

# **Food Innovation: The Mediated Relationship between Marketing Strategies, Sustainable Attitude, and Insect-Based Ice Cream Purchase Propensity**

Kanokwan Seeharat

Innovative Entrepreneur Concentration, Dusit Thani College, Bangkok; TasteLab Co. Ltd, Samut Prakan, Thailand

Lorenzo Conforto

TasteLab Co. Ltd, Samut Prakan, Thailand

Wisuwat Wannamakok\*

Faculty of Agro-industry, Chiang Mai University, Chiang Mai, Thailand

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## **ABSTRACT**

Edible insects are emerging as a promising avenue for sustainable food systems due to their high nutritional value, low environmental footprint, and potential to address global food security challenges. Despite the widespread adoption of edible insects in various developing regions, their acceptance in certain regions remains inconclusive, with consumers often viewing them as novel food. This research thus investigates the influence of marketing mix factors and sustainable attitudes on consumers' purchase intentions towards insect-based protein-enriched ice cream, using Thailand as a case study. Employing a quantitative approach, the study utilizes a questionnaire-based survey administered to 402 participants in Bangkok and surrounding areas. The Smart PLS has been adopted for data analysis for analyzing the proposed eight hypotheses. The result reveals that consumers' attitudes towards sustainability mediate the relationship between most of the marketing mix determinants (product, place, process, and physical evidence) and their intentions to purchase insect-based ice cream. Importantly, the direct effect of attitude towards sustainability has profoundly influenced purchase intentions. As a result, the study underscores the importance of sustainability attitudes in shaping consumer behavior towards insect ice cream, highlighting its potential as a sustainable and nutritious food option. Discussion, implication, and food policies have been addressed.

**Keywords:** Insect-Based Ice Cream; Marketing Strategy; Sustainable Attitude; Purchase Intention.

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## **1. INTRODUCTION**

Inadequacies in resource distribution exacerbate societal disparities, leaving vulnerable demographics with insufficient access to essential amenities and services. This issue is

highlighted across scholarly inquiries emphasizing disparities in healthcare access (Nontarak, Vichitkunakorn & Waleewong, 2023). Simultaneously, prolonged conflicts disrupt food systems, worsening food insecurity and hindering humanitarian aid efforts. The complex relationship between conflict and food security has been extensively studied worldwide. As such, conflict devastates agricultural areas and supply chains, perpetuating cycles of violence and malnutrition, particularly in regions reliant on subsistence agriculture (Kemmerling, Schetter & Wirkus, 2023). Factors like asset dispossession and food price spikes contribute to grievances and social instability. Conflict significantly reduces food consumption in affected households, especially when compounded by other shocks like droughts or floods. Addressing this nexus requires international, national, and community-level interventions, including sustainable agriculture, resilient social safety nets, and effective conflict resolution (Royer & Wharton, 2023).

Climate change further threatens food security by reducing crop yields and water resources essential for agriculture, exacerbated by human activities like industrial practices and intensive agriculture. Mitigating these challenges demands equitable resource allocation, poverty eradication, and sustainable practices (Crippa et al., 2021). By acknowledging these interconnected challenges and committing to multifaceted solutions, global collaboration can eradicate hunger, enhance food security, and ensure equitable nutrition access worldwide (Omuse et al., 2024).

One plausible solution to food insecurity is edible insects. They are presented as sustainable dietary alternative, rich in proteins, essential amino acids, lipids, fiber, and minerals, offering a promising avenue to mitigate the environmental impacts of conventional food production (Ordoñez-Araque et al., 2022; Omuse et al., 2024). The cultivation of edible insects offers a significantly lower environmental footprint compared to traditional livestock farming, particularly as substitutes for fishmeal in aquaculture (Van Huis, 2015). The market for edible insects, valued at \$165 million globally in 2020, is projected to reach \$9.6 billion by 2030, driven by increasing demand in animal feed and recognition of their environmental benefits (Guiné et al., 2021). Despite regulatory and psychological barriers, emerging economies present substantial growth opportunities in this sector, with growing interest even in European markets (Siemianowska et al., 2013). Integration of edible insects into global food systems is critical for sustainability goals, necessitating efforts to overcome acceptance barriers and promote their nutritional value (Van Huis et al., 2022). With over two billion people regularly consuming edible insects, particularly in regions like Southeast Asia, Africa, and South America, their acceptance is widespread despite classification as novel foods in other regions (Rumpold et al., 2013). This dichotomy underscores global initiatives to innovate, promote sustainability, and enhance food security (Rumpold et al., 2013).

