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Molecular & Cellular Biomechanics 2025, 22(4), 1176.
https://doi.org/10.62617/mcb1176

Article

Research on the application of biomechanical theories to e-commerce product selection strategies

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CITATION

Lu M. Research on the application of biomechanical theories to e-commerce product selection strategies. Molecular & Cellular Biomechanics. 2025; 22(4): 1176. https://doi.org/10.62617/mcb1176

ARTICLE INFO

Received: 19 December 2024
Accepted: 20 January 2025
Available online: 10 March 2025

Abstract: In recent years, the proportion of cross-border e-commerce in China's foreign trade has been steadily increasing. Many enterprises have opted to engage in international trade by establishing a presence on overseas e-commerce platforms, making the integration of research findings from various fields with e-commerce product selection strategies a popular research direction. This study focuses on the Southeast Asian e-commerce platform Lazada and incorporates biomechanical theories to conduct cluster analysis. The objective is to uncover product classification patterns through biomechanical aspects and provide strategic recommendations for product selection to novice cross-border e-commerce merchants seeking entry into the Southeast Asian market. First, this study provides a comprehensive analysis of the current development trends in cross-border e-commerce and the application prospects of biomechanical theories in this field. Subsequently, key variables were selected based on biomechanical concepts such as the "stress-strain" relationship and dynamic equilibrium. These core concepts were utilized to draw analogies with the critical variables in cross-border e-commerce product selection. A set of evaluation indexes for product selection was constructed from two dimensions: product attributes and customer reviews. In this framework, product selection strategies were analogized as state variables, product price and brand strength as "external forces," and product ratings and online reviews as "internal forces." Data collection techniques were employed to acquire product data from the first 20 pages of listings across secondary categories on Lazada's Vietnam platform. The data underwent rigorous cleaning, preprocessing, and descriptive statistical analysis. Finally, a clustering algorithm was used to classify the primary product categories into four distinct clusters. Based on comparative analysis of the features among these clusters, the study quantitatively elucidates the patterns of changes in product category under the combined influence of "internal" and "external" forces, and proposes actionable recommendations for product selection strategies. Based on the findings of this study, biomechanical theory provides new insights into e-commerce product selection strategies, demonstrating promising applicability in this field. From a biomechanical perspective, the study identifies women's fashion and accessories, as well as home and lifestyle categories, as the most popular segments in the Vietnamese market. However, these categories are characterized by intense price competition, making them unsuitable for novice merchants to enter impulsively. In contrast, the electronics category, driven by robust market demand and promising growth potential, emerges as an ideal product selection direction for foreign trade enterprises with reliable quality assurance. Drawing on biomechanical theory and clustering analysis, this study offers product selection recommendations, emphasizing that merchants should carefully select target categories and products based on their resources and market positioning. By adopting appropriate market strategies, businesses can achieve steady development in the Southeast Asian market, gradually build and enhance their brand image, and drive the long-term growth of their cross-border e-commerce ventures.

Keywords: cross-border e-commerce; selection strategy; Lazada platform; cluster analysis; biomechanics; stress-strain relationships

1. Introduction

In light of the increasing competition among mainstream e-commerce platforms and other factors, some enterprises have shifted their focus towards untapped markets such as Southeast Asia, Africa, and South America. For small and medium-sized Chinese enterprises, the intense competition posed by established international cross-border e-commerce platforms like Amazon, eBay, and Sizzle can be daunting, particularly for novice merchants. As such, turning to local cross-border e-commerce platforms in Southeast Asia presents a viable strategy for alleviating competitive pressures and avoiding cut-throat competition.

Product selection is a crucial aspect of cross-border e-commerce operations, which leverages internet technology to establish direct contact between enterprises and retailers, wholesalers, and end consumers. This innovative transaction mode simplifies the commodity circulation process and reduces associated costs. Successful product selection strategies enable enterprises to enter the market quickly, increase product sales, enhance corporate profits, and gain a competitive edge. However, the unique customs and habits of different countries render traditional foreign trade commodity structures unsuitable for cross-border e-commerce sales. Novice merchants often lack systematic product selection strategies and may blindly follow market trends, leading to homogenization competition. Additionally, a lack of awareness of intellectual property protection may result in unintentional infringement of others' intellectual property rights.

