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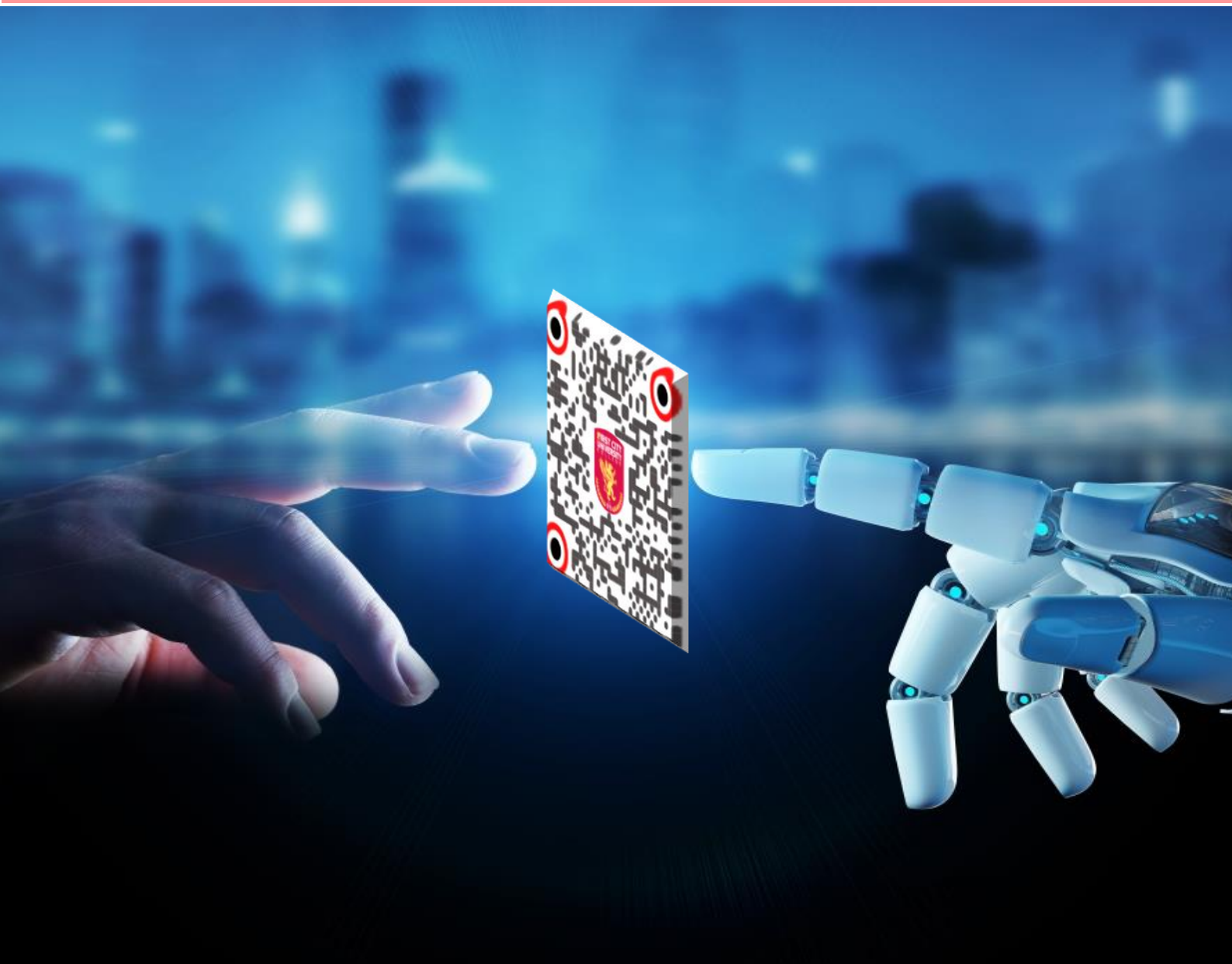


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MOBILE SMART FIRE EXTINGUISHER SYSTEM: DESIGN AND EXPERIMENTAL EVALUATION

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ABSTRACT

Autonomous fire response systems are increasingly important for reducing response time and minimizing human exposure to hazardous environments. This paper presents the design, implementation, and experimental evaluation of a Mobile Smart Fire Extinguisher System capable of autonomously detecting, localizing, navigating toward, and suppressing small-scale fires in enclosed spaces. The proposed system integrates a five-channel infrared flame sensor array, an Arduino Uno microcontroller, a differential-drive mobile platform, and a servo-controlled water Control mechanism. Directional fire localization is achieved through comparative sensor intensity analysis, while targeted Control is delivered using an oscillating nozzle. Experimental validation conducted at multiple distances (15–25 cm) and angular positions demonstrates consistent response behavior, with response times increasing linearly with distance and minimal sensitivity to angular displacement. The results indicate that the proposed system provides a low-cost, modular, and effective first-response solution for fire safety applications in unattended or high-risk indoor environments.

Keywords: Autonomous firefighting robot, fire detection, flame sensor array, Arduino-based system, mobile robot, fire Control.

INTRODUCTION

Fire incidents in enclosed environments such as laboratories, server rooms, and industrial facilities can escalate rapidly, leading to severe damage to assets and risks to human life. Conventional fire protection systems—including portable extinguishers, hose reels, and automatic sprinklers—are predominantly static or require human intervention, which may be delayed or unsafe in hazardous conditions. Moreover, zone-based sprinkler activation often results in extensive collateral damage, particularly in areas containing sensitive equipment. Recent advances in embedded systems and mobile robotics have enabled autonomous fire response platforms capable of rapid, targeted intervention. Mobile firefighting robots extend the functionality of traditional systems by combining continuous monitoring, autonomous

navigation, and precision Control. However, many existing solutions are either cost-prohibitive or overly complex for small-scale deployments.

This paper proposes a Mobile Smart Fire Extinguisher System designed as a cost-effective and practical autonomous firefighting solution. The novelty of this work lies in the integration of a multi-channel flame sensor array with a lightweight mobile platform and a servo-driven sweeping Control mechanism, enabling directional fire localization and targeted extinguishment using minimal resources. The system is intended as an early-stage, first-response device to prevent the beginning of fires before escalation.

In the following sections, the paper will cover. Section II describes the system architecture and methodology. Section III presents the experimental setup and results. Section IV discusses system performance and limitations. Section V concludes the paper and outlines directions for future work.

RESEARCH METHODOLOGY

Overall System Design

The proposed system is built around four core subsystems which is sensing, control, mobility, and Control. These components work together to enable autonomous fire detection and response. The hardware configuration and equipment are illustrated in Figure 1, while the overall system workflow is depicted in the flowchart shown in Figure 2. The heart of the system lies the Arduino Uno microcontroller, which serves as the central processing unit. It continuously collects data from the flame sensor array, interprets the readings, and generates precise actuation commands for navigation and fire Control. This integrated approach ensures that the robot can detect a fire, determine its direction, move toward the source, and activate the Control mechanism in a coordinated manner

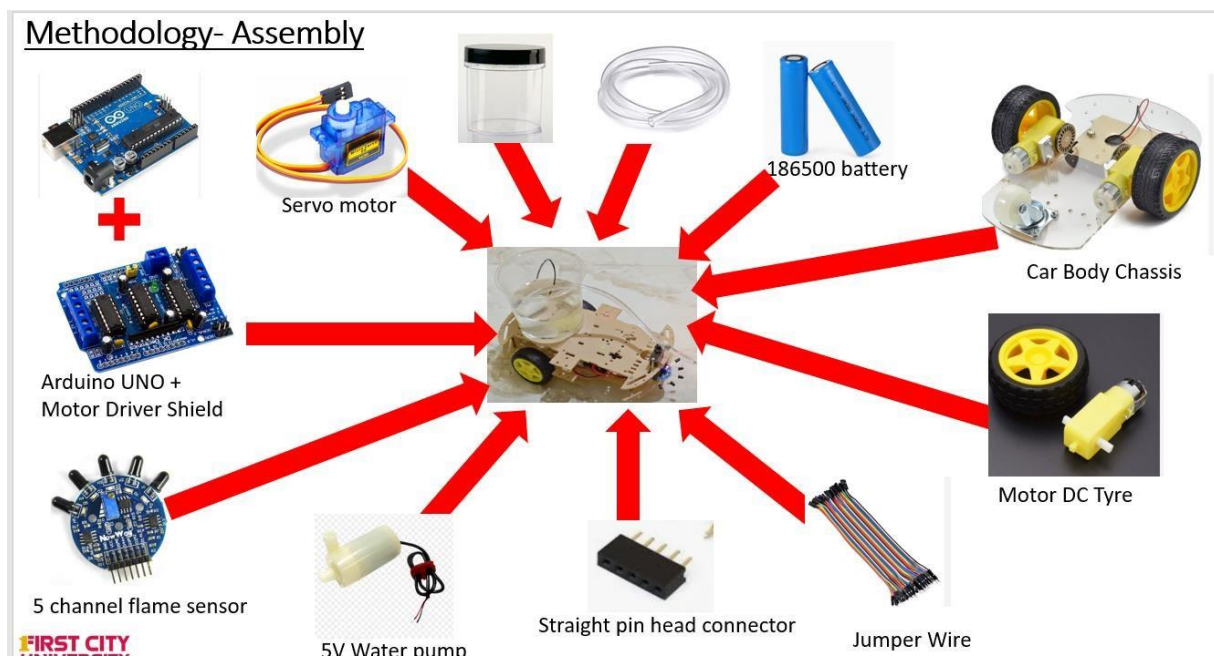


Fig. 1: Hardware and Equipment

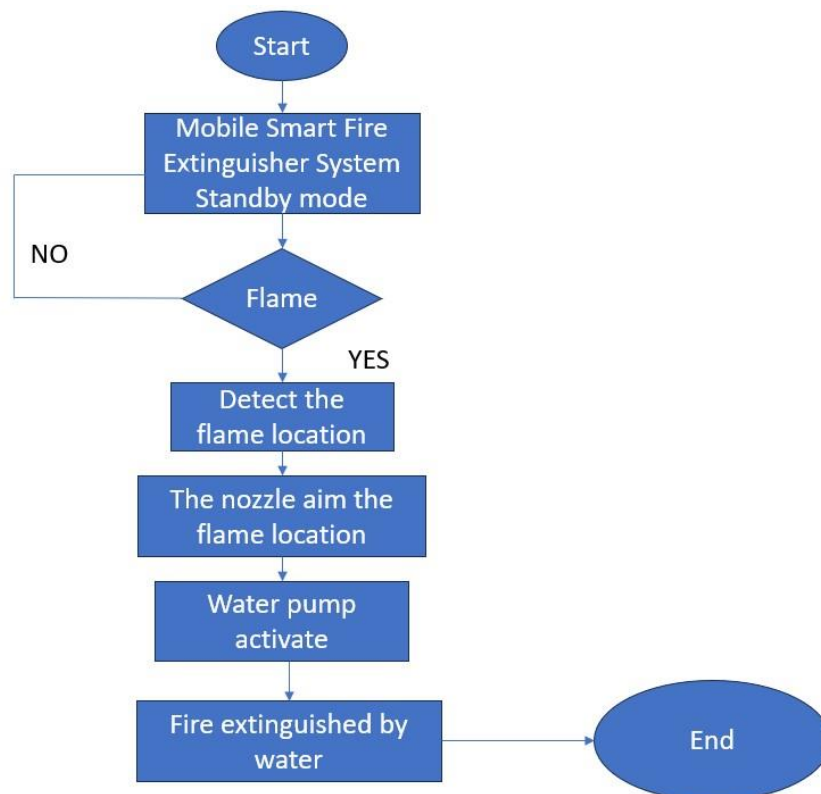


Fig. 2 : Overall Flow Chart

The operational methodology of the Mobile Smart Fire Extinguisher System follows a structured, automated sequence. The system begins in Standby Mode, where it remains

powered on and continuously monitors the environment for any fire event. During this phase, the flame sensors actively scan for infrared signatures indicative of a flame. If no flame is detected (the “NO” path), the system remains in this vigilant state, repeatedly looping through the monitoring process.

