INTERNATIONAL JOURNAL OF AUTOMOTIVE AND MECHANICAL ENGINEERING
ISSN: 2229-8649 e-ISSN: 2180-1606
VOLUME 22, ISSUE 2, 2025, 12344 - 12358
DOI: https://doi.org/10.15282/ijame.22.2.2025.8.0945

RESEARCH ARTICLE

# Analyzing the Impact of Ergonomics, Biodegradability, and Material Science on Consumer Behavior in Food Packaging

**N. Nelfiyanti[1]*, E. Ernyasih[2], Ratri Ariatmi Nugrahani[3], Nik Mohamed[4], Andry Setiawan[5], Muhammad Aditia Al-Hafidz[1], D. Daruki[6]**

[1]Department of Industrial Engineering, Faculty of Engineering, Universitas Muhammadiyah Jakarta, 10510 Jakarta, Indonesia
[2]Faculty of Public Health, Universitas Muhammadiyah Jakarta, 10510 Jakarta, Indonesia
[3]Department of Chemical Engineering, Faculty of Engineering, Universitas Muhammadiyah Jakarta, 10510 Jakarta, Indonesia
[4]Faculty of Manufacturing and Mechatronic Engineering Technology, Universiti Malaysia Pahang Al-Sultan Abdullah, 26600 Pekan, Pahang, Malaysia
[5]Department of Industrial Engineering, Faculty of Engineering, Institut Sains dan Teknologi Nasional, 12640 Jakarta, Indonesia
[6]Department of Industrial Engineering, Faculty of Engineering, Universitas Mercu Buana, Jakarta, Indonesia

**ABSTRACT –** Food packaging performs the important functions of protecting the product and influencing consumer behavior while being convenient and sustainable. There have been few studies that thoroughly debated the role of ergonomics, biodegradability, and material science in shaping consumer behavior toward buying behavior. The problem has come into the spotlight as consumers increasingly look for not only functional, but sustainable and convenient packaging. Thus, in this research, the effects of ergonomic design, biodegradability, chemical and mechanical physics on organizational purchase intention will be investigated. Partial Least Squares Structural Equation Modeling was used to analyze the data from 121 respondents. Analysis Period Initial Rows The four variables explained 62.8% of the variance in purchase intention ($R^2 = 0.628$), the strongest variable was biodegradability ($F^2 = 0.140$), followed by ergonomics ($F^2 = 0.115$)). The fields of physical mechanics and physical chemistry were significantly relevant to this study, as per its study findings. The study results made certain that all presumptions were accurate, three-polite, eccellenze of expertise in sustainable, easy-to-use packaging, form consumer choice to purchase. Thus, out of these conclusions I realized that packaging design is not just being efficient in accomplishing the economic behind packaging, it has to accomplish the genuine human needs of consumers — for practicality and convenience. It indicates that actual innovation in packaging does not emanate from merely trend chasing or where the winds blow, it comes from a good grasp of what the marketplace is actually looking for.

**ARTICLE HISTORY**
Received : 06th Nov. 2024
Revised : 05th Mar. 2025
Accepted : 08th Apr. 2025
Published : 01st June 2025

**KEYWORDS**
*Biodegradability*
*Ergonomic design*
*Food packaging*
*Mechanical physical*
*Physical chemistry*
*SmartPLS*

## 1. INTRODUCTION

The food industry's explosive growth in today's globalized world highlights the growing demand for goods that put consumer safety, environmental responsibility, and sustainable development first. Food packaging is crucial for both protecting the contents and serving as a clever marketing tool that draws in customers, communicates important product details, and guarantees safety and halal compliance [1]–[4]. Consumer expectations have changed over the last few decades, favoring packaging that is both practical and consistent with principles like environmental responsibility and sustainability. As a result, there has been a growing emphasis on packaging innovations that combine biodegradability, ergonomic designs, sustainable materials, and structural elements to improve usability and environmental impact [5]. Consumers' and companies' greater awareness of environmental concerns, such as the urgency of tackling global challenges like plastic waste, have fostered a demand for more sustainable packaging solutions. One feasible solution for successfully addressing these issues is sustainable packaging, which includes biodegradable packs and ergonomic designs that target the reduction of their impact on the environment while maximizing user satisfaction. Biodegradable materials break down naturally in the environment, allowing for their eco-friendly disposal and reducing waste build-up. Handy designs—those that seek to provide a size or shape that makes packaging easy to open, reseal, or store [6], [7] — illustrate how consumers demand products that can be conveniently used day-to-day, but not at the expense of environmental sustainability, should be accommodated in packaging design.

Recent studies highlight the importance of sustainable packaging in influencing consumer behavior. According to research, consumers frequently evaluate packaging based more on aesthetic and emotional impressions than on scientific data, which can result in misunderstandings about the true environmental advantages of particular materials [8]. Ergonomics is the science that adjusts product design to comfort for the user [9]–[12]. This discrepancy between reality and perception emphasizes the need for more investigation into the ways in which packaging that is ergonomic, biodegradable, and scientifically optimized can affect consumer choices. The field of ergonomics in food packaging has become popular because companies want to improve how users feel about their products and how easy these products are to use. By following user-centered design principles, ergonomic packaging simplifies product handling and opening while

***CORRESPONDING AUTHOR | N. Nelfiyanti** | ✉ nelfiyanti@umj.ac.id

enabling efficient resealing and storage, which leads to a better consumer experience [13]. Ergonomic packaging designed with care not only improves product accessibility but also strengthens brand connections, which promotes repeat buying behavior [6], [14]. Beyond functionality, ergonomic packaging boosts product appeal, catering to consumers who increasingly expect ease of use and storage, thus enhancing their overall experience and satisfaction [15]. As consumer awareness of sustainability grows, companies that integrate ergonomic and eco-friendly designs into their packaging strategies stand to gain a competitive advantage in the marketplace [16]. Biodegradability has also been a priority with more ecologically conscious consumers than ever. As plastic trash fills landfills and the environment, biodegradable packaging is an environmentally friendly option that is biodegradable by nature and does not leave much environmental impact. Environmentally conscious consumers appreciate this packaging. For companies, employing biodegradable products shows the company's commitment towards sustainability and appeals to an eco-sensitive clientele [17]. Market studies prove that consumers welcome biodegradable products but don't want to pay extra for green packaging [18]. This requires affordable innovation in addition to enlightening the consumer in order to prompt the use of green packaging.

As important as consumer demand is the physics, chemistry, and mechanical physics of the packaging, both are important to ensuring product quality and safety during its passage along the supply chain. The physics chemistry of the packaging—gas and moisture permeation and reaction with foodstuffs—is central to shelf life and preservation of the sensory characteristics of food. Permeability-controlled packaging can prolong the shelf life of products through the regulation of moisture content and the protection of merchandise from external conditions, thus preserving taste, texture, and appearance. This is critical in sensitive items whose quality relies on uniformity of storage conditions [17]. Furthermore, choosing materials that react with food products in a way that is appropriate avoids unintended chemical reactions that might otherwise affect safety or taste, particularly for delicate products like dairy products [18], [19]. The mechanical physics of packaging, such as flexibility, tensile strength, and resistance to tearing, are also essential for preserving structural integrity during storage and transit. Products are kept safe and intact by robust packaging that can tolerate the physical strains of handling and distribution, which lowers waste and spoiling. Resilient packaging is crucial for reducing the environmental impact of food waste and ensuring customer satisfaction. Food packaging can better preserve quality, freshness, and safety as goods move through the supply chain by striking a balance between mechanical and physics [20].

Notwithstanding improvements in food packaging technology, there is still a major gap in knowledge on how consumer interest is affected by the cumulative effects of ergonomic design, biodegradability, and chemical and mechanical physics of packaging. While existing studies have investigated these variables separately, none have examined their interrelated effects in a thorough manner. Developing more creative, practical, and environmentally friendly packaging options that satisfy changing customer tastes depends on one's knowledge of this link. Recent studies also reveal that the integration of advanced technology—such as nanotechnology and biobased coatings—can improve the protective qualities of biodegradable materials without sacrificing their sustainability [20]. Exploring these advances in combination with ergonomic and environmentally friendly packaging design provides a valuable opportunity for further investigation. To address this research gap, this study aimed to analyze the influence of ergonomic design, biodegradability, and materials science—specifically the chemical and mechanical physics of food packaging—on consumer interest. By understanding these interrelated factors, this research aims to provide insights that can guide the development of innovative, functional and sustainable packaging solutions that are aligned with consumer needs and industry standards. To achieve this goal, this study will answer the following research questions:

a. How does ergonomic packaging design influence consumer perception, usability and purchase decisions?
b. How does the utilization of biodegradable materials influence market preferences and drive consumer adoption of sustainable packaging alternatives?
c. How do physical chemistry and mechanical physics properties of packaging contribute to consumer confidence, product protection and overall satisfaction?