To effectively promote edible insects, a comprehensive marketing approach is essential, addressing pricing strategies, distribution channels, and consumer education about nutritional and sustainability benefits (van Huis & Rumpold, 2023; Kauppi et al., 2019). Ensuring food safety, quality control, and personnel training are also crucial for market acceptance and consumer trust (Kauppi et al., 2019). Therefore, this research aims to explore contemporary consumer behavior regarding sustainable dietary options, particularly insect-derived proteins in Thailand. Understanding consumer preferences and

behaviors within the marketing mix context is essential for stakeholders to promote sustainable dietary choices effectively. By embracing a holistic strategy encompassing energy, economic, social, and consumer-centric dimensions, nascent economies can advance toward sustainable prosperity.

## **2. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT**

### **2.1 The interplay relationship between attitude towards sustainability, marketing mix 7Ps, and insect ice cream purchase intentions**

The correlation between the Marketing Mix 7Ps and attitudes toward sustainability in the context of utilizing insects as alternative protein sources, particularly in ice cream, holds significant importance in understanding consumer behavior (Queiroz et al., 2023). Integrating insects sourced from local communities into products like ice cream establishes a sustainable production cycle, thereby imbuing them with positive sustainability attributes that influence consumer attitudes and purchase intentions (Queiroz et al., 2023). Notably, scholarly investigations highlight the diverse benefits of edible insects, including their nutritional richness, efficient feed conversion rates, and reduced environmental impact compared to conventional livestock (Dagevos, 2021). In response to mounting sustainability concerns, consumers are increasingly receptive to insect-based protein alternatives, fostering a growing interest in incorporating insects into various food products (Alhujaili, Nocella & Macready, 2023). Strategic initiatives, such as transparent labeling and emphasizing the sustainability advantages of insect protein, play a crucial role in normalizing insects within food items and enhancing consumer acceptance (Alhujaili, Nocella & Macready, 2023).

#### **2.1.1 Product**

The focus on insect-enriched ice cream was chosen for its innovative nature and emerging relevance in the sustainable food industry. This product serves as a case study to explore consumer attitudes toward sustainability and novel food sources, providing insights that can be applied to other sectors prioritizing sustainability and nutrition. We discuss how these findings can be generalized by comparing insect-enriched ice cream with other sustainable products and highlighting common factors influencing consumer behavior.

Insect-enriched ice cream epitomizes innovation by using alternative protein sources from local communities and farmers, promoting a sustainable production cycle aligned with consumers' preference for environmentally friendly options (Queiroz et al., 2023). Factors such as taste, ingredients, packaging, and nutritional information enhance the product's appeal and foster positive attitudes towards its sustainability and nutritional value (Queiroz et al., 2023).

As such, empirical evidence suggests that attitudes toward sustainability mediate the relationship between the product and consumers' purchase intentions. Research indicates that consumers are more willing to consume insect-based products when informed about their sustainable benefits, regardless of preexisting sustainability concerns (Verneau et al., 2021). This informational intervention enhances the acceptance of insect-

derived foods among both sustainability-conscious individuals and those less inclined towards sustainability considerations. Thus, our first hypothesis is proposed as follows:

**H1:** The attitude towards sustainability mediates the relationship between the product and purchase intention.

### 2.1.2 Price

Price significantly influences consumer attitudes toward insect ice cream. If the price is perceived as too high compared to traditional ice cream, it may deter potential customers (Sforza, 2022). Conversely, competitive pricing that reflects the product's value can foster a positive attitude among consumers. Sustainable pricing, which includes environmental costs, not only supports a sustainable economy but also enhances consumers' positive attitudes toward the product (Lensvelt & Steenbekkers, 2014).