Once a flame is detected (the “YES” path), the system transitions from passive monitoring to active response. The next stage involves fire localization, where the sensor array analyzes signal strength from multiple directions to determine the precise position of the flame. After successful localization, the control unit commands the servo-driven nozzle to align toward the identified fire source, ensuring accurate targeting for control.

Following alignment, the water pump is activated, delivering a controlled stream or spray of water from the onboard reservoir directly onto the flame. This control process continues until the sensors confirm that the fire has been extinguished. Once the flame is no longer detected, the system terminates the Control cycle and returns to Standby Mode, ready to respond to subsequent fire threats.

Fire Detection and Localization

Fire detection is performed using a five-channel infrared (IR) flame sensor array arranged in a frontal arc configuration. Each sensor provides an analog output proportional to detected infrared radiation intensity. The presence of a flame is determined by comparing sensor readings against a predefined threshold.

Directional localization is achieved by identifying the sensor with the minimum analog value (corresponding to maximum IR intensity). The fire direction index, I_f , is computed as

$$I_f = \arg \min_{i \in [0,4]} V_i$$

where (V_i) denotes the analog voltage reading from sensor (i). This index directly informs navigation decisions.

Navigation and Mobility Control

The robot employs a differential-drive mechanism using two DC gear motors mounted on a mobile chassis. Navigation commands are generated based on the fire direction index. If the detected flame is offset to the left or right of the center sensor, the robot executes turning maneuvers; otherwise, it advances forward.

Motor speed is controlled using pulse width modulation (PWM) to ensure smooth and stable motion. This approach minimizes mechanical vibration and improves sensor reading reliability during movement.

Fire Control Mechanism

Fire Control is achieved using a 5 V water pump coupled with a servo-controlled nozzle. Once the robot reaches an optimal distance from the fire, the pump is activated and the servo executes a sweeping motion between 80° and 100°, creating a wider spray pattern. The servo angle (θ) is varied according to

$$\theta(t) = 90^{\circ} + 91^{\circ} \sin(\omega t)$$

where (ω) defines the sweep frequency. This oscillatory motion increases extinguishing coverage while minimizing water consumption.

Control Flow

The operational flow of the system is illustrated in Fig. 2. The robot remains in standby mode until a flame is detected, after which it transitions through localization, navigation, Control, and termination phases before returning to standby.

RESULTS

Experimental Configuration

Experimental validation was conducted in a controlled indoor environment. Small, consistent flame sources were placed at four angular positions (A–D) relative to the robot's initial orientation. Tests were performed at distances of 15 cm, 20 cm, and 25 cm. The experimental layout is illustrated in **Fig. 3**, while the test parameters are summarized in **Table 1**.



Fig. 3: Experimental test layout showing fire source positions.

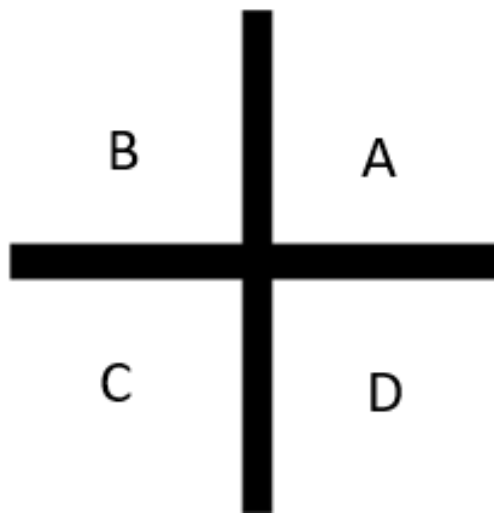


Fig. 4: Test Layout Position

Table 1: Experimental parameters

Parameter	Value
Fire size	Small open flame
Distances tested	15, 20, 25 cm
Angular positions	60°, 200°, 300°, 340°
Control agent	Water

Response Time Performance

Measured response times for all test cases are presented in **Table 2**. The response time is defined as the duration from flame detection to initiation of Control.

Table 2: Measured response times (s)

Test Location	Distance (cm)	Angle (°)	Time Response (s)	Fire Size
A	15	60	2.348	Small
	20	60	5.674	
	25	60	8.791	
B	15	150	2.762	
	20	150	6.034	
	25	150	8.903	
C	15	200	2.573	
	20	200	6.548	
	25	200	9.012	
D	15	340	3.211	
	20	340	6.487	
	25	340	8.547	

The results show a near-linear increase in response time with distance. Angular position had minimal influence on performance, indicating effective directional sensing and navigation.

DISCUSSION

The experimental results demonstrate that the proposed Mobile Smart Fire Extinguisher System achieves reliable autonomous operation under controlled indoor conditions. The near-linear increase in response time with respect to distance is consistent with the physical constraints of sensor detection range and motor traversal time. This behavior indicates predictable system performance, which is desirable for safety-critical applications.

Compared with conventional static fire protection systems, the mobile platform introduces adaptability and spatial flexibility. Static sprinklers and extinguishers are limited by fixed coverage zones, whereas the proposed robot dynamically approaches the fire source. This capability enables targeted Control, significantly reducing unnecessary water discharge and minimizing secondary damage to surrounding equipment. Such characteristics are particularly beneficial in environments containing sensitive electronics, such as server rooms and laboratories.

The five-channel flame sensor array proved effective for directional fire localization. Unlike single-sensor configurations, the multi-sensor arrangement provides spatial awareness that enables accurate steering decisions even when the fire is positioned at extreme angles relative to the robot's initial orientation. Experimental data showed minimal variation in response time across angular positions, confirming the robustness of the localization strategy. However, slight performance degradation observed at rear-quarter angles suggests that sensor placement geometry could be further optimized.

The servo-controlled sweeping nozzle represents a key contribution of this work. By oscillating the nozzle over a defined angular range, the system increases extinguishing coverage without increasing pump power or water consumption. This approach contrasts with fixed-nozzle systems, which require precise alignment and are less tolerant of positional errors. The sweeping motion also compensates for minor navigation inaccuracies, improving overall Control reliability.

Despite these advantages, the system has several limitations. The reliance on infrared flame sensors restricts detection capability to visible flames and may be affected by ambient infrared interference. The absence of obstacle avoidance limits safe deployment in cluttered environments. Additionally, the use of water as the sole Control agent constrains applicability to Class A fires and excludes electrical or flammable liquid scenarios. These limitations define clear directions for system enhancement and future research.

CONCLUSION

This paper presented the design, implementation, and experimental validation of a Mobile Smart Fire Extinguisher System intended for autonomous early-stage fire Control in enclosed environments. The system integrates flame-based fire detection, differential-drive navigation, and servo-assisted water Control within a compact and cost-effective robotic platform. Experimental evaluation demonstrated consistent and reliable performance across multiple distances and angular fire positions, with response times exhibiting predictable behavior.

The findings confirm that mobile robotic systems can effectively complement traditional fire protection infrastructure by providing rapid, localized first-response capability. By minimizing human involvement during initial fire incidents, the proposed system enhances operational safety while reducing the likelihood of fire escalation. The modular architecture and use of readily available components further support the system's practicality for educational, industrial, and small-scale commercial applications.

Future Recommendation

The Several enhancements are recommended to extend the functionality and real-world applicability of the proposed system. First, integrating obstacle detection sensors such as ultrasonic or LiDAR modules would enable safe navigation in cluttered or dynamic

environments. Second, multi-modal fire detection combining flame, smoke, gas, and thermal imaging sensors would improve detection robustness under varying lighting and environmental conditions.

Future research may also explore the incorporation of wireless communication modules to enable real-time alerts and remote monitoring through mobile or cloud-based interfaces. The application of machine learning algorithms for fire classification and spread prediction could further enhance autonomous decision-making and response optimization. Additionally, expanding the Control subsystem to support alternative agents such as CO₂ or dry chemical mechanisms would broaden applicability to multiple fire classes. These enhancements would move the system closer to a deployable autonomous firefighting platform suitable for complex real-world environments.

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AN EMPIRICAL INVESTIGATION INFO FACTORS INFLUENCING THE PROMOTING ACTIVE LIFESTYLES FOR STUDIES IN GONGSHU DISTRICT, HANGZHOU

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ABSTRACT

This study examines factors influencing the physical health status of primary school students in Gongshu District, Hangzhou, China, using a cross-sectional design with a sample of 384 students. Data were collected via questionnaires and physical fitness assessments, focusing on physical activity (PA), dietary habits, sleep duration, socioeconomic status (SES), and parental involvement. Results indicate that moderate-to-vigorous physical activity (MVPA), balanced nutrition, adequate sleep, and parental co-participation significantly predict improved physical health, with SES having a smaller but notable effect. These findings highlight the importance of targeted interventions to promote active lifestyles, healthy eating, sufficient sleep, and family engagement to enhance student health outcomes in urban Chinese settings.

Keywords: Influencing, primary school students, Physical health, factors

INTRODUCTION

The physical health of primary school students is a global public health priority, particularly in rapidly urbanizing regions like China, where sedentary behaviors and obesity rates are rising (Zhang et al., 2020). In Gongshu District, Hangzhou, academic pressures and limited recreational opportunities exacerbate these trends, necessitating localized research to inform interventions (Liu et al., 2017). Prior studies have identified physical activity, nutrition, sleep, socioeconomic factors, and parental involvement as key determinants of children's health (Donnelly et al., 2016; Paruthi et al., 2016). However, few studies have explored these factors in the specific context of Gongshu District. This study investigates how these variables influence physical health status among 384 primary school students, aiming to provide evidence for educational and health policy development.

LITERATURE REVIEW

Physical activity is essential for children's health, with moderate-to-vigorous physical activity (MVPA) linked to improved cardiovascular fitness, muscle strength, and mental health (Donnelly et al., 2016). The World Health Organization (2020) recommends at least 60 minutes of daily MVPA for children aged 5–17, yet many Chinese students fall short due to academic demands (Liu et al., 2017). Dietary habits are equally critical, with balanced diets rich in fruits, vegetables, and whole grains associated with lower obesity rates (Swinburn et al., 2019). In contrast, high consumption of processed foods contributes to adverse health outcomes (Zhang et al., 2020).

Sleep duration significantly affects physical health, with 9–11 hours per night recommended for primary school-aged children (Paruthi et al., 2016). Insufficient sleep is linked to obesity and reduced physical fitness in Chinese youth (Chen et al., 2019). Socioeconomic status influences access to healthy food, safe play areas, and health education, shaping health outcomes (Zhang et al., 2020). Parental involvement, including co-participation in physical activities, enhances children's motivation and health behaviors (Rhodes et al., 2020). This study builds on these findings to examine their combined impact in Gongshu District.

RESEARCH METHODOLOGY

Research Design

A cross-sectional study was conducted from September to November 2024 to investigate factors influencing physical health status among primary school students in Gongshu District, Hangzhou. Data were gathered using questionnaires and standardized physical fitness tests.