By addressing this research question, this research hopes to synthesize the three critical facets of environmental sustainability, product performance, and consumer expectations. This synthesis is expected to stimulate innovation in food packaging that is not just sustainable but also of acceptable performance and market appeal. The findings of the research will provide strategic guidance to industry players and regulators in developing policies or products that balance sustainable practices with real consumer requirements—such as packaging that is easy to use, appealing, and capable of maintaining optimal food quality.

## 2. METHODS AND MATERIAL

This study used a quantitative approach to assess attitudes, opinions, behaviors, and several variables within a structured framework, allowing for general insights from a broader sample population [21]. This method is designed as a causal investigation because it focuses on analyzing how certain independent variables directly affect related dependent variables. The main goal is to look for clear cause-and-effect relationships, not just correlations so that the results of the investigation are more valid and in-depth. Therefore, this approach not only identifies patterns but also explains the mechanisms of influence between the determinants, confirming the trustworthiness of the findings for practical applications [22]. The study employs the SmartPLS 3.0 software and utilizes the PLS-SEM approach, which involves two main stages: analyzing the measurement model (outer model) and examining the structural model (inner model) [23].

### 2.1 Research Variable

Research variables refer to attributes or characteristics that can be measured from individuals or organizations that are observed, which can differ between the subjects studied [23]. In this research, these variables have been selected to evaluate consumer responses to various aspects of food packaging, especially in the context of packaged ready-to-eat foods (Table 1). Attributes of questions that can be asked to consumers of packaged ready meals. Each attribute has different question attributes with varied questions in the hope of knowing the influence of these variables on consumer buying interest. The following describes the research variables used in this research:

i) Biodegradability: Biodegradability is an important environmental attribute that describes a product's capacity to decompose naturally through the action of microorganisms in a disposal environment, such as soil or water. This process includes stages such as fragmentation, where the material is broken down into smaller parts, and mineralization, where these fragments are further reduced to natural elements [20]. Biodegradability involves the oxidation of organic compounds by microbial organisms, which can occur in a variety of ecosystems, thereby promoting effective waste reduction and environmental sustainability [17]. Biodegradable packaging is an extremely important and efficient part of minimizing adverse environmental impacts and may increase the attractiveness of sustainable economic behavior in the future. Public opinion concerning biodegradable packaging is very important, as biodegradable products minimize adverse environmental impacts and may increase the attractiveness of sustainable economic behavior. In this research, it is used as a variable to estimate consumer demand for foods packed in materials that are biodegradable without having a negative impact on soil or aquatic organisms, reflecting increasing consumer interest in packaging that is compatible with environmental stewardship [24]. These variables attempt to reflect people's perceptions of food packaging that can dissolve and biodegrade in the environment without any harm to the soil, with the added benefit of avoiding harmful effects related to negative wastes and sustainable economic development.

ii) Ergonomic Design: Ergonomic design is a product manufacturing methodology wherein convenience, comfort, and practicability are given importance to maximize user experience and satisfaction with minimal user effort, taking into consideration usability, visual beauty, and social image [25]. Ergonomic aspects of packaging involve ease-of-use mechanisms that include intuitive opening, ease of closure, and aesthetics to attract consumer attention[6]. Perceptions of the convenience and usability of food packaging by users drive purchasing decisions, with packaging that is easy to grip, open and close able to create a positive brand image [12]. Generally, convenience- and ease-of-use-oriented designs can enhance satisfaction and build brand image.

iii) Physics Chemistry: Physics chemistry is a science that makes use of chemistry and physics in order to study phenomena in the real world. In the packaging industry, chemical physics is used to determine to what degree the packaging can protect the products from external factors such as gases, moisture, and temperature [26]. For example, packaging's ability to control moisture content or prevent chemical reactions between foods and packages helps to maintain product freshness and safety [3]. This research aims to explore consumers' perceptions of these factors, e.g., how changes in packaging shape, water absorption rates, or temperature fluctuations can affect the quality of the food inside. By understanding consumers' taste in packaging that keeps items fresh without making them spoil, businesses can create packaging solutions that serve their purpose while also being attractive [14].

iv) Mechanical physics: Not only does the toughness of food packaging depend on its design, but also on the physical properties of the materials. Mechanical physics studies properties such as tensile strength, hardness, and stiffness, which all play a major role in maintaining the integrity of the packaging at the manufacturing, transport, and use phases by consumers [27]. For example, tear-resistant and resistant packaging aids in ensuring that the product is not deformed or damaged and retains its shape thus can provide an improved consumer experience [28]. Packaging that is resistant to damage during storage and handling not only assists in saving waste but also renders the product more attractive to consumers. The aim of this research was to identify the way in which consumers judged mechanical package quality and to quantify the extent to which these variables influenced the purchasing decision [28]. These variables were utilized to assess consumer sentiment towards durability, resistance to rip, and overall resistance to damage.

All these variables are specifically selected to obtain in-depth information about consumer interest in sustainable, functional, and durable packaging. By analyzing biodegradability, ergonomic design, physics chemistry, and mechanical physics from the perspective of consumer attitudes, this research can provide beneficial information for food and packaging firms that want to create innovative, sustainable, and consumer-driven packaging systems.

Table 1. Research variables

| Variable | Attributes | Reference |
|---|---|---|
| Biodegradability (X1) | Does the current product packaging not harm the environment? | [29] |
| | Is the current product packaging recyclable? | [29], [30] |
| | Is the current product packaging biodegradable? | [30], [31] |
| Ergonomic Design (X2) | Does the product packaging hold up well now? | [32] |
| | Is the shape of the current packaging good? | [32]-[35] |
| | Does the product packaging design have a large capacity? | [34], [35] |
| | Is the color/design of the product packaging attractive? | [32], [33], [35] |
| Physics chemistry (X3) | Does the current product packaging have water resistance? | [31], [34] |
| | Product packaging has resistance to food temperature? (Hot or cold food temperature) | [31], [36] |
| | Does the current packaging affect the health and quality of food? (Health in consuming food) | [2] |
| | Does the current packaging affect taste, aroma or appearance? | [37] |
| Mechanical physics (X4) | Does the current packaging have good durability? (Not easily dented, torn) | [31], [35], [38] |
| | Current packaging easy to pull or stretch? | [31] |
| | Whether product packaging that has an easy food packaging process | [2] |
| Consumer Purchase Interest (Y) | Will customers purchase and pay more for goods packaged in an environmentally responsible manner? | [39] |
| | How significant is eco-friendly packaging to buyers while making purchases? | [39] |
| | Does the color and type of packaging affect interest in buying products? | [40] |
| | Does consumer interest in practical and easy-to-use packaging affect interest in buying products? | [37] |
| | Is consumer interest in packaging that maintains freshness and food products more important than recycled packaging? | [41] |

### 2.2 Development of the Research Model and Hypothesis

Figure 1 is a flowchart that illustrates variables studied in the current study; this study explores the effect of food packaging on consumer purchasing intention. This study has two variables, independent and dependent variables; the independent variables in this study are biodegradability (X1), which captures consumers' perceptions of how far packaging can naturally decompose and its impact on the environment. Ergonomic design (X2) captures consumers' perceptions of convenience and comfort in packaging use, e.g., ease of opening, physics chemistry (X3) captures consumers' perceptions of the stability of packaging in protecting the product from external conditions such as moisture, heat and chemical reactions that can affect the quality of the product inside. Physical Strength Physics (X4) measures consumer attitudes toward the physical strength aspects of the packaging (pressure, impact, and cracking resistance) and its durability.