In this sense, sustainability acts as a crucial mediator between pricing and purchase intention for insect ice cream. Consumers are more likely to buy insect ice cream when it aligns with sustainability principles, such as environmental impact, resource efficiency, and ethical production (Safitri, 2018; Teixeira et al., 2023). Various marketing factors, including brand image and fair pricing, also influence purchasing decisions (Pham & Ton, 2023; Safitri, 2018).

Therefore, emphasizing sustainability in production can positively impact consumer perceptions and purchase intentions. Highlighting attributes like environmental consciousness and ethical sourcing helps bridge the gap between price and willingness to buy. Thus, sustainability mediates the relationship between the price of insect ice cream and consumers' purchase intentions. Therefore, the next hypothesis is proposed as follows:

**H2:** The attitude towards sustainability mediates the relationship between the price and purchase intentions

### 2.1.3 Place

In Western societies, the acceptance of insect-based food products is significantly influenced by their availability and visibility. A review by Kröger et al. (2022) indicated that 15.1% of respondents preferred insect-based products where insects were not visibly discernible. The visibility of insects affects consumer acceptance, while the use of familiar species like grasshoppers, mealworms, and crickets enhances it. This underscores the importance of both the availability and familiarity of insect species in these products.

Kröger et al. (2022) also found that urban residents or those in densely populated areas showed greater receptivity to consuming edible insects. Factors like distribution channels, location availability, and proximity impact consumer decisions. Studies by Clarkson, Miroso, and Birch (2018) and Van Thielen et al. (2019) revealed a preference hierarchy, with supermarkets as the primary choice, followed by health food stores, restaurants, and kiosks.

Ensuring insect ice cream's availability in mainstream grocery stores or popular ice cream shops can increase consumer acceptance and familiarity. Convenience and accessibility significantly influence consumer perceptions. Additionally, prioritizing sustainability in distribution channels, such as using eco-friendly e-commerce, reduces

environmental impact and appeals to environmentally conscious consumers. The following hypothesis was formulated as:

**H3:** The attitude towards sustainability mediates the relationship between the place and purchase intentions

#### 2.1.4 Promotion

Tailoring the design and promotion of insect-based food products to align with consumers' needs, emotions, and attitudes is crucial for enhancing acceptance. Promotional efforts should highlight the benefits, safety, and potential risks of these products. Emphasizing the advantages, such as the social and individual benefits of insect protein-enriched ice cream, increases consumer willingness to try these products. Positioning insects as a healthy and sustainable dietary choice also garners positive consumer attention.

In this sense, Clarkson et al. (2018) have confirmed how sustainability is related to price and promotion in the context of New Zealand. They conducted research through focus groups which helped design an ideal insect-based product, envisioning it as a convenient snack that emphasizes health benefits, premium pricing, and sustainable packaging. Van Thielen et al. (2019) suggested that clearly stating the presence of insects on packaging could boost consumers' willingness to pay. Promoting insect-based products through affective messages, which evoke positive emotions about health, may be more effective than cognitive messages citing research on health and environmental benefits.

Therefore, insect protein is a sustainable substitute for conventional proteins like meat and dairy. Promoting insect-based foods, such as ice cream, as solutions to global food shortages and environmental issues has garnered attention. Consumer interest in protein-enriched and functional ice cream products reflects a desire for health and sustainability benefits (Zielińska, Pečová & Pankiewicz, 2023). Teixeira et al. (2023) examined Brazilian consumers' perceptions of insect-enriched ice cream, highlighting the role of perceived healthfulness and sustainability in shaping purchase intentions. Consumers who viewed insect-based ice cream as sustainable were more likely to purchase it. Thus, the fourth hypothesis is formulated around the idea that attitudes toward sustainability mediate the relationship between promotion and purchase intention.