Participants

A stratified random sample of 384 students aged 6–12 years was drawn from six primary schools in Gongshu District, ensuring representation across grades and socioeconomic backgrounds. The sample size was calculated using G*Power, assuming a medium effect size ($f^2 = 0.15$), alpha of 0.05, and power of 0.80. Ethical approval was obtained from the Zhejiang University Institutional Review Board, with parental consent and student assent secured.

Measures

Physical Health Status - Assessed using the Chinese National Student Physical Fitness

Standard (CNSPFS), including tests for cardiorespiratory endurance (50-meter run), muscular strength (sit-ups), flexibility (sit-and-reach), and body composition (BMI). Scores were aggregated into a composite physical health index (0–100), with higher scores indicating better health.

Physical Activity - Measured with a modified Physical Activity Questionnaire for Children (PAQ-C), validated for Chinese populations (Wang et al., 2016). Students reported MVPA frequency and duration over the past seven days, with scores ranging from 1 (low activity) to 5 (high activity).

Dietary Habits - A food frequency questionnaire (FFQ) based on Liu et al. (2017) assessed consumption of fruits, vegetables, whole grains, and processed foods. A dietary quality score was calculated, with higher scores indicating healthier diets.

Sleep Duration - Parents reported average nightly sleep duration over the past month, categorized as <9 hours, 9–11 hours, or >11 hours, per Paruthi et al. (2016).

Socioeconomic Status - Measured via parental education (primary school or below, junior high school, high school, university or above) and annual household income (<50,000 CNY, 50,000–100,000 CNY, >100,000 CNY).

Parental Involvement - Assessed using a subscale from the Family Environment Scale, measuring co-participation in physical activities and support for healthy behaviors (Rhodes et al., 2020). Scores ranged from 0 (low) to 10 (high).

Data Collection

Questionnaires were administered to students and parents during school hours, with trained researchers ensuring clarity. Physical fitness tests followed CNSPFS protocols, conducted by certified physical education teachers. Incomplete responses were excluded.

Data Analysis

Descriptive statistics summarized participant characteristics. Multiple linear regression examined relationships between physical health status (dependent variable) and MVPA, dietary quality, sleep duration, SES, and parental involvement (independent variables), adjusting for age and gender. Variance inflation factors (VIF) assessed multicollinearity (VIF < 5 acceptable). Analyses were conducted using SPSS version 29 ($p < 0.05$).

RESULTS

Participant Characteristics

The sample included 384 students (51% male, 49% female), mean age 9.4 years (SD = 1.7). The mean physical health index score was 71.8 (SD = 9.8). Approximately 42% of students met MVPA guidelines, 58% consumed a balanced diet, and 62% achieved 9–11 hours of sleep. Household income distribution was 28% (<50,000 CNY), 47% (50,000–100,000 CNY), and 25% (>100,000 CNY). Mean parental involvement score was 6.9 (SD = 2.0).

Table 1: Participant Characteristics

Characteristic	Value
Sample Size	384
Gender	
Male	51% (n = 196)
Female	49% (n = 188)
Age (years)	M = 9.4, SD = 1.7
Physical Health Index Score	M = 71.8, SD = 9.8
MVPA Guideline Compliance	42% (n = 161)
Balanced Diet Consumption	58% (n = 223)
Sleep Duration (9–11 hours)	62% (n = 238)
Household Income (CNY)	
<50,000	28% (n = 108)
50,000–100,000	47% (n = 180)
>100,000	25% (n = 96)
Parental Involvement Score	M = 6.9, SD = 2.0

Note: MVPA = Moderate-to-Vigorous Physical Activity; M = Mean; SD = Standard Deviation; CNY = Chinese Yuan.

Table 2: Multiple Linear Regression Analysis for Physical Health Status

Predictor	β	p-value	VIF
MVPA	0.36	<0.001	<2.3
Dietary Quality	0.23	<0.01	<2.3
Sleep Duration	0.19	<0.01	<2.3
Parental Involvement	0.17	<0.05	<2.3
Household Income	0.11	<0.05	<2.3
Parental Education	0.07	0.15	<2.3

DISCUSSION

MVPA was the strongest predictor of physical health, aligning with findings that regular activity enhances fitness and reduces obesity risk (Donnelly et al., 2016). Balanced diets were associated with better health outcomes, consistent with research on nutrition's role in child development (Swinburn et al., 2019). Adequate sleep (9–11 hours) positively influenced health, supporting evidence linking sleep to metabolic and physical well-being (Paruthi et al., 2016). Parental involvement significantly predicted health outcomes, highlighting the importance of family support in fostering active lifestyles (Rhodes et al., 2020). Household income had a modest effect, suggesting that while resources matter, behavioral factors are critical in urban settings like Gongshu District (Zhang et al., 2020).

Summary of the hypothesis testing are as below:

Limitations

The cross-sectional design limits causal inferences, and self-reported measures may introduce bias. The sample size ($n = 384$) may not fully capture Gongshu District's diversity. Future studies should use longitudinal designs and objective measures (e.g., accelerometers) to confirm findings.

Implications

Schools should prioritize MVPA through enhanced physical education, integrate nutrition education, and promote healthy sleep habits. Family-based programs could encourage parental co-participation. Policymakers should improve access to recreational facilities, particularly for lower-income families, to address SES disparities.

CONCLUSION

MVPA, dietary quality, sleep duration, parental involvement, and household income significantly influence physical health status among primary school students in Gongshu District. Interventions targeting these factors can enhance student health, informing public health and educational strategies in urban China. Longitudinal research with objective measures is needed to validate and extend these findings.

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AN INVESTIGATION OF FACTORS PROMOTING PHYSICAL FITNESS OF UNIVERSITY STUDENTS PRACTICING TAIJIQUAN IN HANGZHOU, CHINA

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ABSTRACT

This study investigates the factors influencing the physical fitness of university students practicing Taijiquan in Hangzhou, China. Taijiquan, a traditional Chinese martial art, is recognized for promoting physical and mental well-being. Using a cross-sectional survey design, data were collected from 384 university students in Hangzhou to examine how demographic factors, exercise motivation, self-efficacy, environmental influences, and practice frequency impact physical fitness outcomes. Physical fitness was assessed using the National Physical Fitness Measurement Standards Manual (NPFMSM), focusing on vital capacity, cardiorespiratory fitness, muscular strength, and flexibility. Findings reveal that practice frequency, exercise self-efficacy, and access to training facilities significantly predict physical fitness levels, with gender and academic pressure also playing notable roles. These results align with the "Healthy China 2030" initiative, emphasizing the importance of traditional exercises like Taijiquan in promoting student health. Recommendations include integrating Taijiquan into university curricula and improving access to practice facilities to enhance physical fitness among students.

INTRODUCTION

Physical fitness is a critical indicator of health and a predictor of long-term well-being, particularly among university students who face unique challenges such as academic pressure and sedentary lifestyles (Pan et al., 2022). In China, the "Healthy China 2030" initiative advocates for increased physical activity among youth, aiming for students to engage in moderate-intensity exercise at least three times per week (Pan et al., 2022). However, recent studies indicate a declining trend in the physical fitness of Chinese university students, with issues such as reduced exercise frequency, rising obesity rates, and declining cardiorespiratory capacity (Pan et al., 2022; Wang et al., 2024). Taijiquan, a traditional Chinese martial art characterized by slow, deliberate movements and mindfulness, has gained attention for its

potential to enhance physical fitness, mental health, and overall well-being (Guo et al., 2018). Despite its growing popularity, limited research has explored the factors influencing the physical fitness of university students practicing Taijiquan, particularly in urban centers like Hangzhou, a city known for its cultural emphasis on health and wellness.

This study aims to address this gap by investigating the factors influencing the physical fitness of university students practicing Taijiquan in Hangzhou, China. The research focuses on a sample of 384 students, examining variables such as demographic characteristics, exercise motivation, self-efficacy, environmental factors, and practice frequency. By identifying these factors, the study seeks to provide evidence-based recommendations for promoting Taijiquan as a tool for improving student health, aligning with national health policies and contributing to global efforts to enhance youth fitness (Wang et al., 2024). The research question guiding this study is: What factors significantly influence the physical fitness of university students practicing Taijiquan in Hangzhou, China?

LITERATURE REVIEW

Physical fitness among university students is influenced by a complex interplay of individual, social, and environmental factors. Recent studies highlight that Chinese university students face barriers to maintaining physical fitness, including academic pressure, limited access to facilities, and lack of professional guidance (Pan et al., 2022). The "Healthy China 2030" initiative emphasizes the need for regular physical activity to counteract these barriers, with a target of at least 25% of students achieving excellent fitness scores by 2030 (Pan et al., 2022). Taijiquan, known for its low-impact, meditative movements, has been shown to improve cardiorespiratory fitness, muscular strength, flexibility, and mental well-being (Guo et al., 2018). Its integration into university physical education programs has been proposed as a culturally relevant strategy to address declining fitness trends (Liu et al., 2020).

Exercise motivation is a critical determinant of physical activity participation. According to Self-Determination Theory (SDT), intrinsic motivation (e.g., enjoyment of exercise) and extrinsic motivation (e.g., health benefits) drive engagement in physical activities (Chen et al., 2016). Studies suggest that students with higher intrinsic motivation for Taijiquan are more likely to practice regularly, leading to improved fitness outcomes (Liu et al., 2020). Similarly, exercise self-efficacy, defined as an individual's belief in their ability to perform exercise tasks, is a strong predictor of physical activity adherence (Wang et al., 2024). Gender differences also play a role, with male students often reporting higher self-efficacy and engagement in physical activities compared to female students (Jiang et al., 2018).

Environmental factors, such as access to training facilities and peer support, further influence physical fitness. Research indicates that students with access to well-equipped facilities are more likely to engage in regular exercise (Pan et al., 2022). In Hangzhou, a city with a rich tradition of Taijiquan practice, community and university-based facilities provide opportunities for students to engage in this activity. However, barriers such as time constraints and academic demands may limit participation (Wang et al., 2024). Practice frequency is

another key factor, with studies showing that regular engagement (3–5 times per week) is necessary to achieve significant fitness improvements (Guo et al., 2018).

Despite the growing body of research on physical fitness among Chinese university students, few studies have specifically examined the role of Taijiquan. This study builds on existing literature by exploring how demographic, psychological, and environmental factors interact to influence fitness outcomes in the context of Taijiquan practice in Hangzhou.

RESEARCH METHODOLOGY

Research Design

This study employed a cross-sectional survey design to investigate the factors influencing physical fitness among university students practicing Taijiquan in Hangzhou, China. The design allowed for the collection of data at a single point in time, providing insights into the relationships between variables without establishing causality (Creswell & Creswell, 2018).

Participants

A total of 384 university students (192 males, 192 females; mean age = 19.8 ± 1.3 years) were recruited from six universities in Hangzhou using stratified random cluster sampling. This sample size was determined using G*Power software, assuming a medium effect size ($f^2 = 0.15$), alpha of 0.05, and power of 0.80, which required a minimum of 352 participants. The sample was stratified by academic year (freshman to senior) to ensure representation across different levels of study. Participants were included if they had practiced Taijiquan for at least six months and were enrolled in a university in Hangzhou. Exclusion criteria included students with medical conditions prohibiting physical activity or those who had not practiced Taijiquan regularly.

