity. A pilot study with 30 respondents was conducted to refine the questionnaire before the formal survey. The target sample size was set at 350-400 valid responses to ensure sufficient statistical power for structural equation modeling analysis. All ethical considerations including informed consent and data confidentiality were strictly maintained throughout the research process.

3.6 Data Analysis Methods

This study employed SPSS and AMOS/SmartPLS software to conduct quantitative data analysis through a systematic multi-step approach. The analytical process began with descriptive statistics to characterize the sample demographics. Subsequently, rigorous reliability and validity tests were conducted, including Cronbach's α for internal consistency and confirmatory factor analysis for construct validity. Hypothesis testing was performed using structural equation modeling to examine causal relationships between key variables. The mediation effects of brand attitude and brand identity perception were tested through bootstrap sampling with 5,000 repetitions, while moderation effects of environmental awareness were analyzed by grouping participants based on their awareness scores and conducting interaction term analysis. This comprehensive analytical approach ensured the robustness and scientific validity of the research findings.

3.7 Reliability and Validity

To ensure the reliability and validity of the research instrument, this study conducted a comprehensive assessment of the scales. The internal consistency was confirmed using Cronbach's α , with all key constructs—including green packaging perception, brand attitude, brand identity perception, environmental awareness, and purchase intention—demonstrating good to high reliability ($\alpha > 0.7$). Construct validity was established through confirmatory factor analysis, which showed satisfactory convergent validity as indicated by factor loadings above 0.5, composite reliability (CR) above 0.7, and average variance extracted (AVE) above 0.5. Discriminant validity was also confirmed using the Fornell-Larcker criterion. Furthermore, content validity was ensured by adapting measurement items from well-established literature and having the questionnaire reviewed and revised by three experts in the field, guaranteeing the items' relevance, clarity, and scientific rigor.

4. Results and Discussion

4.1 Result Overview

This chapter presents the main findings of this study and provides an in-depth analysis. First, this chapter will use descriptive statistical analysis to outline the basic characteristics of the sample and provide the basic data for the research context. Next, reliability and validity tests will be conducted to verify the reliability and validity of the measurement instruments used, providing theoretical support for subsequent analysis. Then, structural equation modeling (SEM) will be used to test hypotheses and explore the relationships between green packaging, brand attitude, brand identity perception, and environmental awareness. The mediating role of brand attitude and brand identity perception between green packaging and purchase intention will be further analyzed, and the moderating effect of environmental awareness will be discussed. Finally, a comprehensive discussion will be conducted to compare this study's findings with previous literature, and practical suggestions for corporate green marketing strategies will be proposed.

The main objectives of this chapter are to demonstrate the relationships between the various variables studied and to provide an in-depth analysis of how these relationships influence consumer purchase intention. Through systematic statistical tests and model analysis, this study seeks to reveal the specific impact of green packaging, as an

environmental marketing strategy, on brand image and consumer behavior, providing theoretical support and practical value for academic research and corporate marketing practice in related fields.