**H4:** The attitude towards sustainability mediates the relationship between the promotion and purchase intention

#### 2.1.5 People

The influence of individuals on consumer perceptions of insect ice cream is significant. Whether employees, influencers, or representatives, their knowledge, enthusiasm, and credibility shape consumer attitudes. Well-trained advocates for insect ice cream can build trust and cultivate positive attitudes, ultimately influencing purchasing decisions (Teixeira et al., 2023).

Providing comprehensive information to consumers about insect-based food increases their willingness to try it and pay a premium price. Information campaigns highlighting the benefits of entomophagy enhance readiness to sample insects. However,

further research is needed to explore the impact of educational sessions, as existing studies show conflicting results based on the type of information provided.

According to the social norms dimension of the planned behavior theory, consumers are influenced by the behavior of others (Ajzen, 2020). If employees endorse insect ice cream as a sustainable option, consumers may follow suit, driven by social norms. Employees knowledgeable and enthusiastic about the sustainability benefits of insect ice cream can effectively communicate these advantages, positively influencing purchase decisions. When consumers perceive employees as credible sources, they are more likely to trust the product's sustainability claims, leading to higher purchase intentions.

**H5:** The attitude towards sustainability mediates the relationship between the people and the purchase intention of insect ice cream.

### 2.1.6 Process

Insect ice cream offers a unique opportunity to integrate sustainability throughout the marketing mix, from development to promotion (Clarkson et al. 2018; Teixeira et al., 2023). Prioritizing sustainable practices in production, including eco-friendly packaging, allows brands to resonate with consumers' increasing environmental concerns. Thus, consumers' attitudes towards sustainability act as a mediator between the production process of insect ice cream, particularly the emphasis on eco-friendly packaging, and their purchase intention. This involves sourcing sustainable ingredients, eco-conscious manufacturing, and adopting environmentally friendly packaging practices (Queiroz et al., 2023). Emphasizing eco-friendly packaging communicates the brand's commitment to environmental sustainability, positively influencing consumers' attitudes. Favorable perceptions of the product as environmentally responsible align with consumers' sustainability values, enhancing their intention to purchase insect ice cream.

In summary, the relationship between the production process of insect ice cream, specifically eco-friendly packaging, and consumers' purchase intention is mediated by their attitudes towards sustainability. The emphasis on sustainable practices encourages positive attitudes towards the product's environmental impact, thereby boosting consumer willingness to buy.

**H6:** The attitude towards sustainability mediates the relationship between the process and the purchase intention of insect ice cream.

### 2.1.7 Physical evidence

Physical evidence in the context of insect ice cream pertains to tangible attributes that customers can perceive, including packaging, branding elements, and overall presentation. These tangible aspects play a crucial role in shaping consumers' perceptions and experiences with the product. Effective packaging design, coherent branding, and appealing presentation contribute to creating a positive impression of the insect ice cream, influencing consumers' purchase decisions and overall satisfaction with the product. Additionally, physical evidence serves as a tangible representation of the product's quality,

value, and adherence to sustainability principles, further influencing consumer attitudes and behaviors towards insect ice cream.

These tangible assets, as outlined by Bitner (1992), encompass various elements such as production spaces, sales spaces, equipment, real estate, and artifacts that serve to influence customers' perceptions of service. Marketing decisions related to processes often revolve around key considerations such as location positioning, spatial arrangement emphasizing functionality and efficiency, signage for brand recognition, interior design including furniture and furnishings, and environmental conditions. These factors collectively contribute to shaping the overall servicescape, significantly impacting both customer and employee experiences within a service environment.

**H7:** The attitude towards sustainability mediates the relationship between the physical and the purchase intention of insect ice cream.