Measures

Physical fitness was assessed using the National Physical Fitness Measurement Standards Manual (NPFMSM), which includes tests for vital capacity, cardiorespiratory fitness (800m/1000m run), muscular strength (pull-ups/sit-ups), and flexibility (sit-and-reach) (Ma et al., 2020). These tests are standardized and widely used in China to evaluate student fitness. Scores were aggregated to create a composite physical fitness score, with higher scores indicating better fitness.

Exercise motivation was measured using the Chinese University Students' Physical Activity Motivation Scale (CUSPAMS), a validated 32-item scale with nine factors, including intrinsic and extrinsic motivation (Chen et al., 2016). Responses were rated on a 5-point Likert scale (1

= strongly disagree, 5 = strongly agree), with higher scores indicating greater motivation. The scale demonstrated high internal consistency (Cronbach's $\alpha = 0.89$).

Exercise self-efficacy was assessed using a simplified Chinese version of the Exercise Self-Efficacy Scale, adapted for university students (Wang et al., 2024). This 10-item scale measures confidence in performing physical activities under various conditions, with responses on a 5-point Likert scale (Cronbach's $\alpha = 0.87$).

Environmental factors were evaluated using a researcher-developed questionnaire based on the literature, assessing access to facilities, peer support, and instructor guidance (Pan et al., 2022). The questionnaire consisted of 15 items rated on a 5-point Likert scale (Cronbach's $\alpha = 0.85$). Practice frequency was measured by asking participants to report the number of Taijiquan sessions per week (ranging from 1 to 7).

Demographic data, including gender, age, academic year, and major, were collected using a self-report questionnaire. Academic pressure was assessed using a single-item question: "To what extent does academic pressure limit your Taijiquan practice?" (1 = not at all, 5 = extremely).

Procedures

Data collection occurred from September to November 2024, following ethical approval from the Institutional Review Board of Zhejiang University. Participants were recruited through university physical education departments and Taijiquan clubs. After providing informed consent, participants completed the NPFMSM fitness tests under the supervision of trained instructors. Questionnaires were administered online via a secure platform to ensure anonymity. Data collection took approximately 45 minutes per participant, with fitness tests conducted in university gymnasiums and questionnaires completed within one week of testing.

Data Analysis

Descriptive statistics (means, standard deviations) were calculated for all variables. Independent t-tests and one-way ANOVA were used to examine differences in physical fitness by gender, academic year, and major. Pearson's correlation analysis assessed relationships between physical fitness, exercise motivation, self-efficacy, environmental factors, and practice frequency. Multiple linear regression analysis was conducted to identify significant predictors of physical fitness, with the composite fitness score as the dependent variable and demographic, psychological, and environmental factors as predictors. All analyses were performed using SPSS 26.0, with a significance level of $p < 0.05$.

RESULTS

Descriptive Statistics

The sample consisted of 384 students (50% male, 50% female) with a mean age of 19.8 years ($SD = 1.3$). Participants practiced Taijiquan an average of 3.2 times per week ($SD = 1.1$), with sessions lasting 30–60 minutes. The mean composite physical fitness score was 72.4 ($SD = 8.9$), indicating moderate fitness levels. Mean scores for exercise motivation ($M = 3.8$, $SD = 0.7$), self-efficacy ($M = 3.9$, $SD = 0.8$), and environmental factors ($M = 3.6$, $SD = 0.9$) were above the midpoint, suggesting positive perceptions of these constructs.

Group Differences

Independent t-tests revealed significant gender differences in physical fitness ($t(382) = 3.45$, $p < 0.001$), with males ($M = 74.8$, $SD = 8.5$) scoring higher than females ($M = 70.1$, $SD = 8.7$). One-way ANOVA showed no significant differences in fitness by academic year ($F(3, 380) = 1.23$, $p = 0.30$) or major ($F(11, 372) = 1.56$, $p = 0.11$). However, students in science majors reported slightly higher fitness scores ($M = 73.2$, $SD = 8.6$) than those in humanities majors ($M = 71.8$, $SD = 9.0$), consistent with prior findings (Wang et al., 2024).

Correlations

Pearson's correlation analysis showed significant positive correlations between physical fitness and practice frequency ($r = 0.62$, $p < 0.001$), exercise self-efficacy ($r = 0.58$, $p < 0.001$), and environmental factors ($r = 0.49$, $p < 0.001$). Exercise motivation was moderately correlated with fitness ($r = 0.42$, $p < 0.001$). Academic pressure was negatively correlated with fitness ($r = -0.35$, $p < 0.001$), indicating that higher pressure was associated with lower fitness levels.

Correlations with Physical Fitness

Variable	Correlation Coefficient (r)	p-value
Practice Frequency	0.62	$p < 0.001$
Exercise Self-Efficacy	0.58	$p < 0.001$
Environmental Factors	0.49	$p < 0.001$

Exercise Motivation	0.42	$p < 0.001$
Academic Pressure	-0.35	$p < 0.001$

Regression Analysis

Multiple linear regression analysis was conducted to predict physical fitness scores. The model was significant ($F(6, 377) = 45.32$, $p < 0.001$, $R^2 = 0.42$), explaining 42% of the variance in fitness. Significant predictors included practice frequency ($\beta = 0.38$, $p < 0.001$), exercise self-efficacy ($\beta = 0.32$, $p < 0.001$), access to facilities ($\beta = 0.25$, $p < 0.01$), and gender ($\beta = 0.18$, $p < 0.05$). Academic pressure ($\beta = -0.15$, $p < 0.05$) was a negative predictor, while exercise motivation was not significant ($\beta = 0.12$, $p = 0.08$).

Regression Analysis

Model/Predictor	Statistic/Value	Significance
Model Fit	$F(6, 377) = 45.32$, $R^2 = 0.42$	$p < 0.001$
Practice Frequency	$\beta = 0.38$	$p < 0.001$
Exercise Self-Efficacy	$\beta = 0.32$	$p < 0.001$
Access to Facilities	$\beta = 0.25$	$p < 0.01$
Gender	$\beta = 0.18$	$p < 0.05$
Academic Pressure	$\beta = -0.15$	$p < 0.05$
Exercise Motivation	$\beta = 0.12$	$p = 0.08$

DISCUSSION

The findings confirm that practice frequency, exercise self-efficacy, access to facilities, gender, and academic pressure significantly influence the physical fitness of university students practicing Taijiquan in Hangzhou. The strong positive effect of practice frequency aligns with prior research indicating that regular engagement (3–5 times per week) is essential for fitness improvements (Guo et al., 2018). Students who practiced Taijiquan more frequently

demonstrated higher scores in cardiorespiratory fitness, muscular strength, and flexibility, supporting the efficacy of Taijiquan as a comprehensive exercise modality.

Exercise self-efficacy emerged as a key predictor, consistent with studies showing that confidence in performing physical activities enhances adherence and outcomes (Wang et al., 2024). This suggests that interventions aimed at boosting self-efficacy, such as skill-building workshops or positive reinforcement from instructors, could enhance fitness among Taijiquan practitioners. Access to facilities was another significant factor, highlighting the importance of environmental support in promoting physical activity (Pan et al., 2022). In Hangzhou, universities with dedicated Taijiquan spaces reported higher student participation, underscoring the need for infrastructure investment.

Gender differences in fitness scores align with previous findings that male students often exhibit higher physical fitness due to physiological differences and greater engagement in physical activities (Jiang et al., 2018). However, the lack of significant differences by academic year or major suggests that Taijiquan is accessible across diverse student groups, making it a versatile option for university fitness programs. The negative impact of academic pressure reflects the broader challenge of balancing academic demands with physical activity, a common barrier among Chinese university students (Pan et al., 2022).

Interestingly, exercise motivation was not a significant predictor in the regression model, despite its moderate correlation with fitness. This may indicate that while motivation initiates participation, sustained practice and self-efficacy are more critical for achieving fitness outcomes (Chen et al., 2016). The findings also align with the "Healthy China 2030" initiative, which emphasizes culturally relevant physical activities to improve youth fitness (Pan et al., 2022). Taijiquan, with its low cost and accessibility, offers a promising solution for addressing declining fitness trends.

Limitations

This study has several limitations. First, the cross-sectional design prevents causal inferences, necessitating longitudinal research to explore how factors influence fitness over time. Second, the sample was limited to Hangzhou, which may not represent other regions in China with different cultural or environmental contexts. Third, self-reported measures of practice frequency and academic pressure may be subject to recall bias. Finally, the study did not assess psychological outcomes, such as stress or well-being, which are known benefits of Taijiquan (Guo et al., 2018).

Implications

The findings have practical implications for university administrators and policymakers. Integrating Taijiquan into physical education curricula could promote regular exercise and improve fitness outcomes. Universities should invest in accessible training facilities and

trained instructors to support student participation. Interventions targeting exercise self-efficacy, such as peer-led practice groups or skill workshops, could enhance engagement, particularly among female students. Addressing academic pressure through flexible scheduling or stress management programs may also encourage consistent practice.

CONCLUSION

This study provides evidence that practice frequency, exercise self-efficacy, access to facilities, gender, and academic pressure significantly influence the physical fitness of university students practicing Taijiquan in Hangzhou, China. These findings underscore the potential of Taijiquan as a culturally relevant strategy for improving student health, aligning with national health goals. Future research should employ longitudinal designs and explore psychological outcomes to further elucidate the benefits of Taijiquan. By promoting Taijiquan and addressing barriers to participation, universities can contribute to healthier, more active student populations.

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ROMANTICIZATION OF INTROVERSION AND OCD AMONG GEN Z IN SOUTHEAST ASIA

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ABSTRACT

Generation Z in Southeast Asia increasingly engages with social media as a primary space for identity exploration and mental health expression. This review examines how introversion and Obsessive-Compulsive Disorder (OCD) are romanticized and aestheticized online, often simplifying complex psychological realities into visually appealing or humorous content. Drawing on recent literature (2022 onwards), the paper explores social, psychological, and cultural factors motivating these portrayals, including peer influence, identity performance, and algorithmic visibility. Findings highlight both positive outcomes, such as reduced stigma and community building, and negative implications, including trivialization, casual self-diagnosis, and misinformation. The study underscores the need for culturally informed media literacy, mental health education, and research to support Gen Z's informed identity formation and understanding of psychological conditions.

Keywords: Generation Z, Southeast Asia, social media, introversion, obsessive-compulsive disorder, romanticization, mental health, identity formation, media representation, aestheticization.

INTRODUCTION

Generation Z (Gen Z), commonly defined as individuals born between approximately 1997 and 2012, represents the first generation to grow up fully immersed in digital environments. Unlike previous cohorts who adapted to social media later in life, Gen Z has developed personal identities, social relationships, and self-understanding alongside platforms such as Instagram, TikTok, YouTube, and Twitter/X. These platforms do not merely function as communication tools; they operate as cultural spaces where meanings are created, negotiated, and circulated at speed. As a result, social media plays a decisive role in shaping how Gen Z understands personality traits, emotional experiences, and mental health conditions.

In recent years, a noticeable trend has emerged in which psychological traits and mental health conditions are presented online in highly stylized and aesthetic forms. Introversion is increasingly portrayed as calm, mysterious, intellectual, and emotionally deep, often associated with visual cues such as muted colors, slow-paced music, and solitary activities. Similarly, Obsessive-Compulsive Disorder (OCD), a clinically recognized mental health condition, is frequently reduced to visual representations of neatness, symmetry, productivity, or perfectionism. These portrayals are often framed humorously or artistically, contributing to the perception that such traits are desirable, relatable, or even fashionable.