The dependent variable in this study attempts to measure the degree to which packaging variables influence consumers' purchasing decisions for such food products. Consumer buying interest can be measured by variables such as buying desire, product preference, and willingness to pay (Y), specifically the environmental impact and food contamination risk on the health of the human body. As stipulated in the conceptual research model, this research model assumes that each independent variable (X1, X2, X3, X4) has an influence on the dependent variable (Y), thus, the four early hypotheses formulated to guide the research.

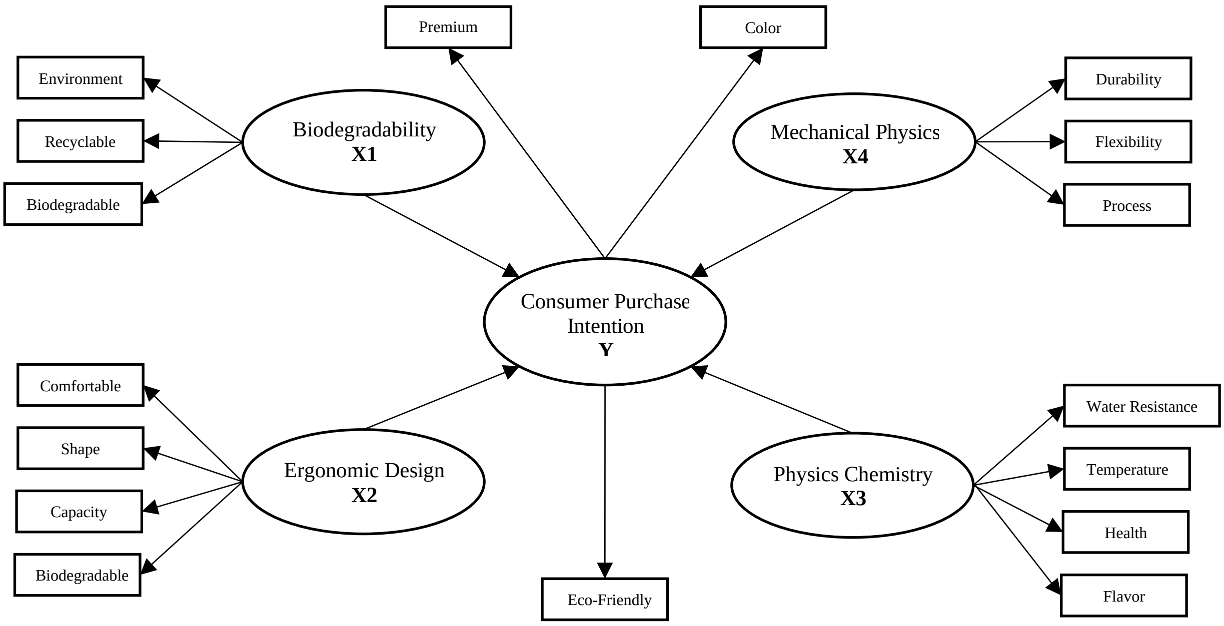


Figure 1. Research conceptual model

H1; Biodegradability (B) has a significant positive influence on consumer purchase intention (CPI).
This hypothesis states that consumer perception of environmentally friendly packaging, which can be naturally decomposed, will significantly increase purchase intention. This is because consumers who are concerned about the environment tend to support products with sustainable packaging.

H2; Ergonomic Design (ED) significantly influences consumer purchase intention (CPI).
This hypothesis suggests that packaging designed for ease of use and user convenience has a positive impact on purchase decisions. Practical and user-friendly packaging not only increases customer satisfaction but also makes them more engaged with the product. The hypothesis suggests that packaging designed for ease of use and consumer comfort positively impacts purchase decisions, as practical and user-friendly packaging often improves consumer satisfaction and engagement.

H3; Chemical Physics (PC) has a significant impact on consumer purchase intention (CPI).
This hypothesis suggests that packaging with the ability to protect the product from environmental factors such as moisture and heat will have a positive impact on consumer purchase intention. Such packaging ensures the safety and quality of the product for a longer period of time, thus providing added value to the consumer.

H4; Mechanical Physics (MP) has a significant influence on consumer purchase intention (CPI).
This hypothesis states that the durability and resistance of packaging to physical stress are important factors in consumer decision-making. Strong packaging not only protects the product from damage but also builds consumer confidence because the risk of damage during distribution or storage is minimized.

The above hypotheses serve as the basis for investigating the connections between package features and consumer purchase intent, offering a methodical way to examine how certain food packaging features can improve customer interaction and influence buying decisions. In order to help the food and packaging sectors create packaging solutions that meet customer expectations and are in line with environmental and functional values, this research attempts to provide insightful information.

### 2.3 Data Collection and Analysis Technique

#### 2.3.1 Data Collection

The primary data collected in this study were obtained directly from the respondents, both consumers and owners of Micro, Small, and Medium Enterprises (MSMEs), and information about how they view and purchase was gathered. The respondents provided answers through structured instruments such as Google Forms, which were both sent directly and through the internet for convenient access and participation. This study utilized a sample size of 121 respondents, which was strategically determined to provide statistical significance for path coefficients of 0.21 to 0.30, as research demonstrates that significant outcomes ($p < 0.05$) often can be had with sample sizes of approximately 69 to 100 for the case of moderate effect sizes, although larger sample sizes are more commonly preferred in order to be able to generalize more strongly [42]. Tables 2-5 summarizes respondent characteristics obtained. Based on Tables 2-5, it is seen that the criteria for determining the respondents are gender, age, education, and user characteristics. In connection with these determining criteria, the number of respondents who completed the questionnaire is 121 persons. The information will thus be used to reach the expected targets.

Table 2. Characteristics of respondents based on gender

| Gender | Number of respondents | % |
|---|---|---|
| Male | 56 | 46% |
| Female | 65 | 54% |
| Total | 121 | 100% |

Table 3. Characteristics by age of respondents

| Age (years) | Number of respondents | % |
|---|---|---|
| 5 - 11 | 0 | 0% |
| 12 - 25 | 46 | 38% |
| 26 - 45 | 67 | 55% |
| 46 - 65 | 8 | 7% |
| Total | 121 | 100% |

Table 4. Characteristics by education

| Education | Number of respondents | % |
|---|---|---|
| Junior high school | 1 | 1% |
| Senior high school | 27 | 22% |
| Advocacy | 9 | 7% |
| Bachelor's degree | 78 | 64% |
| Master | 6 | 5% |
| Total | 121 | 100% |

Table 5. Characteristics of Users

| Respondent Criteria | Number of respondents | % |
|---|---|---|
| Packaging users (consumers) | 117 | 97% |
| Food entrepreneurs (MSMEs, etc.) | 4 | 3% |
| Total | 121 | 100% |

### 2.3.2 Analysis Technique

The methodology employed in the collection of research data is of paramount importance. The manner in which data is obtained from its respective sources is of particular significance. In this particular study, the Partial Least Square (PLS) approach was utilized for data analysis. A notable advantage of Partial Least Square Analysis (PLS) is its capacity to address a wide range of intricate and multifaceted models, encompassing both endogenous and exogenous variables and a substantial number of available indicators [43]. The data analysis in this research utilizes the Smart PLS software program. The following steps must be taken during the testing process with SmartPLS:

i) Outer model testing, a crucial step in research methodology, elucidates the direct relationship between each indicator block and the latent variable. This testing is instrumental in validating the measurement model. The stages of outer model testing, as outlined by [43], are as follows:
   a) Convergent validity measures the degree to which a set of indicators represents a single underlying construct. For this purpose, a loading factor threshold of 0.7 or above is commonly used as a criterion, signifying that the indicator is sufficiently related to its respective latent construct and, thus, reliable in measuring the construct. Convergent validity values above 0.7 affirm that the measuring instrument aligns well with similar measures [44], thereby affirming the instrument's accuracy.
   b) Discriminant validity test: discriminant validity attempts to validate that each latent variable is unique and not closely related to other variables. A discriminant validity test is significant in ensuring that constructs reflect different things and do not overlap conceptually. A valid indicator is a factor that presents the largest loading factor for the intended construct compared to other constructs. This disparity is typically assessed via the Fornell-Larcker criterion or cross-loading [45].