### **2.1.8 The attitude towards sustainability directly affects the purchase intention**

In the past century, human technological and scientific advancements have propelled societies towards prosperity. However, these advancements have also contributed to severe global environmental challenges. Pressures on natural resources have disrupted biogeochemical cycles, resulting in environmental catastrophes worldwide, with climate change being a significant consequence primarily driven by human activities.

Edible insects, such as those rich in protein, vitamins, and amino acids suitable for human consumption, are being increasingly recognized as sustainable alternatives. According to Adegboye et al. (2021), these insects emit fewer greenhouse gases and ammonia compared to traditional livestock, making them environmentally friendly. The Food and Agriculture Organization of the United Nations (FAO) advocates for insects as nutritious "Foods of the Future" (Van Huis, 2016). In Thailand, edible insect powders are produced following strict guidelines like Good Agricultural Practice (GAP) and Good Manufacturing Practice (GMP) set by the Health Information Standards Organization (HISO) (Melgar-Lalanne et al., 2019).

Protim Magket, an artisanal ice cream enriched with peanut-flavored edible insect proteins developed by Tastelab.Co., Ltd., exemplifies this trend. This product utilizes local Thai ingredients and is positioned as a sustainable "Novel Food" of the future (Future Food Apec 2022 – Bangkok, Thailand). Embracing sustainability and innovation is crucial for businesses to attract environmentally conscious consumers and investors, thereby influencing the purchase intention. Companies are increasingly focusing on research and development to create novel products that cater to health-conscious trends, incorporating ingredients like vegetables and fruits while reducing fats and sugars (Kasemchanchoti, 2022). Therefore, the following hypothesis is as follows.

**H8:** The attitude towards sustainability directly affects the purchase intention of insect ice cream.

## **3. METHODOLOGY**

### **3.1 Population determination**

Population determination was crucial in this study, which focused on mixed-population groups residing in Bangkok and its adjacent areas. With a population of approximately 6 million individuals in Bangkok and its vicinity, the sample size was determined using Taro Yamane's method (Yamane, 1973) to ensure a margin of error of no more than 5%. Following this calculation, a sample size of 402 was selected, slightly exceeding the calculated value for enhanced reliability. The sampling method employed was Simple Random Sampling, aiming to ensure diverse representation within the sample group. Through this approach, the study sought to generalize attitudes toward sustainability in ice cream consumption across various demographic segments, thereby bolstering the credibility and applicability of the findings.

**3.2 Questionnaire Creation:** The questionnaire is designed to gather specific quantitative and qualitative data to meet research objectives. It undergoes pilot testing with a small group to identify and resolve any design issues before full implementation.

**3.3 Content Validity:** Ensured through expert evaluation and real-world testing, content validity involves three specialists reviewing the questionnaire for adherence to relevant terminology and clarity. Feedback from the sample group is used to refine the questionnaire, resulting in a reliable tool for data collection and meaningful research conclusions.

**Table 1 The construct reliability and validity**

	<b>Cronbach's Alpha (<math>\alpha</math>)</b>	<b>rho_A</b>	<b>Composite Reliability</b>	<b>Average Variance</b>
<b>Attitude Towards Sustainability</b>	0.919	0.920	0.919	0.740
<b>People</b>	0.901	0.902	0.901	0.821
<b>Physical</b>	0.890	0.891	0.890	0.802
<b>Place</b>	0.843	0.843	0.843	0.728
<b>Price</b>	0.900	0.901	0.900	0.818
<b>Process</b>	0.938	0.939	0.938	0.835
<b>Product</b>	0.867	0.869	0.867	0.766
<b>Promotion</b>	0.895	0.896	0.895	0.811
<b>Purchase Intention</b>	0.953	0.955	0.953	0.836

Table1 presents the reliability and validity measures for each construct in the study. Cronbach's Alpha ( $\alpha$ ) values indicate internal consistency, with all values ranging from 0.843 to 0.953, exceeding the commonly accepted threshold of 0.7. Rho\_A coefficients, another measure of internal consistency, range from 0.843 to 0.955, also demonstrating high reliability. Composite Reliability values further support the reliability of the constructs, ranging from 0.867 to 0.953.