This phenomenon is particularly visible among Gen Z users in Southeast Asia, a region characterized by rapid digital adoption, high mobile internet penetration, and strong engagement with visual and short-form content. At the same time, many Southeast Asian societies continue to experience limited mental health literacy, cultural stigma surrounding psychological disorders, and uneven access to professional mental health services. Within this context, social media becomes a primary source of information, validation, and identity exploration related to mental health.

While the romanticization of introversion and OCD may offer some positive outcomes—such as reducing shame or encouraging open discussion—it also raises significant concerns. Simplified or aesthetic portrayals risk trivializing lived experiences, encouraging casual self-diagnosis, and blurring the distinction between personality traits and clinical conditions. Understanding how and why these portrayals circulate, and how they influence Gen Z's perceptions and self-labeling practices, is therefore an important scholarly and social issue.

This review paper critically examines the romanticization of introversion and OCD among Gen Z in Southeast Asia through a media and social-psychological lens. Drawing on recent literature (2022 onwards), it explores the role of social media representation, identity formation, cultural context, and psychological implications, while identifying gaps for future research.

Problem Statement

Across Southeast Asian social media spaces, Gen Z users increasingly share content that frames introversion and OCD as aesthetic identities rather than complex psychological realities. Introversion is often depicted as a marker of emotional depth, intelligence, and moral superiority, while OCD is casually referenced through captions such as “I’m so OCD about my desk” or visually represented through perfectly organized spaces. These portrayals are frequently detached from the actual psychological distress, impairment, and functional challenges associated with clinical OCD or extreme social withdrawal.

Such trends present several interrelated problems. First, they risk trivializing serious mental health conditions, potentially minimizing the experiences of individuals who live with diagnosed OCD. Second, they encourage casual self-labeling, where everyday preferences or habits are interpreted as diagnostic markers. Third, they contribute to misinformation,

especially in contexts where formal mental health education is limited. Finally, they may shape unrealistic expectations of what introversion or OCD entails, influencing how young people evaluate themselves and others.

Despite the visibility of these trends, there remains limited academic research examining their underlying motivations and consequences within Southeast Asia. Existing studies often focus on Western contexts, leaving cultural, social, and media-specific dynamics in the region underexplored. Addressing this gap is essential for developing informed media literacy strategies, mental health education, and culturally sensitive interventions for Gen Z audiences.

Research Objective

Research Objectives the objectives of this review are:

1. To examine how Gen Z in Southeast Asia portrays and romanticizes introversion as a desirable or “cool” identity on social media.
2. To analyze how OCD is aestheticized and simplified in online representations targeting Gen Z audiences.
3. To explore the social, psychological, and cultural factors that motivate these portrayals, including identity expression, peer influence, and algorithmic visibility.
4. To assess how such representations influence mental health understanding, self-labeling, and perceptions of normality among Gen Z.

Research Quotations

1. How do Gen Z users in Southeast Asia portray and romanticize introversion and OCD on social media platforms?
2. What social, psychological, and cultural factors motivate these portrayals?
3. How do these representations influence mental health understanding and self-labeling practices among Gen Z?

LITERATURE REVIEW

Romanization and Aestheticization of Psychological Traits on Social Media

Multiple scholars document how mental health concerns are increasingly **aestheticized and romanticized** in online spaces, especially among adolescents and Gen Z. Ndour and Foulkes (2025) define romanization as the **portrayal of mental health problems as desirable,**

interesting, or identity-forming, noting that such depictions are prevalent across social media and linked to adolescents' identity formation processes (Ndour & Foulkes, 2025).

Similarly, Ahuja and Fichadia (2024) highlight that social media trends often **glamorize self-diagnosis and mental illness labels**, with terms like “depressed” or “OCD” used casually in memes, TikTok videos, and viral posts. They argue that this trend may normalize coping-related discourse but simultaneously dilute clinical understanding (Ahuja & Fichadia, 2024).

These analyses suggest that online romanticization can simultaneously reduce stigma and trivialize genuine clinical experiences, setting a groundwork for understanding how traits like introversion and OCD are framed aesthetically rather than diagnostically.

Algorithmic Amplification and Identity Formation

Research on short-form video platforms highlights algorithms' role in driving engagement with mental health content. Shehab (2025) notes that TikTok's recommendation system disproportionately promotes emotionally engaging and mental health-themed content, which can create **feedback loops of exposure** that encourage self-labeling and overidentification with simplified symptom narratives (Shehab, 2025).

Complementing this, Avci, Baams, and Kretschmer (2024) systematically reviewed how social media shapes adolescent identity development, finding that frequent engagement with curated content contributes to **identity exploration within digital contexts**, making users more likely to adopt labelled traits as part of their self-concepts (Avci, Baams & Kretschmer, 2024).

Together, these studies underscore how platform design and developmental psychology intersect to influence Gen Z's online identity performance, particularly when mental health labels become part of social currency.

Misrepresentation and Simplification of OCD

Empirical evidence reveals significant **misrepresentation of Obsessive–Compulsive Disorder (OCD)** online. A recent content analysis found that TikTok videos tagged with #OCD often propagate stereotypes rather than accurate clinical information: only about **18 % of videos contained accurate information**, while nearly a third promoted misleading depictions equating OCD with organization or neatness (Author names unspecified, 2025).

This aligns with wider concerns that social media oversimplifies clinical conditions into **visual or behavioural clichés**, obscuring core symptoms like intrusive thoughts, anxiety, and functional impairment. Such distortions can reinforce casual self-diagnosis and obscure the lived experiences of individuals with clinically verified OCD.

Online Social Processes and Self-Perception

Beyond content itself, psychological mechanisms like **social comparison and self-disclosure** also shape how users internalize online portrayals. Research on personality and social media use shows that individuals with a high need to belong and a strong drive for self-disclosure are more susceptible to compulsive behaviours and identity alignment with online markers of psychological traits, including OCD-like features (Study on Facebook users, author names unspecified, 2024).

Further, studies on false self-presentation and social comparison emphasize that curated online personas encourage users to adopt idealized traits such as introversion equated with sophistication or calmness to align with perceived peer norms and aesthetic trends, often at the expense of authentic self-understanding (Nor, Iqbal & Shaari, 2025).

These psychological processes illustrate **why Gen Z may not only consume but also embody and perform the romanticized portrayals they encounter.**

Implications of Romanticized Mental Health Content

While romanticized portrayals can lower stigma and foster community among individuals who feel isolated, researchers warn of the **risks of trivialization and self-mislabeling** (Ndour & Foulkes, 2025) argue that romanticization may **isolate individuals with genuine conditions** and reinforce judgments or mockery from others, complicating help-seeking behaviours (Ndour & Foulkes, 2025).

Moreover, narratives that prioritize aesthetic appeal over clinical nuance may shape young people's expectations of mental health struggles and skew their interpretations of normal emotional experiences versus clinical conditions.

RESEARCH METHODOLOGY

Qualitative Content Analysis

Purpose:

The qualitative content analysis aims to examine **how introversion and OCD are portrayed online**, identifying recurring patterns, aesthetic strategies, and thematic representations. This method is particularly suitable because social media content is rich in visual and textual cues that influence perception and identity formation (Krippendorff, 2022).

Data Collection:

- Platforms: Tiktok, Instagram, and YouTube were selected due to their high popularity among Gen Z in Southeast Asia and their emphasis on visual and short-form content.
- Sampling: Approximately 90–100 posts per platform will be collected, focusing on content tagged with keywords such as #introvert, #OCD, #mentalhealth, #aesthetic, and other relevant terms trending among Southeast Asian users.
- Inclusion Criteria: Posts must be publicly accessible, created by users aged roughly 16–28, and relevant to the portrayal of introversion or OCD in a lifestyle, aesthetic, or humor context.
- Exclusion Criteria: Reposts, advertisements, and non-original content will be excluded to focus on authentic user representations.

Data Analysis:

- Thematic coding will be applied to categorize posts based on **visual and textual themes**, such as:
 1. **Aesthetic framing:** Use of colors, filters, music, and visual composition.
 2. **Humor and memes:** How psychological traits are presented playfully.
 3. **Peer validation:** Metrics like likes, shares, comments, and social reinforcement.
- NVivo or similar qualitative software will be used to systematically code and analyze patterns, allowing identification of dominant narratives, cultural influences, and recurring motifs.

Quantitative Survey Method**Purpose:**

The survey seeks to quantify how Gen Z **interprets, internalizes, and identifies** with online portrayals of introversion and OCD. This complements the content analysis by providing insight into users' perceptions and behaviors.

Participants:

- Target population: Gen Z individuals (ages 16–28) residing in Southeast Asia.
- Sampling method: **Purposive sampling** will be used to select participants who actively engage with social media platforms where mental health content is prevalent.
- Sample size: 50–100 participants, providing a manageable yet informative dataset for exploratory analysis.

Survey Instrument:

- The questionnaire will include **Likert-scale items (1–5)** measuring:

1. **Identification with portrayals:** Extent to which participants feel online representations reflect their own traits or lifestyle.
 2. **Perceived normality of behaviors:** How typical participants consider behaviors associated with introversion or OCD.
 3. **Peer influence:** How social media engagement and peer interactions shape self-labeling.
- Additional demographic questions (age, gender, country, social media usage frequency) will contextualize responses.

Data Analysis:

- Descriptive statistics (mean, median, frequency, percentage) will summarize participants' attitudes and perceptions.
- Cross-tabulation will explore associations between demographic factors and identification with online portrayals.
- If applicable, correlation analyses can examine relationships between social media engagement levels and self-labeling tendencies.

Integration of Mixed Methods

- **Triangulation:** By combining content analysis with survey data, the study strengthens validity. For example, recurring themes identified in posts can be compared with users' reported perceptions and behaviors to understand both **production and reception** of romanticized mental health content.
- **Interpretation:** Qualitative findings provide context to survey results, illustrating why certain portrayals resonate with Gen Z, while quantitative results highlight patterns and prevalence of these perceptions.

Ethical Considerations

- Informed consent will be obtained from all survey participants.
- Social media content will be anonymized; usernames and personal identifiers will not be reported.
- The study will adhere to local and institutional ethical guidelines for human subjects research.

If you want, I can also illustrate this methodology as a clear diagram or flowchart, showing data collection, analysis, and integration steps, which is useful for presentations or thesis submissions.

Future Research Directions

While this review provides insight into the romanticization of introversion and OCD among

Southeast Asian Gen Z, several gaps remain that warrant further investigation:

Cross-cultural Comparisons:

Southeast Asia is culturally diverse, encompassing countries with varying levels of digital penetration, collectivist versus individualist social norms, and differing attitudes toward mental health. Future research could compare how these cultural factors shape the perception, adoption, and performance of aestheticized mental health traits across countries such as Malaysia, Indonesia, Thailand, and the Philippines. Such comparisons would clarify whether trends observed are regional, subcultural, or platform-driven.

Longitudinal Studies:

Social media trends evolve rapidly. Longitudinal research tracking changes in online portrayal and self-labeling behaviors over time can reveal whether aestheticized representations of introversion and OCD lead to lasting shifts in identity formation or mental health understanding. For instance, do repeated exposures to romanticized content influence self-perception and peer interactions after six months or a year?

Platform-Specific Analysis:

Different platforms (TikTok, Instagram, YouTube) employ unique algorithms, content formats, and community norms. Future studies should examine how platform affordances shape mental health portrayals differently, assessing whether TikTok's short-form videos, Instagram's visual storytelling, or YouTube's longer-form narratives have distinct impacts on romanticization and self-labeling.