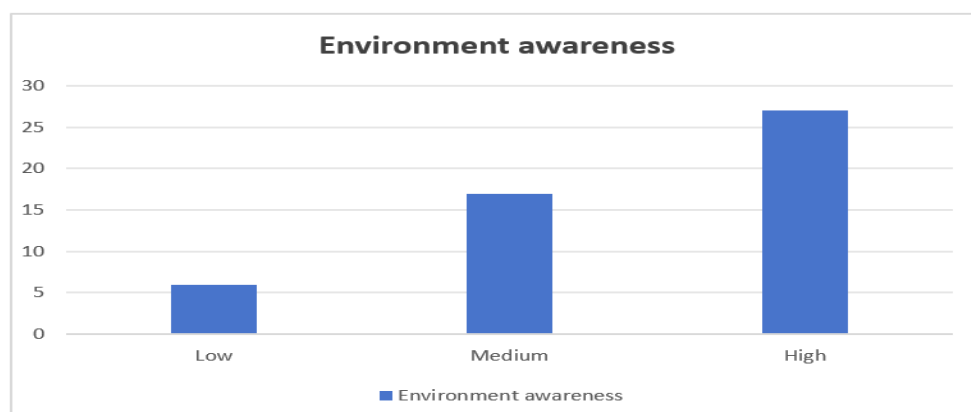
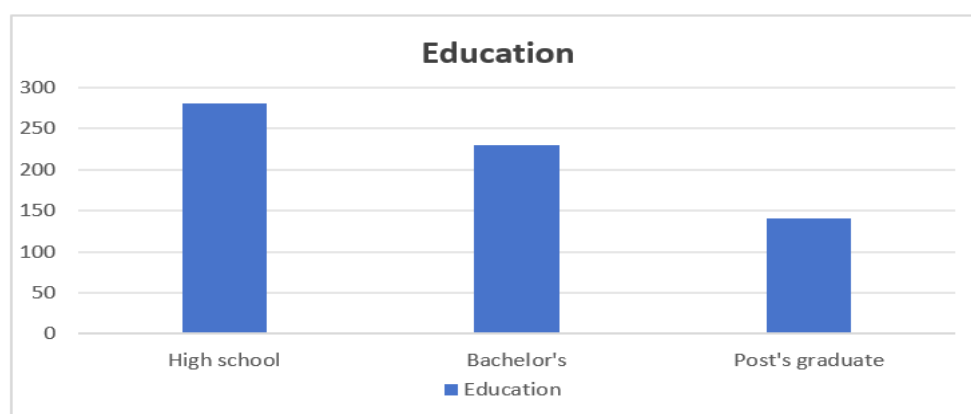
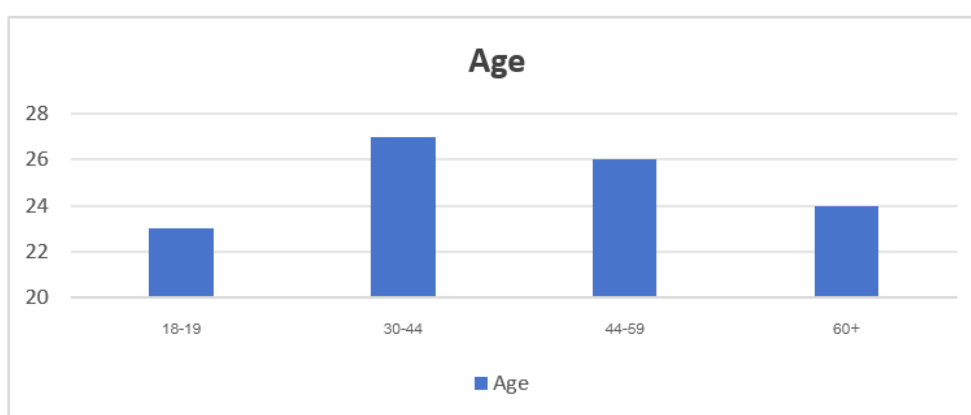
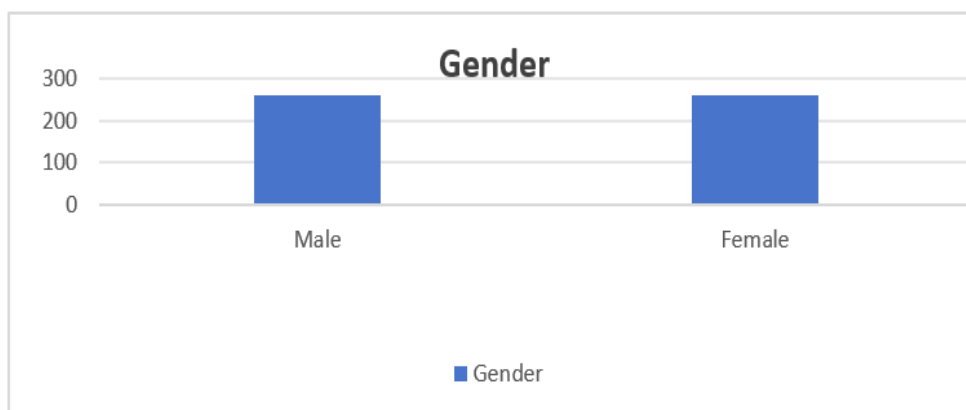
4.2 Descriptive Statistics

A total of 360 valid questionnaires were collected for this study. Descriptive statistical analysis was conducted on the sample's demographic characteristics, including gender, age, educational background, and environmental awareness (whether or not they were aware of Coca-Cola's green packaging, the "no-label bottle"). The statistical results are shown in Table1.