c) Reliability test: Reliability testing ensures the stability of the instrument employed in data collection, i.e., that responses do not vary with time and lack random error. For the study, Cronbach's Alpha is used to quantify reliability, and 0.7 is used as the threshold, ensuring there is enough reliability. This reliability measure assumes a confidence level of 95% with a 5% margin of error, which is the potential effect of various internal and external influences on respondent answers. A Cronbach's Alpha of more than 0.7 is taken to be evidence that the instrument reliably measures the constructs it is intended to measure [23], [46].

ii) Structural Model Testing (Inner Model): The inner model, or structural model, examines the relationships between latent constructs based on the theoretical model. The model testing here strives to confirm the presumed relationships between exogenous (independent) and endogenous (dependent) variables in the research mode [45]. The structural model test endeavors to look at the correlation between the measured constructs and the t-test of the partial least square itself. The following inner model testing is carried out:

a) Determinant Coefficient (R2): The ability of exogenous factors to explain endogenous variables is determined by the coefficient of determination. The better the model will be, the higher the coefficient of determination. The R-Square value is checked through the PLS model using three criteria, which are as follows [47] :

i. R-Square value between 0.25 - 0.50 is considered weak

ii. R-Square value between 0.51 - 0.75 is considered moderate

iii. R-Square value > 0.75 is declared substantial

b) F-Square (F2), (F2) is a measure used in assessing the relative impact of an influencing variable (exogenous) on the influenced variable (endogenous). The following are the F-Square criteria [43]:

i. The F-Square value of 0.02 states the small effect of exogenous variables on endogenous ones.

ii. The F-Square value of 0.15 states that the medium effect of the exogenous variable on the endogenous one.

iii. The F-Square value of 0.35 states the large effect of exogenous variables on the endogenous.

c) Path Coefficient (Hypothesis Test t): The value of path coefficients is standardized from -1 to +1, with a coefficient close to +1, which is a positive relationship and a strong coefficient, while the value of path coefficients close to -1 indicates a strong negative relationship [43]. Following hypothesis testing criteria:

i. T-value > 1.96 with an alpha value of 5%, then the hypothesis is accepted, and the influence of the variable is declared significant.

ii. T-Value < 1.96 with an alpha value of 5%, then the hypothesis is rejected, and the influence of the variable is stated to have no significant effect.

According to the preceding description, Figure 2 shows the flow chart of this study in achieving the anticipated goals:

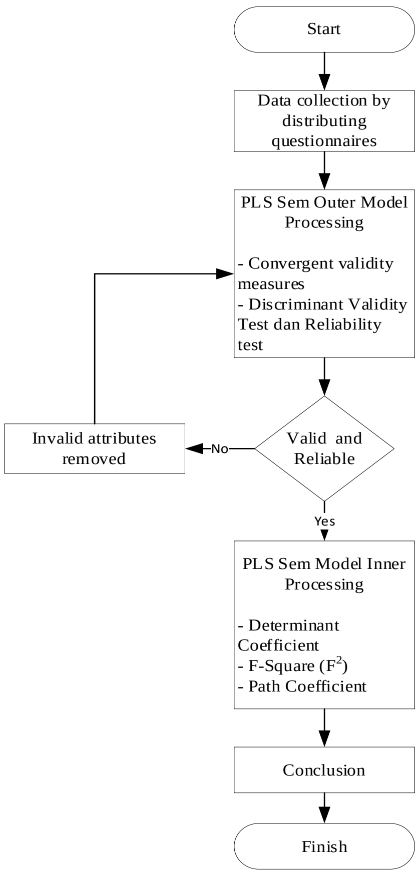


Figure 2. Flowchart of research

# 3. RESULTS AND DISCUSSION

## 3.1 Outer Model Analysis of PLS-SEM

The analysis of the outer model in Partial Least Square Structural Equation Modeling (PLS-SEM) aims to validate the measurement model, ensuring that each indicator accurately measures the intended latent construct. As depicted in Figure 3**,** each attribute has a convergent validity value > 0.7, which means that all of them are declared valid for details of the value of convergent validity for each attribute of each variable. The following are the outcomes of the testing of the outer model:

### 3.1.2 Convergent validity

Outer loading values are used as evaluation criteria in convergent validity testing. Table 6 Confirm that the loading factor values for all indicators across each variable exceed the 0.7 threshold, an ideal value for establishing convergent validity. Convergent validity, a critical aspect of measurement reliability, measures the correlation strength between construct items, as indicated by standardized factor loadings. By meeting or surpassing the 0.7 threshold, each indicator proves its reliability in consistently measuring its associated construct. The convergent validity test proves that indicators measuring every construct are strongly correlated and share a common underlying factor, enhancing the predictive capability of the model. The results, as shown in Figure 3 on SmartPLS3, prove that each attribute for every variable has a substantial contribution to the measurement model. The value of the factor loadings proves to be acceptable, with high correlations between indicators and their respective constructs, validating the selection of these indicators as accurate measurements of each latent variable.

Table 6. Convergent validity test results

| Variable | Indicator | Loading Factor | Note |
|---|---|---|---|
| Consumer Purchase Interest | CPI1 | 0.812 | Valid |
| | CPI2 | 0.893 | Valid |
| | CPI3 | 0.848 | Valid |
| | CPI4 | 0.859 | Valid |
| | CPI5 | 0.778 | Valid |
| Biodegradability | B1 | 0.798 | Valid |
| | B2 | 0.841 | Valid |
| | B3 | 0.794 | Valid |
| Ergonomics Design | ED1 | 0.844 | Valid |
| | ED2 | 0.860 | Valid |
| | ED3 | 0.831 | Valid |
| | ED4 | 0.873 | Valid |

| Variable | Indicator | Loading Factor | Note |
|---|---|---|---|
| Physics Chemistry | PC1 | 0.811 | Valid |
| | PC2 | 0.865 | Valid |
| | PC3 | 0.788 | Valid |
| | PC4 | 0.820 | Valid |
| Mechanical Physics | MP1 | 0.782 | Valid |
| | MP2 | 0.779 | Valid |
| | MP3 | 0.880 | Valid |

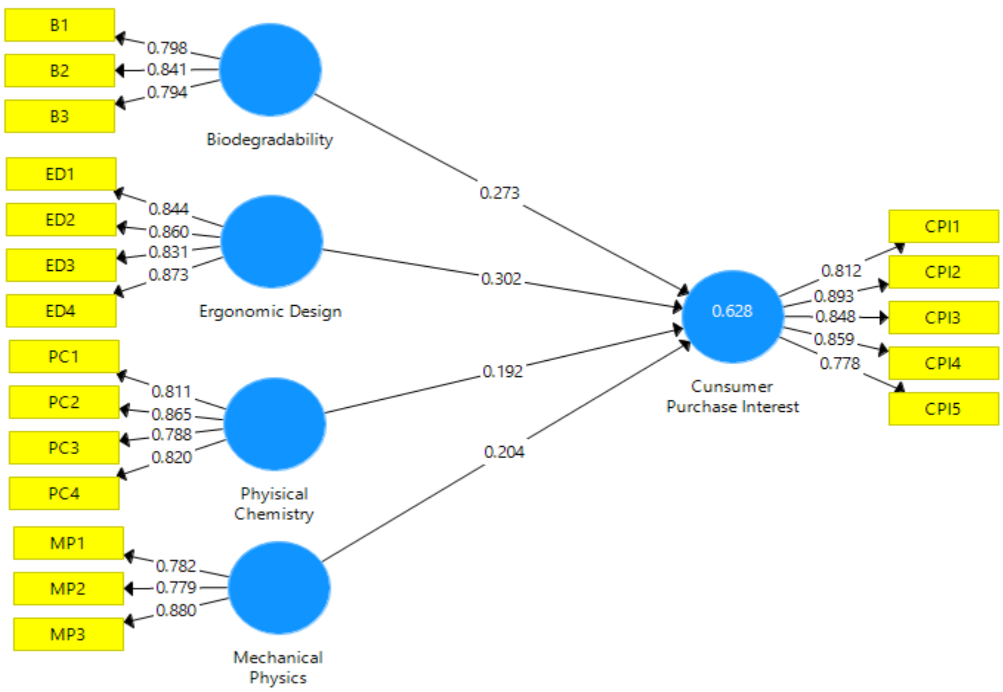


Figure 3. Model outer loading test results

### 3.1.3 Discriminant validity

Discriminant validity establishes the extent to which every construct varies relative to the remaining constructs in the model, i.e., it measures a separate concept without intersecting. Discriminant validity for this study employs cross-loading as well as HTMT to evaluate discriminant validity, which actually confirms that a given construct will be more closely related to its own indicators and less so to other constructs' indicators. A cross-loading measure is applied to compare each indicator's correlation with its given construct to correlations with other constructs. An indicator will be stated to possess sufficient discriminant validity if it loads more with its own construct than with any other construct. This ensures that all constructs are well-defined and measured by their indicators. If an indicator is more closely connected to other constructs than with itself, then it may indicate a measurement issue because it implies the construct is not specifically predicting its indicators as intended.