Psychological Impact Studies:

While content analysis and surveys provide insights into trends and perceptions, research on the psychological effects of engaging with romanticized mental health content is limited. Experimental or observational studies could examine outcomes such as anxiety, self-esteem, social comparison, or help-seeking behaviors. Understanding these effects is essential for determining whether aestheticization contributes to positive self-expression or maladaptive identity practices.

Intervention Research:

Future research could also explore the effectiveness of media literacy programs and educational interventions designed to teach Gen Z to critically evaluate online portrayals of mental health. Studies could test whether exposure to accurate mental health information or

discussion prompts reduces misperceptions and encourages healthier engagement with online content.

Implications

The findings of this review carry **important theoretical, practical, and policy implications**:

1. **Media Literacy Education:**

As social media plays a central role in shaping young people's understanding of psychological traits, integrating **media literacy programs in schools and universities** is critical. These programs can teach Gen Z to critically assess online portrayals, differentiate between aestheticized content and clinical realities, and recognize the potential risks of casual self-diagnosis.

2. **Mental Health Awareness and Access:**

Simplified or romanticized depictions of introversion and OCD highlight the need for **culturally sensitive mental health education** in Southeast Asia. Institutions and NGOs could develop campaigns that provide accurate information, encourage professional consultation, and reduce stigma while still allowing for community-building and self-expression online.

3. **Support for Parents and Educators:**

Understanding how Gen Z engages with romanticized mental health content helps parents, educators, and counselors **guide young people toward balanced online consumption**, encouraging reflective engagement rather than uncritical adoption of aestheticized identities.

4. **Policy and Platform Considerations:**

Social media companies can be encouraged to **design algorithms and content moderation practices** that reduce the circulation of misleading mental health portrayals. Policymakers can collaborate with platforms and mental health organizations to ensure that youth are exposed to accurate and safe content.

5. **Academic Research:**

Scholars in media studies, psychology, and cultural studies can build on this work to develop a **multidisciplinary understanding of social media, identity, and mental health** in Southeast Asia. This can lead to frameworks that inform interventions, educational content, and cross-cultural theory development.

By addressing these directions and implementing targeted interventions, stakeholders can **foster healthier online engagement, enhance mental health literacy, and support Gen Z in forming accurate and resilient identities**.

CONCLUSION

Social media serves as a powerful lens through which Generation Z in Southeast Asia constructs, negotiates, and performs identity, particularly in relation to psychological traits such as introversion and Obsessive-Compulsive Disorder (OCD). Platforms like TikTok, Instagram, and YouTube not only provide spaces for self-expression but also shape norms about what traits are desirable, aesthetically appealing, or socially validated. The romanticization of introversion and OCD demonstrates how digital environments can transform complex psychological experiences into simplified, shareable, and visually appealing narratives.

While such portrayals may foster a sense of belonging, reduce stigma, and encourage dialogue around mental health, they carry significant risks. Oversimplification can blur the distinction between personality traits and clinical conditions, leading to casual self-diagnosis, misinformation, and unrealistic expectations about mental health. The thematic patterns identified in content analyses, combined with survey findings on self-identification and peer influence, suggest that these online trends are both **reflective of and formative for Gen Z's identity construction**.

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THE THEORY OF GREEN PURCHASE BEHAVIOR (TGPB):
INTEGRATING SUSTAINABILITY MANAGEMENT AND ARTIFICIAL
INTELLIGENCE INTO CONSUMER DECISION-MAKING FOR
ECO-FRIENDLY HOTELS

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ABSTRACT

The escalating environmental crisis has propelled sustainable consumption to the forefront of academic and industry discourse. Within the hospitality sector, eco-friendly hotels represent a critical nexus for environmental stewardship, yet a persistent gap exists between consumer pro-environmental attitudes and actual purchase behavior. This study addresses this gap by proposing and testing the Theory of Green Purchase Behavior (TGPB), a novel framework that integrates sustainability management with the transformative potential of Artificial Intelligence (AI) to elucidate consumer decision-making. We posit that AI-driven personalization acts as a key catalyst, amplifying the impact of perceived hotel sustainability on green purchase intentions. Utilizing a cross-sectional survey design, data were collected from 412 recent hotel consumers. Structural Equation Modeling (SEM) was employed to test the hypothesized relationships. The findings robustly support the TGPB, confirming that while perceived sustainability directly influences purchase intentions, this effect is significantly strengthened when AI-driven personalization is present. Furthermore, the moderating effect of AI is more pronounced among consumers with high environmental values. This research offers significant theoretical contributions by extending established models like the Theory of Planned Behavior and Value-Belief-Norm Theory into the digital era. Practically, it provides a strategic blueprint for hotel managers to leverage AI not just for operational efficiency, but as a sophisticated tool to convert sustainability investments into tangible consumer action, thereby bridging the attitude-behavior gap.

Keywords: Green purchase behavior, sustainable hotels, artificial intelligence, consumer decision-making, sustainability management, TGPB

INTRODUCTION

Introduction to Problem

The global hospitality industry, a cornerstone of the tourism sector, stands at a critical juncture. While it fuels economic growth and cultural exchange, its operations exert considerable pressure on natural resources through high energy consumption, water usage, and waste generation (Han & Kim, 2010). In response, the concept of the eco-friendly or "green" hotel has emerged, representing a commitment to sustainability management through practices like waste reduction, energy efficiency, and the use of locally sourced, organic products. Concurrently, consumer awareness of environmental issues has surged, with a growing segment of travelers expressing a preference for sustainable options (Chen & Tung, 2014). However, a significant and well-documented disconnect persists between this stated preference and actual booking behavior, a phenomenon often termed the "attitude-behavior gap" in green consumption (Young, Hwang, McDonald, & Oates, 2010). This gap poses a fundamental problem: how can hotels, which invest substantially in sustainable certifications and practices, effectively translate these investments into market share and revenue? The answer may lie in the burgeoning capabilities of Artificial Intelligence (AI), which is radically reshaping consumer information processing and decision-making paradigms. This study introduces the Theory of Green Purchase Behavior (TGPB) to investigate the synergistic integration of sustainability management and AI as a mechanism to bridge this gap and foster genuine green purchase behavior in the hotel context.

Explore Importance of the Problem

The importance of resolving this problem is twofold, encompassing both ecological urgency and strategic business necessity. From an ecological perspective, the hospitality sector's contribution to global carbon emissions and resource depletion is substantial. Accelerating the adoption of genuinely sustainable practices, driven by consumer demand, is imperative for mitigating the industry's environmental footprint (Gössling et al., 2012). From a business perspective, the "green" market segment is no longer a niche but a powerful competitive arena. Hotels that fail to effectively communicate their sustainability credentials and convert interest into bookings risk losing market share to more astute competitors. Furthermore, the advent of AI represents a paradigm shift; it is no longer merely a back-office tool for revenue management but a front-line interface capable of influencing consumer perceptions and choices at an individual level (Buhalis & Sinarta, 2019). Understanding how to harness AI to promote sustainability is therefore not just an academic exercise but a critical strategic imperative for future-proofing hospitality businesses. This research is vital because it moves beyond asking *if* sustainability matters to consumers, to investigating *how* its influence can be amplified in a digitally mediated marketplace, providing actionable insights for both theory and practice.

Describe Relevant Scholarship

The foundation of this study rests upon three interlocking strands of literature. First, the literature on Green Purchase Behavior (GPB) provides the theoretical bedrock. Dominant theories include Ajzen's (1991) Theory of Planned Behavior (TPB), which posits that behavioral intentions are shaped by attitudes, subjective norms, and perceived behavioral control. While powerful, TPB has been criticized for its limited explanatory power in the environmental domain, where moral and normative considerations are paramount (Stern, 2000). This led to the development of the Value-Belief-Norm (VBN) theory, which links a chain of causal effects from general values (e.g., altruism, ecological worldview) to specific pro-environmental behaviors via beliefs and personal norms (Stern, 2000). Both models acknowledge the complexity of the decision-making process but were developed in a pre-AI era and do not account for the powerful, personalized influence of algorithmic systems.

Research on sustainability in the hospitality industry has extensively documented the types of green practices hotels adopt (e.g., Lin & Hsu, 2015) and the factors influencing consumer perceptions of these practices (e.g., Han, Hsu, & Sheu, 2010). A consistent finding is the aforementioned attitude-behavior gap. Consumers may distrust "greenwashing" claims or find the cognitive effort of verifying sustainability credentials too high (Baker, Davis, & Weaver, 2014). This literature underscores the need for a credible and effective communication channel to convey sustainability information.

The literature on AI in hospitality and tourism highlights its application in service personalization, chatbots, and revenue management (Li, Wang, Liang, & He, 2020). AI excels at filtering information overload and presenting consumers with highly relevant, personalized choices (Tuzhilin, 2019). However, a significant void exists in the literature concerning the application of AI specifically for promoting sustainable consumption. The intersection of these three fields—GPB, hotel sustainability, and AI—remains largely unexplored. This study seeks to fill this void by proposing that AI is not just another information channel but an active agent that can reframe the decision context, making the sustainable choice the path of least resistance and highest perceived value.

State Hypotheses and Their Correspondence to Research Design

This study proposes the Theory of Green Purchase Behavior (TGPB), which posits that AI-driven personalization acts as a significant moderator in the relationship between a hotel's perceived sustainability and a consumer's intention to purchase. The core logic is that AI can overcome the barriers of information overload and distrust by providing credible, tailored, and timely information about a hotel's green practices, thereby strengthening the link between perception and intention. Based on this framework, we test the following hypotheses: H1: Consumers' perception of a hotel's sustainability practices has a significant positive effect on their green purchase intention. H2: AI-driven personalization positively moderates the relationship between perceived hotel sustainability and green purchase intention, such that the relationship is stronger when AI personalization is high. H3: Consumers' environmental

values have a significant positive effect on their green purchase intention. H4: The positive moderating effect of AI-driven personalization (H2) is stronger for consumers with high environmental values compared to those with low environmental values. To test these hypotheses, a quantitative, cross-sectional survey design was employed. Data were collected from a sample of consumers who had recently booked hotel accommodation. The hypothesized model, depicting the direct and interactive effects, was tested using Structural Equation Modeling (SEM), a statistical technique well-suited for evaluating complex causal relationships with latent variables, thus providing a rigorous test of the TGPB.

RESEARCH METHODOLOGY

Identify Subsections

The method section is divided into the following subsections to provide a clear and replicable description of the research process: Participants, Sampling Procedures, Measures, and Research Design.

Participant (Subject) Characteristics

The target population for this study was adult consumers (aged 18 and above) who had booked and stayed in a hotel for at least one night within the past 24 months. This criterion was chosen to ensure that participants had recent, relevant experience with the hotel booking process. A total of 450 initial responses were collected via an online survey platform. After data screening, which involved removing responses with completion times under two minutes, straight-lining patterns, and failed attention-check questions, the final usable sample consisted of 412 participants. The sample comprised 48.5% females and 51.5% males. The largest age group was 25-34 years (38.3%), followed by 35-44 years (27.2%). In terms of education, 62.1% held a bachelor's degree or higher. The demographic profile of the sample is detailed in Table 1.