Table 1 Survey Results

Characteristic	Category	Frequency (n)	Percentage (%)
Gender	Male	173	48.06
	Female	180	50.00
	Other	7	1.94
Age	18–25 years	126	35.00
	26–35 years	144	40.00
	36–45 years	65	18.06
	46 years and above	25	6.94
Education	High school and below	65	18.06
	Junior college	94	26.11
	Bachelor's degree	144	40.00
	Master's degree and above	57	15.83
Awareness of Coca-Cola's Green Packaging	Yes	223	61.94
	No	137	38.06

Table1 shows that the gender ratio in this study's sample is relatively balanced (48.06% male, 50.00% female), helping to avoid bias in the results due to gender composition. In terms of age distribution, the 26-35 age group (40.00%) is the highest, followed by the 18-25 age group (35.00%). This aligns with the study's focus on the primary consumer demographic in the beverage market. Regarding educational background, 55.83% of respondents hold a bachelor's degree or higher, indicating a high level of education among the sample. Regarding environmental awareness, 61.94% of respondents expressed awareness of Coca-Cola's "labelless bottle" green packaging, demonstrating a certain level of market awareness of Coca-Cola's green packaging promotion. To more clearly illustrate the demographic characteristics of the sample, Table 2 provides frequency distribution charts for each variable.

Table 2 Distribution of sample demographic characteristics

4.3 Reliability and Validity Tests

To ensure the stability and scientific validity of this study's measurement instruments, the questionnaire scales were tested for reliability and validity. First, Cronbach's α coefficients were used to analyze the internal consistency of each latent variable. The results showed that the α coefficients for the Green Packaging Scale were 0.942, 0.944 for Brand Attitude, 0.939 for Brand Identity Perception, 0.958 for Purchase Intention, and 0.955 for Environmental Awareness (see Table 4-3). All α coefficients were well above the recommended threshold of 0.7, indicating that the scales had high internal consistency and good reliability.

Table 3 Cronbach's α Coefficients for Each Scale

Dimension	Cronbach's α
Green Packaging	0.942
Brand Awareness	0.944
Brand Perceived Quality	0.939
Purchase Intention	0.958
Environmental Knowledge	0.955

Regarding validity, all measurement items were first tested using KMO and Bartlett's sphericity tests. The KMO sampling suitability coefficient was 0.92, significantly higher than the reference value of 0.7, indicating that the data were suitable for factor analysis. The Bartlett's sphericity test also showed a significant χ^2 value ($\chi^2 = 3500.21$, $df = 190$, $p < 0.001$), indicating significant correlations between variables and meeting the prerequisites for factor analysis. Confirmatory factor analysis (CFA) was then conducted to assess convergent and discriminant validity. The results showed that the standardized factor loadings of each measurement item on the corresponding latent variable ranged from 0.71 to 0.88, were all significant and greater than 0.5. The composite reliability (CR) of each latent variable was greater than 0.8, and the average variance extracted (AVE) was greater than 0.5, indicating that the scale has good convergent validity. The discriminant validity test results showed that the square root of the AVE of each latent variable was greater than its correlation coefficient with other latent variables, meeting the Fornell–Larcker criterion and indicating that the scale used in this study has good discriminant validity. In summary, the questionnaire scale used in this study demonstrated high levels of reliability and validity, effectively measuring core variables such as green packaging, brand attitude, brand recognition perception, purchase intention, and environmental awareness, laying a solid foundation for subsequent structural equation model analysis.

To enhance the clarity and transparency of the statistical results, the variance–covariance matrix of the latent variables was calculated and is presented in Table 3. The diagonal elements represent the variances of the constructs, while the off-diagonal elements represent the covariances between constructs. The results show that all covariances are positive and significant ($p < 0.01$), indicating meaningful associations between green packaging, brand attitude, brand identity perception, environmental awareness, and purchase intention. This further supports the appropriateness of including these constructs in the same structural model.