Biomechanical theory offers a novel research perspective for cross-border e-commerce. E-commerce companies usually have a large amount of user data and transaction records, and data analysis can provide insight into consumer behavior and preferences. Combining the theory of biomechanics with these data can provide e-commerce companies with a more accurate basis for product recommendation, personalization and marketing strategy development.

Cross-border e-commerce has had a great positive impact on China. Nowadays, cross-border e-commerce platforms not only help Small and Medium Enterprises (SMEs) avoid a certain degree of trade risks and save trade costs, but also build their own brands and increase brand awareness, bringing new opportunities for Chinese SMEs to build international brands.

The "Belt and Road" initiative has led to Southeast Asia emerging as a significant growth point in the cross-border e-commerce sector. The region's vast market potential and business value have made it an emerging hotspot in the e-commerce industry. Cross-border export e-commerce has become a crucial pillar of China's economic development, with many Chinese enterprises launching cross-border e-commerce businesses to export to Southeast Asia. The selection of categories is a critical issue that cross-border e-commerce merchants must emphasize. Novice merchants who blindly follow market trends in product selection and rely on hot lists without understanding their own capabilities and the foreign market are susceptible to the problem of homogenization.

In the current era of cross-border e-commerce, Southeast Asia has emerged as a significant growth point, attracting the attention of many e-commerce platforms. Among these platforms, Lazada, an important component of Ali's system in Southeast

Asia, has been identified by Chinese merchants as a potential breakthrough for enterprise development. However, the majority of cross-border e-commerce enterprises are small and medium-sized, lacking in-depth understanding of foreign markets and effective operational strategies. This often results in the inability to develop a scientific and reasonable product selection plan, leading to poor sales performance, reduced market competitiveness, and long-term business development challenges. To address this issue, this study employs web crawler technology to collect and analyze the best-selling product categories on the Lazada platform in Vietnam, providing product selection suggestions for novice Chinese merchants. The study also proposes a method of selecting products based on biomechanical clustering analysis, which combines the disciplines of biomechanics and e-commerce to inspire new innovative thinking and business models.

2. Related work

Zhu and Wu [1] have highlighted the transformative impact of the "Belt and Road" initiative on foreign trade foundry enterprises, which has been facilitated by the rapid development of the internet. Empirical research conducted by Zhao and Li [2] has revealed the potential of cross-border e-commerce in narrowing the income gap between urban and rural areas, particularly in the central and eastern regions, where rural residents have benefited from participating in cross-border e-commerce activities. Wu [3] has suggested that the Regional Comprehensive Economic Partnership (RCEP) will provide a broader development space for China's cross-border e-commerce market, optimizing the country's foreign trade system and significantly improving the efficiency of customs clearance and logistics of goods.

From the consumer perspective, Ma et al. [4] found that companies tend to ignore consumers' actual needs and shopping experience when making product selections, which limits the development potential of cross-border business. They suggested that companies should gain a deeper understanding of the culture and religious beliefs of their target markets as a basis for product selection and optimize supply chain management to meet consumer expectations. Zhu's [5] study has revealed that the details of product information play a crucial role in stimulating consumers' purchasing impulses. Specifically, well-written product descriptions enhance consumers' perceptions of the goods, even though such descriptions do not significantly increase their interest in the product or enhance their perceptions of the autonomous experience. Xiao et al. [6] analyzed the online shopping scenarios that determine consumers' purchase intention and believed that online promotions, content marketing, personalized recommendations, and social reviews would positively affect consumers' purchase intention. Hazarika et al. [7] have highlighted the impact of consumers' confidence in the quality of e-services and their quest for product uniqueness on their online purchasing attitudes, which in turn influences their purchasing decisions. Among these factors, price concessions are a key driver of online purchasing behavior. Anastasiadou et al. [8] explored the impact of Corporate Social Responsibility (CSR) on consumers' willingness to buy through cross-country data analysis. They found that CSR activities per se do not directly enhance consumers' purchase intention. However, this effect becomes significant under the positive moderating effect of brand

commitment. Zhao and Kim [9] have proposed a new research framework that incorporates consumers' information cognitive abilities into the context of cross-border e-commerce. The framework assesses how consumers' ability to obtain information about goods directly affects their purchase motivation. Among these factors, the ability to obtain information independently and consumers' socioeconomic status are considered to be the core factors influencing purchase desires.