HTMT ratio is a more advanced and rigorous method of testing discriminant validity, which is well suited for use in PLS-SEM. HTMT is a method for testing the ratio of average heterotrich correlations across constructs and traits to average monocratic correlations on the same trait. For establishing discriminant validity, the HTMT values should be below 0.90 for conceptually related constructs and below 0.85 for conceptually unrelated constructs. The presence of values greater than the above-specified thresholds may indicate a lack of discriminant validity and thus indicate that the desired constructs may perhaps not be distinctly unique to one another. Upon Discriminant Validity testing, the square root of the average extracted (AVE) and discriminant validity may be seen and compared with each other. In case the square root value of Average Variance Extracted (AVE) for each construct is greater than the value of correlation between the construct and other constructs within the model, it is said to possess a good discriminant validity value. Moreover, the expected value of AVE is greater than 0.5. Table 7 shows the results of the validity measurement using HTMT inference. All variables have a confidence interval (CI) value of less than or equal to 1, indicating valid discriminant validity based on the HTMT inference calculation. Additionally, when tested using AVE, the AVE value exceeds 0.5, further confirming that the data possesses discriminant validity.

Table 7. Discriminant validity test results

| Variable | Biodegradability | Consumer Purchase Interest | Ergonomic Design | Mechanical Physics | Physical Chemistry |
|---|---|---|---|---|---|
| Biodegradability | | | | | |
| Consumer Purchase Interest | 0.735 | | | | |
| Ergonomic Design | 0.534 | 0.764 | | | |
| Mechanical Physics | 0.667 | 0.781 | 0.782 | | |
| Physics Chemistry | 0.613 | 0.747 | 0.776 | 0.777 | |

### 3.1.4 Composite Reliability

Composite reliability is a measure of the internal consistency of a construct, which contrasts how well items in a construct correlate and collectively define the construct. Composite reliability in this context is determined through two measures: Cronbach's Alpha and Composite Reliability estimates. These estimates provide information about the consistency and reliability of every construct. Table 8 is the result of the composite reliability calculation of all the variables used in this study. It shows that Cronbach's Alpha value is more than 0.6 and the composite reliability value is more than 0.7, thus, this study variable is reliable.

Table 8. Composite reliability test results

| Variable | Cronbach's Alpha | Composite Reliability |
|---|---|---|
| Biodegradability | 0.740 | 0.852 |
| Ergonomics Design | 0.894 | 0.922 |
| Mechanical Physics | 0.874 | 0.914 |
| Physics Chemistry | 0.749 | 0.855 |
| Consumer Purchase Interest | 0.840 | 0.892 |

## 3.2 Inner Analysis of SEM PLS Model

In Structural Equation Modeling using Partial Least Squares (SEM PLS), the inner model analysis focuses on understanding how the constructs are structurally connected and how effectively the independent variables explain the dependent variable. This process involves evaluating two key measures: the Determinant Coefficient ($R^2$) and Effect Size ($F^2$) for each variable:

### 3.2.1 Determinant coefficient ($R^2$)

R-squared ($R^2$) value gives an idea of the goodness-of-fit of the model because it indicates the proportion of the variance in the dependent variable (Consumer Purchase Interest) explained by the independent variables

(Biodegradability, Ergonomics design, Mechanical Physics, and Physics Chemistry). The R Square value (R2) is used to identify how much the independent variable explains the dependent variable in the research model. Based on Table 9, the R Square value is 0.615, this states that 61.5% of consumer purchasing interest is influenced by biodegradability, ergonomics, mechanical physics and chemical physics, while the remaining 38.5% is explained by other variables not mentioned by this study. This level of $R^2$ suggests a moderately strong model, indicating that the chosen variables contribute significantly to explaining consumer purchase interest.

Table 9. R-Square test result

| Variable | R Square | R Square Adjusted |
|---|---|---|
| Consumer Purchase Interest | 0.628 | 0.615 |

### 3.2.2 F-Square

In contrast to $R2$, which looks at how much the independent variables as a whole explain the dependent variable, $f2$ assesses the specific contribution of each independent variable. In SMART PLS (PLS-SEM), the F Square (f2) value is used to measure the effect size of an independent variable on the dependent variable in the model. In other words, $f2$ shows how much influence the exogenous variable has on the endogenous variable after considering changes in $R2$. These F-Square values assess the impact each independent variable has on the dependent variable. This effect size helps to understand the relative importance of each predictor within the model.

Table 10. F-Square test result

| Variable | Consumer Purchase Interest |
|---|---|
| Biodegradability | 0.140 |
| Ergonomics design | 0.115 |
| Mechanical Physics | 0.055 |
| Physics Chemistry | 0.046 |

Table 10 shows the F-Square value reveals that biodegradability (0.140) has a moderate and notable impact on consumer purchase interest, making it the most influential factor in the model. Ergonomics Design (0.115) shows a weaker but still meaningful effect, while mechanical physics (0.055) and physics chemistry (0.046) contribute minimally. These findings highlight that biodegradability and ergonomics design are the primary attributes influencing consumer interest, suggesting that businesses should emphasize these factors in packaging design to boost consumer appeal.

### 3.2.3 Path Coefficient Hypothesis Testing

The path coefficient is not just used to evaluate the relationship but also the robust strength of the coefficient between variables. Figure 4 presents the results of hypothesis testing, showcasing the significance and robustness of the path coefficients for each hypothesized relationship.

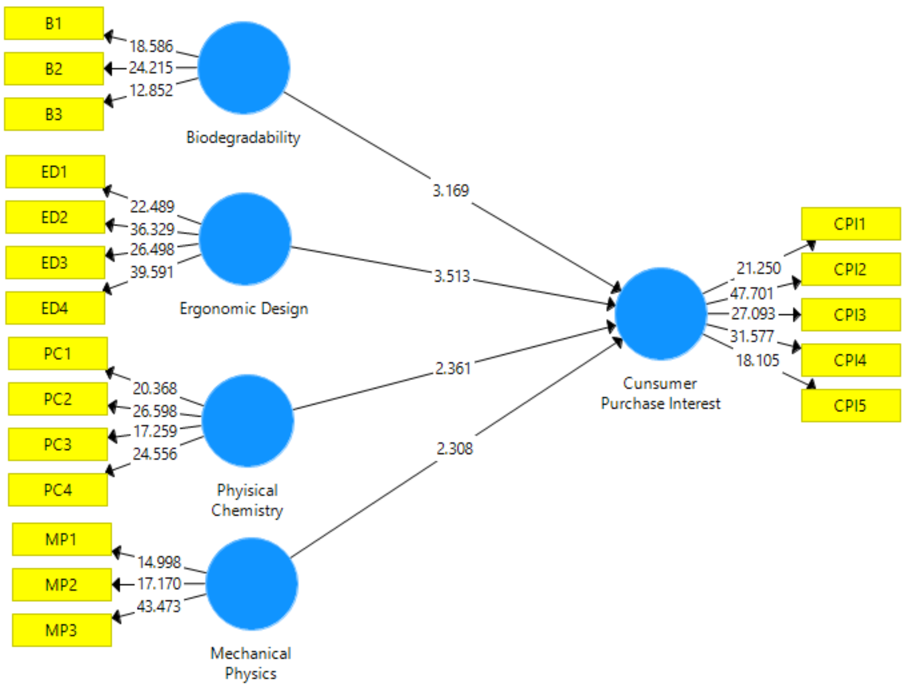


Figure 4. Hypothesis test results model

Higher path coefficient values indicate stronger relationships, providing insight into how each independent variable affects consumer purchase interest. This robust analysis reinforces the study's conclusions regarding the key factors that drive consumer interest in sustainable packaging.