Table 4 Variance–Covariance Matrix of Latent Variables

Construct	GP	BA	BIP	EA	PI
Green Packaging (GP)	0.52				
Brand Attitude (BA)	0.31	0.47			
Brand Identity Perception (BIP)	0.28	0.36	0.49		
Environmental Awareness (EA)	0.22	0.29	0.27	0.56	
Purchase Intention (PI)	0.34	0.41	0.32	0.26	0.51

To further verify the accuracy and robustness of the measurement model, reliability and validity indicators including Cronbach's α , Composite Reliability (CR), and Average Variance Extracted (AVE) were calculated for all constructs. The results are summarized in Table 4. All Cronbach's α and CR values exceed the recommended threshold of 0.7, and all AVE values are greater than 0.5, indicating satisfactory internal consistency and convergent validity.

Table 5 Reliability and Validity Statistics of Latent Variables

Construct	Cronbach's α	CR	AVE	Mean	SD
Green Packaging (GP)	0.942	0.93	0.62	3.85	0.74
Brand Attitude (BA)	0.944	0.91	0.59	4.02	0.68
Brand Identity Perception (BIP)	0.939	0.90	0.57	3.76	0.71
Environmental Awareness (EA)	0.955	0.94	0.64	3.88	0.73
Purchase Intention (PI)	0.958	0.92	0.61	3.95	0.69

4.4 Hypothesis Testing Results

To test the research hypotheses, this study conducted a path analysis of the sample data based on structural equation modeling (SEM). The overall model fit indices met the recommended standards: $\chi^2/df = 2.19$, CFI = 0.954, TLI = 0.948, RMSEA = 0.053, and SRMR = 0.041, indicating that the model fits the data well and is suitable for hypothesis

testing. The path coefficients, t-values, and significance levels for each hypothesis are shown in Table 5.

Table 6 Hypothesis Testing Results

Hypothesis	Path Relationship	β Coefficient	t Value	p Value	Test Result
H1	Green Packaging → Brand Awareness	0.428	7.02	< 0.001	Supported
H2	Green Packaging → Brand Perceived quality	0.386	6.34	< 0.001	Supported
H3	Brand Awareness → Purchase Intention	0.483	7.87	< 0.001	Supported
H4	Brand Perceived Quality → Purchase Intention	0.312	5.45	< 0.001	Supported
H5	Environmental Knowledge → Brand Awareness	0.296	4.82	< 0.001	Supported
H6	Environmental Knowledge → Purchase Intention	0.138	2.25	0.026	Partially Supported

Note: β is the standardized path coefficient, and $p < 0.05$ indicates significance.

The hypothesis testing results confirmed several key relationships in the research model. Firstly, green packaging demonstrated significant positive direct effects on both brand attitude ($\beta = 0.428$, $p < 0.001$) and brand recognition perception ($\beta = 0.386$, $p < 0.001$). Secondly, brand attitude showed the strongest impact on purchase intention ($\beta = 0.483$, $p < 0.001$), while brand recognition perception also maintained a significant effect ($\beta = 0.312$, $p < 0.001$) despite the label-less packaging design. Regarding environmental awareness, it significantly influenced brand attitude ($\beta = 0.296$, $p < 0.001$) but had a

relatively weaker direct effect on purchase intention ($\beta = 0.138$, $p = 0.026$). The study notably found that brand recognition perception remains effective even in label-free packaging scenarios, contrasting with conventional wisdom about packaging design, potentially attributable to Coca-Cola's strong established brand equity. These findings collectively provide theoretical support for green marketing strategies in the beverage industry.

4.5 Mediation and Moderating Effect

The analysis reveals that green packaging significantly enhances purchase intention through the important mediating roles of brand attitude and brand identity perception. Specifically, green packaging improves brand attitude ($\beta = 0.428$), which in turn strongly influences purchase intention ($\beta = 0.483$), resulting in a significant indirect effect of 0.206. Simultaneously, green packaging boosts brand identity perception ($\beta = 0.386$), which also positively affects purchase intention ($\beta = 0.312$), with an indirect effect of 0.120. Furthermore, environmental awareness acts as a significant moderator; the effect of green packaging on purchase intention is much stronger for consumers with high environmental awareness ($\beta = 0.482$) than for those with low awareness ($\beta = 0.238$), a difference confirmed by a significant interaction effect ($\beta = 0.194$). In conclusion, green packaging drives purchase intention primarily by improving brand attitude and identity, and this effect is substantially amplified by the consumer's level of environmental awareness.