In the research field of merchandise category management, Yi [10] synthesized the research results over the years, pointing out that most of the current research focuses on the retailer's selection strategy and case studies. Liu [11], for his part, applied the concept of category management to the data-based operation of e-commerce enterprises and provided real-time operation and management support for e-commerce enterprises by establishing a systematic data analysis system.

Regarding the selection strategy of cross-border e-commerce, scholars have proposed a variety of research methods based on data from inside and outside the platform. Ye [12] has employed Chrome's crawler technology to automate the collection and editing of product information, simplifying the product selection process for SMEs. Wang [13] has analyzed the product selection techniques adopted by cross-border enterprises on the Amazon platform, including the use of search engine keywords to discover popular products, selection based on product rankings, and mining product potential from user reviews. Deng [14] has proposed a new product selection methodology from the perspective of big data, which involves rapid market inspiration, keyword collection, market outlook and competition analysis, and market capacity estimation, and delves into issues such as data silos, product homogenization, and localization. Zhu [15] and Chen and Chen [16] have analyzed the factors affecting product selection from multiple dimensions, including cultural differences, technology platforms, pricing strategies, risk assessment, brand influence, B2C cross-border factors, logistical considerations, religious beliefs, consumer behaviors, and product life cycle. Yu [17] has emphasized the importance of product life cycle in product selection, suggesting that merchants analyze historical sales data and current sales to determine the stage of the product and make decisions accordingly. Tu [18] has summarized seven major product selection models based on the synthesis of previous studies and the opinions of experts from cross-border e-commerce forums, and analyzed the advantages and limitations of each model.

In terms of cluster analysis research, in order to make an objective and comprehensive assessment of the data, it is necessary to construct a scientific and reasonable clustering index system in order to form a framework that can reflect the characteristics of the data in a relatively comprehensive manner, thus making the data analysis and evaluation more precise and effective. According to the research of Shan [19] and Ye [20], the establishment of cluster analysis indicators needs to ensure the principles of purposefulness and scientificity, completeness and availability, and the combination of qualitative and quantitative.

As a mature subject, biomechanics has achieved remarkable results and wide applications in the fields of medicine, sports, and rehabilitation [21,22]. The theories of biomechanics are also widely used in other non-traditional fields. Yichen [23] have applied it to ideological and educational management strategies. Yan [24] combined it with English language education. The theory of biomechanics can also be applied to

evaluate the humanistic qualities and mental health of teachers [25]. Biomechanical theory has also found relevant applications in the financial sector. By integrating biomechanical principles with neural network architectures, Ye [26] proposed a novel financial decision-making method. The incorporation of biomechanical principles provides a more robust and adaptable framework for financial decision-making. Compared to traditional approaches, this method offers improved accuracy, enhanced risk management, and greater responsiveness. Its research methodology and theoretical system have been continuously improved, providing a solid foundation for its application in the field of e-commerce.

The current academic literature on e-commerce product selection provides a relatively comprehensive perspective and demonstrates certain practical value. However, research specifically focused on cross-border e-commerce mainly centers on listing influencing factors. While the application of big data technologies offers a data-driven new perspective for cross-border e-commerce product selection, related research has not yet been fully developed. Much of the literature remains at the level of identifying product selection influencing factors and data-driven methods, lacking empirical analyses to specifically guide sellers in formulating product selection strategies. The absence of sufficient empirical data makes the research outcomes on product selection strategies less broadly applicable and persuasive. As a well-established theoretical framework, biomechanical theory has been widely applied across various fields, including the financial sector. It can help researchers overcome traditional research limitations and introduce new innovations in the study of cross-border e-commerce.

Furthermore, research in the cross-border e-commerce domain often focuses on mainstream Western markets, while analyses of e-commerce platforms in emerging markets such as Southeast Asia remain relatively scarce. This phenomenon suggests the need for more attention and research on cross-border e-commerce platforms in emerging markets, particularly in Southeast Asia, to fill the gaps in the existing literature.

3. Methods

3.1. Theoretical foundation

3.1.1. Theory of category management

Category management is a method of managing items based on the categorization of customer purchasing behaviors. This concept has been widely adopted in product selection strategies since its inception. In the realm of cross-border e-commerce, SMEs primarily engage in merchandise retailing and often procure goods through domestic e-commerce platforms, which provide access to a broad range of commodity resources at a lower cost. These SMEs maintain a low level of merchandise inventory and offer a diverse range of products. Effective category management strategies can assist these SMEs in meeting market demand, enhancing competitiveness, and managing costs and risks.