The result of hypothesis testing for the correlation between variables and consumers' purchase intent. The T-statistic provides some indication of whether or not the regression coefficient is significant, but this should be interpreted further to apply to practical significance, for example, whether a small change in the variable would actually have a significant impact in the context of a larger operational or strategic decision. By extending the meaning of these statistics in a practical scenario, the result of the analysis can provide more meaningful insights for more effective and practical decision-making. The gained value is greater than the P-value, illustrating that each of the variables has an association or influence on consumer purchase intention. The result of testing the hypothesis of the variables' relationship and consumer purchase intention in this study states that the T-statistic value being tested is greater than the P-value, which displays that there exists a relationship or each variable's influence towards consumer purchase intention.

Table 11. Hypothesis test results

| Relationship Between Variables | T- Statistic | P-Value | Note |
|---|---|---|---|
| Biodegradability → Consumer Purchase Interest | 3.412 | 0.001 | Accepted |
| Ergonomics Design → Consumer Purchase Interest | 3.696 | 0.000 | Accepted |
| Mechanical Physics → Consumer Purchase Interest | 2.424 | 0.017 | Accepted |
| Physics Chemistry → Consumer Purchase Interest | 2.325 | 0.016 | Accepted |

Based on Table 11 above, analysis can be carried out on the three hypotheses:

a) Test Hypothesis 1 (H1)
Biodegradability (B) on Consumer Purchase Interest (CPI), it can be observed that the T-statistic value of the Biodegradability variable is 3.412, which is larger than 1.96 and the p-value of 0.001 is smaller than 0.05 such that the first hypothesis is accepted and it can be said that biodegradability has a significant and positive effect on Consumer Purchase Interest.

b) Test Hypothesis 2 (H2)
Ergonomic Design (ED) on consumer purchase intention (CPI), it could be observed that the T-statistic value for the ergonomic variable is 3.696, which is above 1.96, and the p-value of 0.000 is below 0.05 such that the second hypothesis is accepted that ergonomics has a positive and significant effect on Consumer Purchase Interest.

c) Test Hypothesis 3 (H3)
Physics Chemistry (PC) of consumer purchase intention (CPI), it can be seen that the size of the physical chemistry variable has a T-Statistic value of 2.424, which is greater than 1.96, and the p-value 0.017 is lesser than 0.05 such that the third hypothesis is accepted that there exists a positive and significant impact of ergonomics on Consumer Purchase Interest.

d) Test Hypothesis 4 (H4)
Mechanical Physics (MP) influences consumer purchase intention (CPI) significantly, it can be observed that the value of the mechanical physics (MP) variable is 2.325 with a T-Statistic value of more than 1.96 and the p-value of 0.016 is less than 0.05, hence the fourth hypothesis is confirmed that mechanical physics has a significant and positive effect on Consumer Purchase Interest.

Based on the processing output and the hypotheses carried out, the results show that the four variables have a positive influence on consumers' interest in buying packaged food. The implication is that the industry takes into consideration the four variables in producing sustainable food packaging, which consider convenience, durability, and health.

### 3.3 Ergonomics and Its Influence on Purchase Behaviour

Ergonomics plays a significant role in shaping consumer decision-making, with an F-Square value of 0.115 and a T-statistic of 3.696, indicating its meaningful influence on consumer interest. Although its effect size is smaller than that of biodegradability, ergonomics remains a vital factor that enhances consumer convenience and usability. Key ergonomic design features, such as ease of handling, resealability, and user-friendliness, contribute to a more satisfying experience for consumers, ultimately driving their purchase decisions. This finding aligns with previous research emphasizing the importance of ergonomic packaging in boosting consumer satisfaction and enhancing product interaction [9], [15]. Research [14] stated that consumers tend to be more interested in buying products with packaging that is easy to use and listen to because packaging that is difficult to use can cause disappointment and reduce buying interest. Packaging that is easy to use gives the impression of high quality, is sustainable, and tends to be more attractive to consumers. Packaging design that considers ergonomics can improve user experience and encourage positive purchasing decisions. Packaging design elements, including ergonomics, play an important role in attracting consumers' attention and influencing their purchasing decisions [48], [49]. These insights suggest that packaging designers should prioritize user-centric features, as these elements can broaden appeal and resonate with a larger audience by meeting the needs of today's convenience-focused consumers. Therefore, packaging companies are expected to focus on ergonomic packaging design, such as the use of comfortable handles and easy-to-open closures. For example, ergonomically designed beverage bottles that allow consumers to pour easily can improve the user experience, as can fast food packaging that uses handles on packaging to make it easier for consumers to carry the product.

### 3.4 Impact of Biodegradability on Consumer Purchase Interest

Biodegradability has emerged as a major factor influencing consumer purchase interest, as demonstrated by its F-Square value of 0.140 and T-statistic of 3.412. This substantial effect highlights consumers' growing preference for eco-friendly packaging solutions, mirroring the rising global demand for sustainable products. Biodegradable packaging, perceived as essential for reducing plastic waste and environmental impact, strongly resonates with eco-conscious consumers. These findings support previous studies underlining the influence of sustainable packaging on consumer choices [17], [50]. For businesses, this underscores the need to integrate biodegradable materials into their packaging strategies to meet environmental expectations and strengthen their competitive positioning. By addressing these eco-friendly preferences, manufacturers can align with consumers' values, fostering loyalty and enhancing brand appeal. Companies should consider using biodegradable packaging materials such as PLA (polylactic acid) or agricultural waste materials such as bagasse and corn husks. This not only meets consumer demand but also enhances the brand's image as a socially responsible company.

### 3.5 Influence of Physical Chemistry on Purchase Intent

The study reveals that while significant, the influence of physics chemistry attributes in packaging—such as moisture resistance, permeability, and their role in preserving food quality—is relatively weaker (F-Square = 0.046, T-statistic = 2.325) compared to biodegradability and ergonomics design. This suggests that while consumers acknowledge the importance of protective qualities in packaging, these considerations tend to be secondary to environmental sustainability and ease of use. Prior studies echo this sentiment, finding that consumer priorities often lean toward ecological impact and functionality rather than the technical attributes of physical chemistry [26], [31]. However, for certain product categories, especially perishables, the physical chemistry of packaging remains crucial to maintaining product freshness and safety. For these goods, protective qualities directly influence consumer trust and satisfaction. The company is developing packaging with better barrier layers to protect products from oxygen, moisture and light. For example, snack food packaging uses lamination technology to preserve product freshness and flavor.

### 3.6 Influence of Mechanical Physics on Consumer Purchase Decisions

Mechanical physics attributes—such as the durability and structural integrity of packaging—also play a positive, albeit smaller, role in consumer purchase interest (F-Square = 0.055, T-statistic = 2.424). Packaging that withstands tearing or deformation during handling and transportation is particularly valued by consumers, who see it as essential for product protection. Although the influence of mechanical physics is less prominent than biodegradability and ergonomics design, it still contributes to overall consumer satisfaction, especially for products that require robust packaging solutions. This aligns with findings from prior studies that highlight the need for durable packaging, especially for items that are more susceptible to damage [27], [35]. These insights suggest that businesses should not overlook mechanical resilience as a core element of effective packaging design, particularly for goods requiring extra protection. The company uses materials with high mechanical strength for packaging, such as corrugated boards for frozen food packaging. This ensures that the products remain intact during transportation and storage.

### 3.7 The Priority of Overall Results

The research model explained 61.5% of the variance in consumer purchase interest, indicating that biodegradability, ergonomics design, physics chemistry, and mechanical physics collectively play a substantial role in influencing consumer behavior. However, the remaining 38.5% variance suggests that other factors—such as branding, price, and cultural influences—may also impact purchase decisions. The findings confirm that packaging attributes significantly affect consumer preferences, with a strong emphasis on environmentally friendly features. This aligns with global trends favoring sustainable and convenient packaging designs, revealing that consumers are increasingly conscious of ecological impact and functionality in their choices. Positive attitudes towards biodegradable packaging and perceived behavioral control are the main drivers of consumer purchase intentions. However, low awareness and understanding of biodegradable packaging, as well as barriers such as skepticism and lack of adequate waste management facilities, can hinder purchase interest. Appropriate education and information can help increase consumer awareness and buying interest in biodegradable packaging.