Average Variance Extracted (AVE) values assess convergent validity, indicating the amount of variance captured by the construct relative to measurement error. AVE values



above 0.5 are acceptable, and in this study, they range from 0.728 to 0.836, demonstrating satisfactory convergent validity.

Discriminant validity, crucial in partial least squares structural equation modeling (PLS-SEM), ensures each latent variable is distinct and minimizes multicollinearity. It is evaluated by comparing the correlations between latent variables with the square root of the AVE. Discriminant validity is confirmed when the square root of AVE is greater than these correlations, indicating unique contributions from each variable. Strong discriminant validity enhances SEM reliability. Table 2 provides further insights into the questionnaire's validation process.

**Table 2 Discriminant validity**

	Attitude Towards Sustainability	People	Physical	Place	Price	Process	Product	Promotion	Purchase Intention
Attitude Towards Sustainability	0.86								
People	0.749	0.906							
Physical	0.882	0.901	0.896						
Place	0.761	0.788	0.847	0.853					
Price	0.725	0.682	0.732	0.821	0.905				
Process	0.744	0.835	0.848	0.735	0.664	0.914			
Product	0.734	0.663	0.687	0.79	0.882	0.628	0.875		
Promotion	0.707	0.874	0.869	0.906	0.741	0.803	0.69	0.9	
Purchase Intention	0.797	0.714	0.775	0.771	0.741	0.699	0.763	0.708	0.914

### 3.4 Data Collection and Data Analysis

The research used both primary and secondary data. Primary data was collected via a structured questionnaire distributed online (200 responses) and offline (202 responses) in April 2023. All 402 responses were thoroughly checked for completeness and accuracy, ensuring reliable quantitative analysis. Secondary data included research papers, websites, theses, and publications from national and international agencies, adding context to the findings. Data analysis was conducted using SmartPLS software for partial least squares (PLS) path modeling.

## 4. RESULT

The study first analyzed respondents' characteristics and their ice cream consumption habits. The majority (66.2%) reported consuming ice cream 1-2 times weekly, with 26.9% consuming it 2-5 times, 5.2% 6-8 times, and 1.7% over 10 times. More females (55.5%) than males (44.3%) participated, predominantly aged 16-20 years (38.6%) and 21-25 years (26.9%). Educationally, most held a Bachelor's degree (81.1%), with students comprising the largest group (60.4%), followed by private company employees (18.2%) and business

owners (13.7%). Income-wise, the highest proportion earned between 10,001-20,000 THB monthly (28.6%), followed by below 10,000 THB (37.1%).

Regarding ice cream types, ready-made sticks (45.3%) and Thai-flavored scoops (45.5%) were most consumed, followed by high-quality sticks (28.9%) and yogurt ice cream (30.3%). Acceptable price ranges were below 100 baht for 56.7%, 100-200 baht for 38.5%, and higher for fewer respondents. Reasons for purchase included enjoyment (65.4%) and exploration of new foods (20.6%). Main purchase channels were convenience stores (44%), ice cream parlors (42.8%), fairs (8.5%), and online (4.7%).

**Table 3 Partial least squares result**

Paths	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T-Statistics (IO/STDEVI)	P values
Product > Attitude towards sustainability > Purchase intention	0.151	0.151	0.051	2.992	0.003**
Price > Attitude towards sustainability > Purchase intention	0.076	0.073	0.048	1.592	0.112
Place > Attitude towards sustainability > Purchase intention	0.087	0.09	0.055	1.592	0.012*
Promotion > Attitude towards sustainability > Purchase intention	-0.087	-0.086	0.062	1.396	0.163
People > Attitude towards sustainability > Purchase intention	0.072	0.064	0.059	1.222	0.222
Process > Attitude towards sustainability > Purchase intention	0.143	0.147	0.051	2.799	0.005**
Physical > Attitude towards sustainability > Purchase intention	0.249	0.252	0.053	4.745	0.000***
Attitude towards sustainability > Purchase intention	0.747	0.747	0.032	23.652	0.000***

Note: \* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$ .