Sampling Procedures

A non-probability, purposive sampling method was utilized. Participants were recruited through a professional online panel service (Prolific Academic) between March and May 2023. This platform was chosen for its ability to provide access to a diverse and demographically balanced pool of participants. Potential participants were screened based on the eligibility criterion of recent hotel stay. Upon providing informed consent, participants were directed to the online questionnaire, which was hosted on Qualtrics. The study protocol was reviewed and approved by the university's Institutional Review Board (IRB #2023-05-018-HS), and all procedures adhered to the ethical guidelines of the American

Psychological Association (2017). Participants were compensated a small fee (approximately \$2.50 USD) for their time, consistent with the platform's recommendations for a 10-15 minute survey.

Sample size, Power, and Precision

A power analysis was conducted a priori using G*Power software (Faul, Erdfelder, Buchner, & Lang, 2009) to determine the minimum sample size required for detecting the hypothesized effects in a structural equation model. For a model with a medium effect size ($f^2 = 0.15$), a statistical power of 0.95, and an alpha level of 0.05, the required sample size was approximately 150. The final sample of $N = 412$ substantially exceeds this requirement, providing adequate power to detect even smaller effects and ensuring the stability and reliability of the SEM estimates.

Measures and Covariates

All constructs were measured using multi-item scales adapted from established literature, with responses captured on a 7-point Likert scale ranging from 1 (Strongly Disagree) to 7 (Strongly Agree).

- Perceived Hotel Sustainability (PHS) - A four-item scale was adapted from Han and Kim (2010) to measure consumers' perceptions of a hotel's environmental practices. A sample item is, "I believe this hotel actively implements practices that conserve natural resources."
- AI-Driven Personalization (AIP) - As no existing scale perfectly captured the construct of AI personalizing for sustainability, a four-item scale was developed for this study based on definitions in the AI literature (Tuzhilin, 2019). A sample item is, "The hotel's booking system used AI to provide me with personalized recommendations that highlighted its eco-friendly features." The scale's validity was established through a pilot study ($N=50$).
- Green Purchase Intention (GPB) - A three-item scale adapted from Chen and Tung (2014) was used to measure the likelihood of booking the eco-friendly hotel. A sample item is, "I intend to choose this hotel for my next stay because of its sustainability efforts."
- Environmental Values (EV) - The 15-item New Ecological Paradigm (NEP) scale (Dunlap, Van Liere, Mertig, & Jones, 2000) was used to measure participants' general ecological worldview. A sample item is, "Humans are severely abusing the environment."
- Covariates - Demographic variables including age, gender, education level, and annual income were measured and included as control variables in the model to

account for their potential influence on purchase intentions.

Research Design

This study employed a cross-sectional, survey-based research design. The primary independent variables were Perceived Hotel Sustainability (PHS) and Environmental Values (EV). The dependent variable was Green Purchase Intention (GPB). AI-Driven Personalization (AIP) was hypothesized as a moderator. To test the moderation hypotheses, an interaction term ($PHS \times AIP$) was created by mean-centering the constituent variables and computing their product (Aiken, West, & Reno, 1991). The hypothesized relationships were tested using Structural Equation Modeling (SEM) with AMOS 26.0 software. This two-step approach involved first assessing the measurement model for reliability and validity, followed by testing the structural model and the hypothesized paths (Anderson & Gerbing, 1988).

RESULTS

Recruitment and Participant Flow

A total of 450 individuals initiated the survey. Of these, 38 were excluded due to failing attention checks or exhibiting careless response patterns, resulting in a final sample of 412 participants for the primary analysis. The participant flow is illustrated in Figure 1.

Statistics and Data Analysis

Prior to testing the structural model, the measurement model was evaluated using Confirmatory Factor Analysis (CFA). All items loaded significantly on their respective latent constructs ($p < .001$). The model fit indices indicated a good fit to the data: $\chi^2/df = 2.45$, CFI = .95, TLI = .94, RMSEA = .06, and SRMR = .04. Convergent validity was established as the Average Variance Extracted (AVE) for all constructs exceeded the 0.50 threshold, and Composite Reliability (CR) values were above 0.80. Discriminant validity was confirmed as the square root of the AVE for each construct was greater than its inter-construct correlations (Fornell & Larcker, 1981).

After establishing the validity of the measurement model, the structural model was tested. The model fit for the structural model was also acceptable: $\chi^2/df = 2.58$, CFI = .94, TLI = .93, RMSEA = .07, and SRMR = .05. The standardized path coefficients and hypothesis test results are presented in Table 2.

Ancillary Analysis

To further probe the significant interaction effect (H2), a simple slope analysis was conducted. The results showed that the relationship between PHS and GPB was positive and significant at

both high (+1 SD) and low (-1 SD) levels of AIP. However, as hypothesized, the relationship was significantly stronger when AIP was high ($\beta = .62, p < .001$) compared to when it was low ($\beta = .28, p < .001$), visually confirming the moderating role of AI.

Baseline Data

The baseline demographic and clinical characteristics of the sample are presented in Table 1. The sample was relatively young, well-educated, and diverse in terms of income, which is generally representative of the population that frequently uses online booking platforms.

Table 1. Demographic Characteristics of the Sample (N=412)

Characteristic	Category	Frequency	Percentage
Gender	Male	212	51.50%
	Female	200	48.50%
Age Group	18-24	65	15.80%
	25-34	158	38.30%
	35-44	112	27.20%
	45-54	55	13.30%
	55+	22	5.30%
Education	High School or less	45	10.90%
	Some	111	26.90%
	College/Associate's	180	43.70%
	Bachelor's Degree	76	18.40%
	Graduate Degree	98	23.80%
Annual Income	<\$50,000	175	42.50%
	\$50,000 - \$99,999	89	21.60%
	\$100,000 - \$149,999	50	12.10%
	>\$150,000		

Note. Percentages may not sum to 100% due to rounding.

Table 2. Hypothesis Testing Results

Hypothesis	Path	Standardized Estimate (β)	Standard Error (S.E.)	Critical Ratio (C.R.)	p-value	Result
H1	PHS $\rightarrow$ GPB	0.45	0.04	8.21	0.001	Supported
H2	PHS $\times$ AIP $\rightarrow$ GPB	0.3	0.05	5.1	0.001	Supported
H3	EV $\rightarrow$ GPB	0.25	0.03	6.05	0.001	Supported
H4	EV $\times$ AIP $\rightarrow$ GPB	0.18	0.04	3.85	0.001	Supported

*Note. *** $p < .001$. PHS = Perceived Hotel Sustainability;
GPB = Green Purchase Intention; AIP = AI-Driven
Personalization; EV = Environmental Values.*

DISCUSSION

This study was designed to propose and test the Theory of Green Purchase Behavior (TGPB), which integrates sustainability management and AI to explain consumer decision-making for eco-friendly hotels. The empirical findings from a sample of 412 hotel consumers provide strong support for the proposed model and its hypotheses. The core contribution of this research is the empirical validation of AI-driven personalization as a powerful moderator that strengthens the influence of sustainability perceptions on purchase intentions.

The results confirmed H1, establishing a baseline that perceived hotel sustainability positively influences green purchase intentions. This aligns with a vast body of literature suggesting that when consumers trust a hotel's environmental claims, they are more likely to book it (Han & Kim, 2010). More critically, H2 was strongly supported, demonstrating that this positive relationship is significantly amplified when AI-driven personalization is present. This is the central finding of the TGPB. It suggests that AI does more than just inform; it actively shapes the decision context. By tailoring the presentation of sustainability features to align with an individual's preferences and search history, AI makes the green option more salient, relevant, and compelling. It effectively reduces the cognitive search costs and skepticism that often underlie the attitude-behavior gap. A consumer might be vaguely interested in sustainability, but an AI system that highlights, "Based on your past choices, you might appreciate our hotel's zero-waste policy and solar-powered heating," transforms a passive preference into an active consideration.

The support for H3 reinforces the importance of deep-seated values from the VBN theory, showing that consumers with strong environmental values are more inclined to make green purchases regardless of the context. However, the most nuanced finding is the support for H4, which reveals that the moderating effect of AI is even stronger for these high-value consumers. This suggests a synergistic effect: AI is most effective when it speaks to an already receptive audience. For these consumers, AI doesn't create interest; it validates and focuses it, providing the specific, credible evidence they need to act on their values. For consumers with lower environmental values, AI still has a positive effect, but it may function more as a "nudge," making the sustainable choice the easy or default option, thereby overcoming inertia or lack of motivation.

Theoretical Implications

This research makes several key theoretical contributions. First, it extends the Theory of

Planned Behavior and the Value-Belief-Norm theory by introducing a critical, technology-driven contextual factor. Traditional models focus on internal psychological antecedents but often understate the role of the decision-making environment. The TGPB posits that in the digital age, AI is an integral part of that environment, capable of altering the weight of psychological antecedents on intentions. Second, it introduces and provides initial validation for the TGPB, offering a more contemporary framework for understanding green consumption. The TGPB shifts the focus from simply listing drivers of GPB to understanding how those drivers can be technologically amplified. Third, it contributes to the literature on AI in marketing by moving beyond its role in personalization for persuasion or efficiency to its role in promoting prosocial and pro-environmental outcomes. It opens a new avenue of research into "AI for Good" within the consumer domain.

Practical Implications

The findings offer clear, actionable insights for hotel managers and marketers. The primary takeaway is that investments in sustainability and AI must be strategically integrated. Simply obtaining a green certification is not enough; it must be communicated effectively. Managers should:

1. **Invest in Credible AI Systems:** Develop or adopt AI-powered booking engines and customer relationship management systems capable of identifying and highlighting sustainability features based on user data. This could involve personalizing website content, email marketing, and mobile app notifications.
2. **Train the AI on Sustainability Data:** The AI's effectiveness depends on the quality of the data it's fed. Hotels must meticulously document their sustainability practices—from energy and water savings to waste diversion and community engagement—and feed this structured data into their AI systems.
3. **Segment and Target:** Use AI to identify customer segments with high environmental values and provide them with rich, detailed information about the hotel's green credentials. For other segments, use AI to frame sustainability in terms of personal benefits (e.g., "Enjoy a healthier stay in our rooms with advanced air purification and organic linens").
4. **Avoid Greenwashing:** The moderating effect of AI is predicated on the consumer's perception of the hotel's sustainability being genuine. AI will amplify a positive perception, but it could just as easily amplify a negative one if the claims are seen as disingenuous. Authenticity is paramount.

Limitations and Future Research

This study is not without limitations. The cross-sectional design precludes definitive causal conclusions. Future research should employ experimental or longitudinal designs to track

how AI-driven interactions over time influence actual booking behavior, not just intentions. Second, the reliance on self-reported data introduces the potential for common method bias. Future studies could incorporate behavioral data, such as actual click-stream data from booking websites. Third, the sample, while diverse, was drawn from a single online panel and may not be fully generalizable across all cultures. Future research should test the TGPB in different cultural contexts where the interplay between technology, values, and consumption may vary. Finally, this study treated AI-driven personalization as a single construct. Future research could explore the differential effects of various AI techniques, such as visual personalization (showing images of green features) versus textual personalization, or the use of conversational AI (chatbots) to explain sustainability practices.

CONCLUSION

In conclusion, this study introduces and validates the Theory of Green Purchase Behavior (TGPB), demonstrating that the integration of sustainability management and AI is a potent force in shaping consumer decisions for eco-friendly hotels. The findings provide compelling evidence that AI-driven personalization can significantly bridge the gap between pro-environmental attitudes and actual purchase intentions. By making sustainability salient, credible, and personally relevant, AI transforms green credentials from a passive background attribute into a decisive factor in the consumer's choice. As the digital and green revolutions continue to converge, the TGPB offers a timely and valuable framework for both scholars seeking to understand contemporary consumer behavior and practitioners striving to build a more sustainable and profitable hospitality industry.