#### 3.7.1 The final decision

In the food packaging industry, effective packaging design can influence product quality and consumer behavior. A study of cake packaging showed that good design not only protects the product but also improves quality perceptions [51]. Research on sustainable packaging has also found that eco-friendly solutions can reduce environmental impact and increase product appeal [5], highlighting the importance of packaging innovation to meet the needs of a sustainability-conscious market. In addition, visual and functional elements of snack packaging also influence consumer purchasing decisions [52], while appropriate packaging solutions can reduce food waste, providing economic and environmental benefits [53], [54]. This study shows that four variables - biodegradability, ergonomic design, chemical physics and mechanical physics - play an important role in consumer purchase intentions, which the industry needs to consider to ensure product sustainability, convenience, durability and health.

However, this study has limitations, such as a limited sample and being conducted only in two geographical areas (Jakarta and Depok) with specific age groups, so the results cannot be generalized. In addition, this study only includes ergonomics, biodegradability, and material science variables, while other factors such as price, brand, and promotion may also influence consumer behavior. Future research is recommended to use a larger and more diverse sample and to conduct longitudinal studies to monitor changes in consumer behavior over time. In addition, cross-national or cross-cultural comparative studies can provide insights into how ergonomic and biodegradability factors are perceived differently and how this affects consumer behavior.

## 4. CONCLUSIONS

Based on the result of the analysis, it is found that biodegradability, ergonomic design, physics chemistry and mechanical physics variables influence consumer purchasing interest in food packaging with a 61.5% adjusted R-squared. Sellers and consumers recognize the importance of the four variables towards sustainability, environmental-friendliness, health and food safety based on the 1.96 hypothesis test. Therefore, the packaging industry will have to explore the use of eco-friendly packing material so that the environment and human health can be protected. For future studies, experimenting with more variables such as price, product ease of use, and brand perception as independent variables that affect the consumer's interest in buying is recommended. Besides, there is a need to carry out a deeper comparison between green and traditional packaging materials as far as food durability and environmental effects are concerned in order to offer complete insights into the food packaging sector.

## ACKNOWLEDGEMENTS

The research team would like to thank the Directorate of Research, Technology, and Community Service (DRTPM), Directorate General of Education, Culture, Research, and Technology, for providing funds with the main contract 105/E5/PG.02.00.PL/2024 and derivative contract number 811/LL3/AL.04/2024 and 111/R.UMJ/VI/2024, as well as to LLDIKTI region III, LPPM UMJ, Industrial Engineering Study Program and Faculty of Engineering for their facilities.

## CONFLICT OF INTEREST

This article has not been published in any journal and is not under consideration by any other journal. All authors involved agree, and there is no conflict of interest with each other in this article.

## AUTHORS CONTRIBUTION

N. Nelfiyanti (Conceptualization; Methodology; Writing - original draft; Supervision; Validation)

E. Ernyasih (Formal analysis; Project administration; Resources)

Ratri Ariatmi Nugrahani (Project administration; Resources; Investigation)

Nik Mohamed (Writing - review & editing; Data curation)

Andry Setiawan (Formal analysis; Software)

Muhammad Aditia Al-Hafidz (Validation; Investigation)

D. Daruki (Resources; Investigation)

## REFERENCES

[1] R. Çakmakçı, M. A. Salık, and S. Çakmakçı, “Assessment and principles of environmentally sustainable food and agriculture systems,” *Agriculture*, vol. 13, no. 5, pp. 1–27, 2023.

[2] C. Bou-Mitri, M. Abdessater, H. Zgheib, and Z. Akiki, “Food packaging design and consumer perception of the product quality, safety, healthiness and preference,” *Nutrition & Food Science*, vol. 51, no. 1, pp. 71–86, 2021.

[3] J. Muncke, B. Geueke, L. Parkonson, and L. Zimmermann, “Food packaging contaminants,” *Encyclopedia of Food Safety*, vol. 2, pp. 321–333, 2024.

[4] J. W. Han, L. Ruiz-Garcia, J. P. Qian, and X. T. Yang, “Food packaging: A comprehensive review and future trends,” *Comprehensive Reviews in Food Science and Food Safety*, vol. 17, no. 4, pp. 860–877, 2018.

[5] F. Versino, F. Ortega, Y. Monroy, S. Rivero, O. V. López, and M. A. García, “Sustainable and bio-based food packaging: A review on past and current design innovations,” *Foods*, vol. 12, no. 5, p. 1057, 2023.

[6] G. Bošnjaković and G. Vladić, “Research methodologies for assessing the ergonomics of packaging products-a review,” In *Proceedings of the 10th International Symposium on Graphic Engineering and Design*, Novi Sad, Serbia, pp. 12-14, 2020.

[7] M. Forsman, E. Bernmark, B. Nilsson, S. Pousette, and S. E. Mathiassen, “Participative development of packages in the food industry - Evaluation of ergonomics and productivity by objective measurements,” *Work*, vol. 41, no. S1, pp. 1751–1755, 2012.

[8] S. Otto, M. Strenger, A. Maier-Nöth, and M. Schmid, “Food packaging and sustainability – Consumer perception vs. correlated scientific facts: A review,” *Journal of Cleaner Production*, vol. 298, p. 126733, 2021.

[9] Z. Hassan, N. Hayati, and H. Mohd, "Ergonomic problems and stress among workers in a manufacturing company," *International Journal of Management Studies*, vol. 22, no. 2, pp. 17–31, 2015.

[10] Nelfiyanti and M. Z. N. Mohamed, "Quick response manufacturing and ergonomic consequences in manufacturing environment," *IOP Conference Series: Materials Science and Engineering.*, vol. 788, no. 1, p. 012031, 2020.

[11] H. Tarwaka, *Ergonomi Industri Dasar-Dasar Pengetahuan Ergonomi dan Aplikasi di Tempat Kerja*. Surakarta, Indonesia: Harapan Press, 2015.

[12] N. Nelfiyanti, N. Mohamed, M. Rashid, and C. C. Seik, "Ergonomic chair design in minimizing MSD chassis assembly workers complaints using Ergonomic Function Deployment (EFD)," in *Technological Advancement in Instrumentation & Human Engineering, Lecture Notes in Electrical Engineering*, Springer Nature Singapore, pp. 73-87, 2023.

[13] S. Hensler, D. B. Herren and M. Marks, "New technical design of food packaging makes the opening process easier for patients with hand disorders," *Applied Ergonomics*, vol. 50, pp. 1–7, 2015.

[14] G. Bošnjaković, G. Vladić, T. Gvoka, and K. Maričić, "Importance of cognitive ergonomics in packaging design," *11th International Symposium on Graphic Engineering and Design*, pp. 527–532, 2022.

[15] B. Benaissa and M. Kobayashi, "The consumers' response to product design: A narrative review," *Ergonomics*, vol. 66, no. 6, pp. 791–820, 2023.

[16] K. C. Yao, H. H. Hsieh, K. Y. Li, J. R. Xu, W. S. Ho, W. L. Huang, et al., "Sustainable packaging solutions: Food engineering and biodegradable materials," *Designs*, vol. 8, no. 6, p. 133, 2024.

[17] A. Panou and I. K. Karabagias, "Biodegradable packaging materials for foods preservation: Sources, advantages, limitations, and future perspectives," *Coatings*, vol. 13, no. 7, p. 1176, 2023.

[18] A. Cammarelle, R. Viscecchia, and F. Bimbo, "Intention to purchase milk packaged in biodegradable packaging: Evidence from Italian consumers," *Foods*, vol. 10, no. 9, pp. 2068, 2021.

[19] S. Jafarzadeh, A. Salehabadi, A. Mohammadi Nafchi, N. Oladzadabbasabadi, and S. M. Jafari, "Cheese packaging by edible coatings and biodegradable nanocomposites; improvement in shelf life, physicochemical and sensory properties," *Trends in Food Science & Technology*, vol. 116, pp. 218–231, 2021.

[20] J. Nilsen-Nygaard, E. N. Fernández, T. Radusin, B. T. Rotabakk, J. Sarfraz, N. Sharmin et al., "Current status of biobased and biodegradable food packaging materials: Impact on food quality and effect of innovative processing technologies," *Comprehensive Reviews in Food Science and Food Safety*, vol. 20, no. 2, pp. 1333–1380, 2021.