Table 3 presents the results of partial least squares structural equation modeling (PLS-SEM), revealing insights into consumers' attitudes towards sustainability and their intention to purchase insect ice cream as follows;

H1: Supported (\*\* $p < 0.01$ , Coef = 0.151, t-value = 2.992), indicating that a positive attitude towards sustainability mediates the relationship between product characteristics and purchase intention.

H2: Not supported (n.s., Coef = 0.076, t-value = 1.592), suggesting reasonable prices do not significantly impact purchase intentions.

H3: Not supported (\* $p < 0.05$ , Coef = -0.087, t-value = 1.396), indicating promotional activities do not significantly affect purchase intentions.

H4: Not supported (n.s., Coef = 0.087, t-value = 1.592), showing that attitudes towards sustainability do not significantly mediate the relationship between promotion and purchase intention.

H5: Not supported (n.s., Coef = 0.072, t-value = 1.222), suggesting online and offline assistance do not significantly influence consumer behavior during the research phase.

H6: Supported (\*\*p < 0.01, Coef = 0.143, t-value = 2.799), showing that attitudes towards sustainability mediate the relationship between process and purchase intention.

H7: Supported (\*\*p < 0.001, Coef = 0.249, t-value = 4.745), indicating that sustainability attitudes mediate the relationship between physical evidence and purchase intention.

H8: Supported (\*\*p < 0.001, Coef = 0.747, t-value = 23.652), confirming a significant relationship between sustainability attitudes and purchase intention.

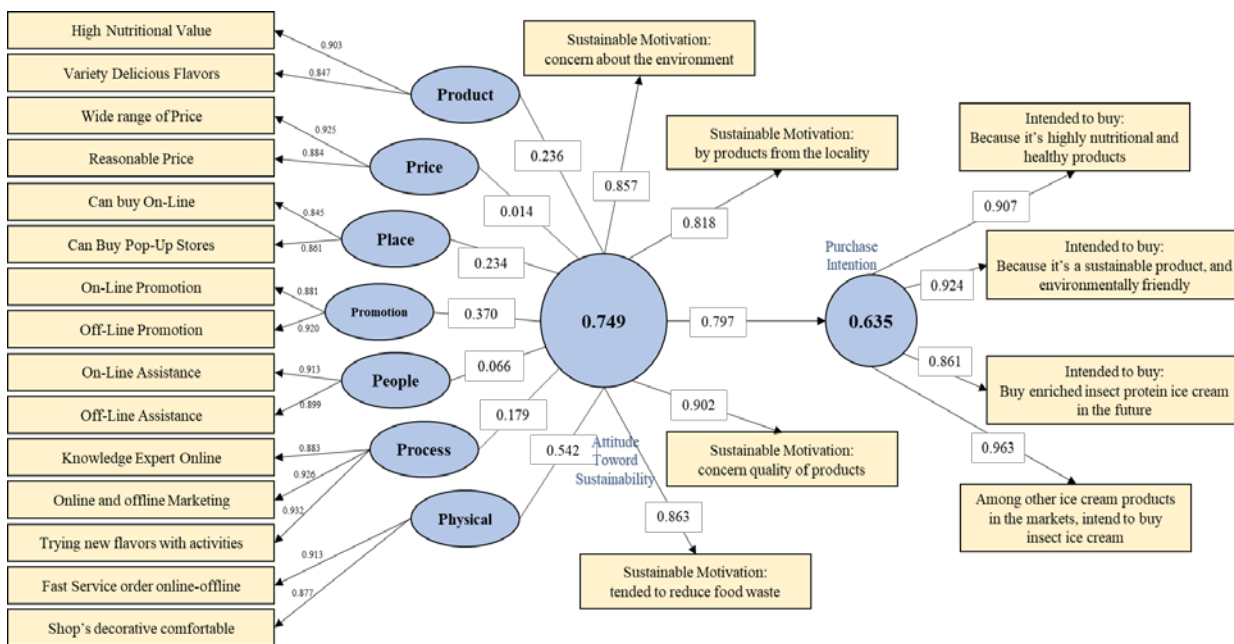


Figure 1. Research results.