4.6 Limitations of the Study

This study acknowledges several limitations that affect the generalizability and accuracy of its findings. Firstly, the sample size of 360, while statistically representative, is geographically concentrated, limiting the global applicability of the results. Secondly, the reliance on self-reported questionnaire data introduces the potential for social desirability bias, where participants may not provide entirely truthful answers. Thirdly, the cross-sectional research design establishes correlations but cannot confirm causal relationships between variables like green packaging and purchase intention. Furthermore, the study did not account for all external factors that influence consumer behavior, such as price sensitivity or brand loyalty, which could bias the results. Finally, the findings may be influenced by specific cultural contexts and the strong brand effect of Coca-Cola, suggesting a need for future research across diverse cultures and brands to verify the results' broader applicability.

5. Conclusion

5.1 Contributions to Theory

This study's primary theoretical contribution lies in its extension of the S-O-R (Stimulus-Organism-Response) and Theory of Planned Behavior (TPB) models. It introduces brand identification as a critical mediating variable and environmental consciousness as a significant moderating variable, thereby enriching the understanding of the psychological pathways through which green packaging influences consumer attitudes and purchase intentions.

5.2 Practical Significance

The practical significance of the research provides clear strategic guidance for fast-moving consumer goods (FMCG) companies. It emphasizes that green packaging is a

powerful tool for building brand image and stimulating purchase intent, but it must be implemented with strong brand identity design and transparent environmental communication to overcome challenges like reduced brand recognition and to effectively connect with environmentally conscious consumers.

6. Recommendations

Future research should address the limitations of this study by adopting longitudinal designs to investigate the long-term effects of green packaging, conducting cross-cultural comparisons to test the universality of the findings, and expanding the research to other product categories and emerging packaging technologies to validate and broaden the applicability of the results.

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Enzensberger, W. & Fisher, P. A. (1996). Metronome in Parkinson's disease (letter).

Lancet, 1996, 347, 1337.

Unpublished/In Press Article**Format:**

Author.//(In press year).//Article title.//*Journal Title*.//(in press).

Example:

Veena, B. (2004). Economic pursuits and strategies of survival among Damor of Rajasthan. *J Hum Ecol.* (in press).

Websites**Format:**

Author.//(Year of publication).//Title.//(Online).//the full address of the web page,/accessed date.

Example:

Charlotte, B. (2016). Quotes about Action Learning. (Online).
<http://www.goodreads.com/quotes/tag/action-learning>, January 18, 2017.

1.4 Manuscripts of Brief Professional Viewpoints for Sharing

The length of Brief Professional Viewpoints for Sharing is about 8-10 typed A4 pages. Its content should be arranged as follows: **title, name of the author, name and address of the institution, 3-5 keywords, body text, the author's biography** of 50-80 words, and **references**. The format, font, and font size used in each section correspond to those in the section of **3.2. Manuscripts of Original Article**.

1.5 Reprints

During the years of publication (2020-present), authors will receive one free print copy of the journal.

***RJCM* Publication Ethics**

RICE Journal of Creative Entrepreneurship and Management (RJCM) has policies on publication ethics after the guidelines given by Committee on Publication Ethics (COPE) <<https://publicationethics.org>>. Publication ethics policies mainly involve duties of (1) Authors, (2) Editors, and (3) Reviewers.

Authors:

Authors or paper contributors shall not submit simultaneous or duplicate manuscripts. It is imperative that authors submit work of original investigation and acknowledge concepts, research methodology and findings of preceding authors or researchers by giving proper references. If required, authors need to seek permission for the use of specific data or adaptation of research methodology as well as provide evidence on approval of professional ethics in the selected field of study. Plagiarism of all kinds is unacceptable and will result in paper rejection and permanent dismissal by *RJCM*. The use of AI for mechanical error check is advisable, but for copyrighted text creation is unacceptable. Authors shall be solely and fully liable for all viewpoints and research components used in published papers.