[21] H. Mohajan, "Quantitative research: A successful investigation in natural and social sciences," *Journal of Economic Development, Environment and People*, vol. 9, no. 4, pp. 50–79, 2020.

[22] S. Haryati, "Research and Development (R&D) sebagai salah satu model penelitian dalam bidang pendidikan," *Majalah Ilmiah Dinamika*, vol. 37, no. 1, p. 15, 2012.

[23] K. Nallaluthan, S. Kamaruddin, R. Thurasamy, A. M. Ghouri, and K. Kanapathy, "Quantitative data analysis using PLS-SEM (SmartPLS): Issues and challenges in ethical consideration," *International Business Education Journal*, vol. 17, no. 2, pp. 41–54, 2024.

[24] P. Paramita, M. Shovitri, and N. D. Kuswytasari, "Biodegradasi limbah organik pasar dengan menggunakan mikroorganisme alami tangki septik," *Jurnal Sains dan Seni ITS*, vol. 1, no. 1, pp. 23–26, 2012.

[25] G. B. Pratama, A. Widyanti, N. Nurfitrisari, and S. A. Salma, "Ergonomic product design: An empirical study on the influencing factors to use and to buy," *Strategic Design Research Journal*, vol. 15, no. 3, pp. 248–261, 2022.

[26] S. B. Bunally, C. N. Luscombe, and R. J. Young, "Using physicochemical measurements to influence better compound design," *SLAS Discovery*, vol. 24, no. 8, pp. 791–801, 2019.

[27] P. Domone and J. Illstone, *Construction Materials Their Nature and Behaviour*, 4 th Editi. London: CRC Press, 2010.

[28] S. M. Subramanian, "Mechanical properties of materials: Definition, testing and application," *International Journal of Modern Studies in Mechanical Engineering* vol. 6, pp. 28–38, 2020.

[29] S. Nuojua, S. Pahl, and R. C. Thompson, "Plastic alternatives and substitutes in the packaging sector – A UK consumer perspective," *Sustainable Production and Consumption*, vol. 46, pp. 68–81, 2024.

[30] A. Ivankovic, K. Zeljko, S. Talic, A. Bevanda, and M. Lasic, "Biodegradable packaging in the food industry," *Journal of Food Safety and Food Quality*, vol. 8, pp. 23–52, 2017.

[31] Adil, Patang, and A. Sukainah, "Sintesis kulit ubi kayu (manihot esculenta) sebagai bahan dasar pembuatan kemasan biodegradabl," *Jurnal Pendidikan Teknologi Pertanian*, vol. 6, no. 1, pp. 55–64, 2020.

[32] N. P. Sari, J. Immanuel, and A. Cahyani, "Aplikasi kansei engineering dan fuzzy analytical hierarchical process dalam pengembangan desain kemasan," *Journal Printing and Packaging Technology*, vol. 1, pp. 9–21, 2020.

[33] R. G. Pramono, M. Iqbal, and S. Wulandari, "Design improvement of packaging of kerupuk strawberry kencana mas using quality function deployment method," *eProceedings of Engineering*, vol. 2, no. 1, pp. 1–10, 2015.

[34] M. F. B. Harahap, A. Mubarak, and A. Suzianti, "Designing a green food delivery packaging with QFD for Environment (QFDE) and TRIZ," *IOP Conference Series: Earth and Environmental Science*, vol. 464, no. 1, p. 012004, 2020.

[35] M. H. Pulungan, L. D. Hastari, and I. A. Dewi, "Perbaikan desain kemasan produk biskuit brownies menggunakan metode Quality Function Deployment (QFD)," *Teknotan: Jurnal Industri Teknologi Pertanian*, vol. 13, no. 2, p. 39-46, 2019.

[36] Waryat and Y. Handayani, "Implementasi jenis kemasan untuk memperpanjang umur simpan sayuran pakcoy," *Jurnal Ilmiah Respati*, vol. 11, no. 1, pp. 33–45, 2020.

[37] R. Rahmadhanimara and T. Purwinarti, "Sensory marketing: Aroma dan cita rasa terhadap pembentukan persepsi konsumen (studi kasus: gerai roti o di Stasiun KRL Commuter Line Jakarta Selatan)," *Epigram*, vol. 19, no. 2, pp. 162–173, 2022.

[38] E. K. Rastini, S. Astuti, F. Handoko, and P. Vitasari, "Pelatihan Pembuatan Bioplastik untuk Peningkatan Kreativitas Siswa ii Sma Nasional Malang," *Jurnal Aplikasi Sains Teknologi Nasional*, vol. 1, no. 1, pp. 7–13, 2020.

[39] M. Ketelsen, M. Janssen, and U. Hamm, "Consumers' response to environmentally-friendly food packaging - A systematic review," *Journal of Cleaner Production*, vol. 254, p. 120123, 2020.

[40] C. Ginting and F. A. Hartati, "Analisis minat beli konsumen berdasarkan kemasan produk makanan dan minuman," *Jurnal Pendidikan Tambusai*, vol. 7, no. 3, pp. 28195–28203, 2023.

[41] M. Kakisina and Y. Lego, "Pengaruh citra merek, kualitas makanan, dan kualitas layanan terhadap niat pembelian kembali pada pelanggan KFC Cabang Kakialy di Ambon," *Jurnal Manajerial dan Kewirausahaan*, vol. 3, no. 4, p. 1118, 2021.

[42] J. Hair and A. Alamer, "Partial Least Squares Structural Equation Modeling (PLS-SEM) in second language and education research: Guidelines using an applied example," *Research Methods in Applied Linguistics*, vol. 1, no. 3, p. 100027, 2022.

[43] J. F. Hair, C. M. Ringle, S. P. Gudergan, A. Fischer, C. Nitzl, and C. Menictas, "Partial least squares structural equation modeling-based discrete choice modeling: an illustration in modeling retailer choice," *Business Research*, vol. 12, no. 1, pp. 115–142, 2019.

[44] I. Ghozali, *Aplikasi Analisis Multivariat Dengan Program IMB SPSS 23 (Edisi 8)*. Semarang: Universitas Diponegoro, 2016.

[45] J. Hair, G. T. M. Hult, C. Ringle, and M. Sarstedt, *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM) using R: A workbook*. Springer Nature, 2021.

[46] I. Ghozali and K. Kusuma, *Partial Least Squares Konsep, Teknik dan Aplikasi SmartPLS 4.0 untuk Penelitian Empiris, 1st ed*. Semarang: Yoga Pratama, 2023.

[47] M. Sarstedt, C. M. Ringle, and J. F. Hair, "Partial Least Squares Structural Equation Modeling," *Handbook of Market Research*, pp. 587–632, 2021.

[48] S. Hussain, S. ali, A. Noreen, and S. Fayaz Ahmad, "Impact of product packaging on consumer perception and purchase intention, " *Journal of Marketing and Consumer Research*," vol. 10, no. 1, pp. 1–10, 2015.

[49] C. Daggett and G. L. Klingaman, "Influence of photoperiod and minimum overwintering temperature on growth of nursery liners," *Journal of Environmental Horticulture*, vol. 3, no. 1, pp. 25–27, 1985.

[50] M. R. Havstad, "Chapter 5 - Biodegradable plastics," T. M. B. T.-P. W. and R. Letcher, Ed., Academic Press, 2020, pp. 97–129.

[51] Organisation for Economic Co-operation and Development, "Case study on biscuit wrappers: An example of weighing sustainability criteria for plastic flexible food packaging from a chemicals perspective," *Series on Risk Management No.64 JT03486959 OFDE*, no. 64, p. 91, 2021.

[52] H. Wang, M. A. A. Ab Gani, and C. Liu, "Impact of snack food packaging design characteristics on consumer purchase decisions," *SAGE Open*, vol. 13, no. 2, p. 21582440231167108, 2023.

[53] V. Guillard, S. Gaucel, C. Fornaciari, H. Angellier-Coussy, P. Buche, and N. Gontard, "The next generation of sustainable food packaging to preserve our environment in a circular economy context," *Frontiers in Nutrition*, vol. 5, p. 121, 2018.

[54] F. Wikström *et al.*, "Packaging strategies that save food: a research agenda for 2030," *Journal of Industrial Ecology*, vol. 23, no. 3, pp. 532–540, 2019.