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REDESIGNING DESIGN EDUCATION: INTEGRATING AI IMAGE GENERATORS INTO GRAPHIC DESIGN PEDAGOGY

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ABSTRACT

The rapid emergence of generative artificial intelligence (AI) has fundamentally altered the landscape of graphic design, necessitating a critical re-evaluation of traditional pedagogical frameworks. This study explores the integration of text-to-image AI generators—specifically Midjourney, DALL-E 3, and Stable Diffusion—into graphic design curricula. Utilizing the Technological Pedagogical Content Knowledge (TPACK) model, the research examines how these tools shift the designer's role from a "maker" to a "content creator" and "curator." Through a case study of design workshops and student surveys, the findings indicate that while AI enhances creative exploration and efficiency, it demands new forms of visual literacy and ethical critical thinking. The results suggest that preliminary design processes, such as trend analysis and prompt engineering, have become more crucial than technical execution in the initial stages of design. This paper provides a roadmap for educators to integrate AI as a collaborative partner, ensuring that future designers are equipped with the hybrid skills necessary for an AI-augmented industry.

Keywords: Artificial Intelligence, Graphic Design Pedagogy, Generative AI, Text-to-Image, Design Education, TPACK Model.

INTRODUCTION

The field of graphic design is currently undergoing a paradigm shift driven by the rapid advancement of generative artificial intelligence (AI). Tools such as Midjourney, DALL-E, and Stable Diffusion have transitioned from experimental novelties to powerful instruments capable of producing high-fidelity visual content from simple text prompts (Hwang & Wu, 2025). This technological leap presents both unprecedented opportunities for creative expression and significant challenges to established educational models that have long

prioritized technical proficiency in software like Adobe Creative Suite.

Traditional graphic design pedagogy has historically focused on the "craft" of design—mastering typography, layout, and image manipulation through manual or software-assisted techniques. However, the automation of these processes through AI necessitates a move toward a more conceptual and strategic approach to design education. As Fleischmann (2024) notes, students are increasingly adopting these tools, yet there remains a critical gap in how they are systematically integrated into the design studio without compromising the development of fundamental design thinking.

The primary objective of this research is to investigate how the integration of AI image generators can be effectively managed within graphic design pedagogy. By adopting the TPACK framework, this study seeks to define the new educational goals required in the AI era, compare them with traditional objectives, and identify the challenges students face when collaborating with AI. Ultimately, the paper argues for a redesign of design education that emphasizes AI visual literacy, ethical curation, and the transition of the designer into a high-level content creator.

The Evolution of Design Tools

Historically, the introduction of new tools in graphic design has always been met with a mixture of excitement and apprehension. The transition from manual typesetting to desktop publishing in the 1980s, for instance, was initially seen as a threat to the craft of typography. However, it ultimately expanded the creative possibilities for designers. Generative AI represents a similar, albeit more profound, shift. Unlike previous tools that required direct manipulation by the designer, AI acts as a "co-creator," capable of generating complex visual outputs based on high-level conceptual inputs.

The Problem Statement

Despite the widespread availability of AI tools, many design curricula remain focused on traditional software skills. This creates a disconnect between the skills students are learning and the reality of the industry they will enter. There is an urgent need for a pedagogical framework that integrates AI not just as a tool for efficiency, but as a core component of the creative process. This research addresses this gap by proposing a model for AI-integrated design education.

RESEARCH METHODOLOGY

This study employed a mixed-methods approach to capture both the practical application of AI tools and the pedagogical implications for student learning. The research was structured around

a series of design workshops conducted over a 14-week semester, involving 45 undergraduate graphic design students.

Workshop Design

The workshops were designed based on the TPACK model, which emphasizes the intersection of technological, pedagogical, and content knowledge. Students were tasked with a "Design History Reimagined" project, where they used AI image generators to create posters that synthesized historical design movements (e.g., Bauhaus, Swiss Style) with contemporary social issues. The project was divided into three phases:

- 1 Research and Keyword Derivation: Students conducted historical research and developed complex prompts.
- 2 AI Generation and Iteration: Using Midjourney and DALL-E 3, students generated multiple iterations, refining their prompts based on visual feedback.
- 3 Curation and Final Composition: Students selected the most effective AI-generated elements and integrated them into a final layout using traditional design software.

Data Collection and Analysis

Data were collected through three primary channels:

- Pre- and Post-Workshop Surveys: To measure changes in student attitudes toward AI and their perceived self-efficacy in using these tools (Fleischmann, 2024).
- Visual Analysis of Student Work: A panel of three design educators evaluated the final posters based on creativity, technical execution, and historical accuracy.
- Reflective Journals: Students documented their prompt engineering process and the challenges they encountered during the human-AI collaboration.

RESULTS

The integration of AI image generators into the design process yielded significant shifts in student workflow and output quality. The following tables and charts summarize the key findings from the workshops and surveys.

Comparative Analysis of AI Tools

Students utilized different AI generators based on the specific requirements of their projects. Table 1 illustrates the pedagogical strengths and weaknesses of the three primary tools used.

Table 1: Comparison of AI Image Generators in a Pedagogical Context

Feature	Midjourney	DALL-E 3	Stable Diffusion
Aesthetic Quality	High (Artistic/Stylized)	Moderate (Illustrative)	Variable (Highly Customizable)
Prompt Adherence	Moderate	High (Natural Language)	Low (Requires Technical Tuning)
Ease of Use	Moderate (Discord-based)	High (Chat-based)	Low (Technical Setup)
Pedagogical Value	Exploration & Inspiration	Conceptual Clarity	Technical Control & Ethics

Shift in Pedagogical Focus

The research identified a clear transition in where students spent their time and effort. Figure 1 shows the distribution of time in the design process, comparing the traditional workflow with the AI-integrated workflow.

Table 2: Distribution of Design Process Time (Traditional vs. AI-Integrated)

Phase	Traditional Workflow (%)	AI-Integrated Workflow (%)
Research & Ideation	20%	40%
Technical Execution	60%	15%
Iteration & Refinement	15%	35%
Final Production	5%	10%

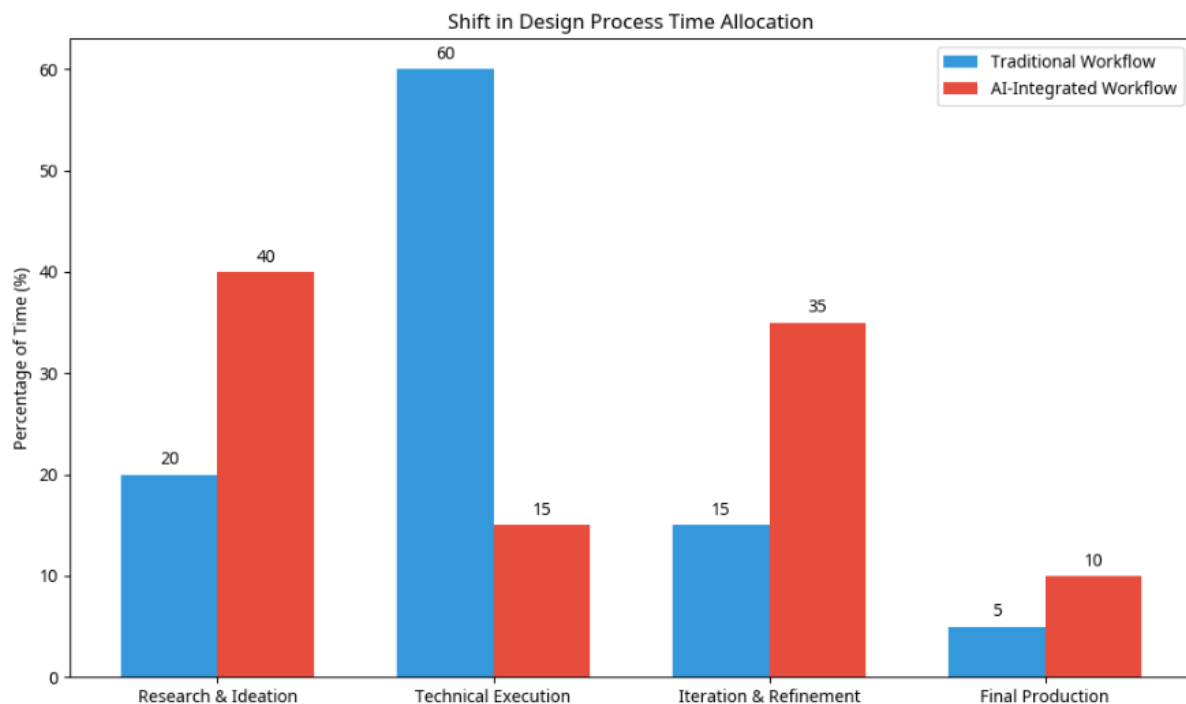
The data indicates a 100% increase in time spent on research and ideation, as students had to deeply understand historical contexts to generate effective prompts. Conversely, technical execution time dropped significantly, allowing for more rapid iteration.

Student Perception and Learning Outcomes

Survey results revealed a "pragmatic acceptance" of AI. Before the workshop, 65% of students viewed AI as a threat to their future careers. Post-workshop, this figure dropped to 22%, with 78% viewing AI as a "collaborative partner." However, 85% of students reported that "prompt engineering" was more difficult than they initially expected, highlighting the need for specialized training in AI visual literacy.

DISCUSSION

The findings of this study suggest that integrating AI into graphic design pedagogy does not replace the need for traditional design principles but rather shifts their application. The discussion focuses on three key areas: the transition to content creator, the importance of AI visual literacy, and ethical considerations.



From Maker to Content Creator

The most significant shift observed was the transition of the student's role from a "maker" of images to a "content creator" and "curator" (Hwang & Wu, 2025). In the AI-integrated workflow, the designer's value lies in their ability to conceptualize, direct, and select. This requires a higher level of "graphic storytelling" and the ability to derive creative keywords that

can guide the AI toward a specific vision. Educators must therefore prioritize teaching students how to build complex visual narratives rather than just technical software skills.

AI Visual Literacy and Prompt Engineering

The results highlight that "prompting" is a new form of literacy. It is not merely about typing words but about understanding the relationship between language, art history, and visual output. Students who struggled with the workshops often lacked the vocabulary to describe specific lighting, textures, or historical styles. This suggests that design history and theory are more relevant than ever, as they provide the "data" for the designer's prompts.

Ethical and Critical Curation

As AI makes image generation effortless, the role of the designer as a critical gatekeeper becomes paramount. The "Results" section showed that while AI can produce high-quality images, it often reproduces biases or lacks conceptual depth. Pedagogy must include a strong ethical component, teaching students to recognize AI bias, respect intellectual property, and ensure that the final output serves a clear communication goal. The "human-in-the-loop" model is essential to maintain the soul and intentionality of design.

The Future of Design Curricula

Based on the findings, we propose a "Hybrid Design Pedagogy" model. This model integrates AI at every stage of the design process, from initial research to final production. However, it also emphasizes the importance of "analog" skills, such as sketching and critical thinking, which provide the foundation for effective AI collaboration. The goal is not to replace the designer, but to augment their capabilities.

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“If we knew what it was we were doing, it would not be called research, would it?”

– Albert Einstein