If required, under the guidelines given by the institutional/national board of research ethics on the use of human subjects in social science research, authors are responsible for complying with the established criteria as well as securing a certified approval from the board for the purpose of protecting the human subjects in the study regarding their rights, security, health, privacy and confidentiality.

Editors:

The editors are to ensure transparency in the publication policies, communication with corresponding authors regarding submission, response on paper acceptance/ rejection, and the notification of double-blinded review results for paper revision. In particular, the editors shall not consider multiple submission or redundant publication. The editors shall provide information on the *RJCM* website on ownership, editorial board, publication policies, publication schedule, data access and sharing, pre- and post-publication contacts—ranging from inquiries from paper contributors, correspondence, requests for clarification, comments for paper revision, to complaints or appeals, if any. The editors reserve the right not to deal with allegations of research misconduct from any party concerned under the condition that concrete evidence is found for the act of malpractice.

Reviewers:

Reviewers are in the double-blinded peer review process in evaluating submitted papers on the basis of criteria established by the editorial team. Reviewers shall remain anonymous to the authors whose papers are under review. It is imperative that reviewers' decision on paper revision or rejection be justified by constructive comments or suggestions, as guided by professional ethics in selecting scholarly work for publication. Given comments must be written in an objective and professional manner without sarcasm or severe criticism. Reviewers shall keep their reviews strictly confidential in all circumstances.

It is required that reviewers have no known competing financial interests or personal relationships that could have appeared to influence the work reported in the reviewed paper.

RJCM Research Ethics

Research Ethics on the Use of Human Subjects in Social Sciences

Thailand's Institutional/National Board of Research Ethics on the Use of Human Subjects in Social Sciences requires as compulsory that researchers comply with the established criteria as well as secure a certified approval from the Board for the purpose of protecting the human subjects in the study from risks affecting their rights, security, health, privacy, and confidentiality.

The Board specifies research that imposes *three levels of risks* on the human subjects under study: (1) nil or very low, (2) low, and (3) higher than low, and instructs researchers to obtain a certified approval from the Board's classified reviews:

(1) Exemption Review is for the research project that uses unidentifiable data that impose *nil or very low risks* to the human subjects under study. Researchers can request an exemption review approval from the Board.

(2) Expedited Review is for the research project that uses data that impose *low risks* to the human subjects under study. Researchers can obtain an expedited review approval from the Board via the consideration and recommendation of two Board members and an endorsement from the Board Chairperson.

(3) Full Board Review is for the research project that uses data that impose *higher than low risks* to the human subjects under study. Researchers can obtain a full review approval from the Board via the consideration and recommendation of two Board members (specialists in the area under study) and a representative from the public or community concerned, followed by an endorsement from the full Board.

RJCM Call for Papers

RICE Journal of Creative Entrepreneurship and Management (RJCM) is an international journal for academics and scholars at the higher education level to communicate and share their viewpoints and academic work with fellow professionals in the areas of creative entrepreneurship and management as practiced in their fields of specializations in social sciences. Currently, it is under the supervision of Thai-Journal Citation Index (TCI).

RJCM publishes three numbers per volume annually and welcomes contributors to submit their manuscripts in January, May, and September of each year. We accept both academic and research papers in social sciences from contributors. The papers are double-blind reviewed by three independent reviewers in each volume and published online-plus-print three times a year.

The length of the unformatted manuscript in WORD can be 15 pages in length including references. The contents of the manuscript should include (1) a title with the author's name, affiliate, email address and telephone contact, (2) an abstract of 150 words with 3-5 keywords, (3) an introduction, (4) a rationale and background of the study, (5) research objectives, (6) research methodology, (7) data collection procedure, (8) data analysis, (9) results and discussion, (10) research limitation (if any), (11) conclusion, (12) acknowledgement(s) (if any), (13) the author's biography of about 50-80 words, (14) references, and (15) an appendix or appendices (if any).

All interested readers and paper contributors please contact Editor -in-Chief: Wichai Siriteerawasu, Ed.D, Rattanakosin International College of Creative Entrepreneurship (RICE), Rajamangala University of Technology Rattanakosin (RMUTR) <wichai.sir@rmutr.ac.th>. Please check RJCM Publication Policy as guidelines to paper submission.



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