### 5. DISCUSSION

It is worth noting that adjusting the marketing mix to incorporate the 7Ps framework enables big companies offering services sold by product manufacturers to address the unique characteristics and challenges of service-based offerings comprehensively. By considering each element within the framework, companies can develop tailored strategies to effectively market their services, meet customer needs, and maintain a competitive edge in the market (Riswanto & Wicaksono, 2021). In the same vein, this study explores the discourse surrounding edible insects in the context of insect-based ice cream, highlighting innovation and sustainability in the food industry. Foundational studies by Van Huis et al. (2013) and Omuse et al. (2024) underscore the potential of edible insects for enhancing food security and sustainability. Further insights from Van Thielen et al. (2019) and Verneau et al. (2021) delve into evolving consumer attitudes toward insect-based foods.

In this sense, understanding the nutritional composition, safety considerations, and processing methods is critical in developing insect-infused ice cream (Ordoñez-Araque et

al., 2022; Queiroz et al., 2023; Rumpold & Schlüter, 2013). Factors such as taste, texture, and nutritional profiles are pivotal in consumer acceptance. Insect-based ice cream also aligns with discussions on novel foods and their role in environmental sustainability (Sforza, 2022; Van Huis et al., 2022). However, challenges persist in consumer acceptance, necessitating effective communication and education strategies (Royer & Wharton, 2023; van Huis & Rumpold, 2023). Also, mixed-methods studies provide insights into consumer preferences and behaviors regarding insect-based ice cream, combining quantitative data with qualitative insights (Reverberi, 2010; Teixeira et al., 2023). Research on sensory attributes and functional properties of insect-derived ingredients contributes to innovative ice cream formulations (Zielińska et al., 2023; Siemianowska et al., 2013).

In summary, several studies underscore the multidimensional discourse on edible insects in ice cream production. By addressing diverse facets, researchers aim to unlock the potential of insect-based ice cream as a sustainable and nutritious food option, advancing resilient and eco-friendly food systems. Finally, our findings highlight the importance of sustainable attitudes in shaping consumer behavior towards insect ice cream. Positive sustainability attitudes significantly influence purchase intentions, emphasizing the potential of insect protein as a future food source. The analysis suggests that while price and promotion may not strongly impact purchase intentions, the perceived sustainability of the product, its process, and its physical evidence play crucial roles. Effective marketing strategies should thus focus on emphasizing the nutritional and sustainable benefits of insect-enriched ice cream.

## **6. LIMITATIONS AND FUTURE STUDIES**

Addressing the study's limitations and delineating avenues for further investigation reveal several pivotal directions for scholarly inquiry. Primarily, augmenting the sample size and diversity promises to enhance the external validity of research findings. Enlarging and diversifying sample compositions can bolster researchers' ability to extrapolate results to broader populations. Therefore, future research should conduct similar studies on a range of products within the same industry to validate and compare our findings. This would help in identifying patterns and drawing broader conclusions. Additionally, future studies should extend the research framework to other industries to assess the broader applicability and adaptability of our results. Longitudinal studies reveal temporal patterns and evolutions, providing deeper insights into the subject matter. Combining quantitative methodologies with qualitative techniques like focus groups and interviews offers richer perspectives on participants' motivations and experiences. Independent replication studies using diverse samples and methodologies validate findings and enhance confidence in research outcomes. Cross-cultural investigations that address cultural perspectives and confounding variables promise a comprehensive understanding of observed phenomena. Employing a mixed-methods research design integrates quantitative and qualitative approaches to furnish nuanced insights. Embracing these diverse research trajectories allows scholars to refine their inquiries and contribute substantially to the field.

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