3.1.2. Concept of biomechanics

Biomechanics is a field that investigates the integration of mechanical principles with biological systems, focusing on the underlying relationships and structural features. A central aspect of biomechanics is the study of how forces in living organisms produce motion, which involves the application of Newton's Laws of Motion. For instance, human locomotion, such as walking and running, is the outcome of the interaction between internal forces generated by muscle contraction and external forces, such as ground reaction forces. During muscle contraction, tension is generated, which is transmitted to the bones through tendons, resulting in limb movement. In running, the force generated by the contraction of the leg muscles propels the body forward, while the ground provides a reaction force of equal magnitude and opposite direction, enabling the body to accelerate forward, as per Newton's third law.

Moreover, biomechanics investigates the stresses and strains that occur in biological tissues when subjected to internal and external forces. This approach can also be applied to the study of evolutionary development mechanisms resulting from internal and external causes in other fields.

3.1.3. Cluster analysis method

Cluster analysis is a statistical method that divides data objects into subsets based on similarity characteristics by identifying patterns in the data set. This process involves exploring the intrinsic structure of the data in order to categorize the individuals in the data set based on their similarity to each other into sets called "clusters". Data points within a cluster have a high degree of similarity, while data points between different clusters differ significantly. Cluster analysis is a descriptive analysis method that helps to reveal the underlying relationships and structural features in a data set, which can assist in recognizing the existing market and developing a more appropriate selection plan.

The K-means algorithm, a commonly used clustering technique, is popular for its simplicity and computational efficiency when dealing with large-scale datasets. The core steps of the algorithm are outlined below:

a) The algorithm determines K data points as initial clustering centers by random sampling;
b) Each data point is grouped into the cluster represented by its nearest center based on the principle of minimizing distance;
c) Calculating the average distance of all points within each cluster to its center of mass to assess the tightness of the clusters;
d) Updating the cluster grouping of the data points based on the calculation to ensure that each point is located in the cluster corresponding to its nearest centroid.
e) Repeat steps c and d until the location of the clustering center point no longer changes, at which point the algorithm reaches convergence and the clustering process ends.

In this paper, K-means cluster analysis is used to classify the goods of cross-border e-commerce platforms according to the first level of category indexes, and to suggest product selection strategies according to the characteristics of each category after classification.

3.2. Overview of Lazada platform and current status of product selection strategy

This chapter focuses on Lazada, one of the big hit platforms in Southeast Asia, giving a brief overview of its current status and a general idea of the selection patterns and issues on the platform today.

3.2.1. Basic overview of the Lazada platform

Lazada is a Southeast Asian e-commerce platform that was developed by Indonesian e-commerce company Gearbest in 2012 and officially launched in April 2014. Lazada is designed to help sellers enter the Southeast Asian market. In February 2016, Alibaba Group officially announced the completion of the wholly-owned acquisition of Lazada, and launched the Alibaba International website in June 2016. In March 2018, Alibaba Group acquired an 80% controlling stake in Lazada for $650 million.

Lazada is headquartered in Singapore. Its business covers a wide range of fields, from daily necessities to professional instruments. As a leader in the Southeast Asian e-commerce market, Lazada has successfully built sites in six countries—Indonesia, Malaysia, the Philippines, Singapore, Thailand and Vietnam—serving about 500 million potential consumers in these regions, providing online shoppers in these countries with convenient shopping channels and a Lazada offers a variety of services, including a product catalog, to make it easy for consumers to find products when shopping online.

Lazada currently has more than 10 million active sellers, with more than 1 million new products hitting the shelves every day. Currently, there are about 5 million items on the platform, including categories such as apparel, home furnishings, and electronics. As the largest e-commerce platform in Southeast Asia, Lazada currently has close to 300 million registered users, as well as more than 20 million sellers and more than 1 million buyers. Lazada's development in the local markets of Indonesia and Vietnam is more mature, with e-commerce penetration rates of more than 50% in all four countries—Indonesia, Vietnam, Thailand, and Malaysia.

3.2.2. Lazada platform selection strategy

- Market analysis to select products:

Merchants can analyze the market and select products to meet the market demand. This requires a deep understanding of the target market in advance, including local consumer demand, consumption habits, purchasing power. However, if the merchants' market analysis is not accurate enough, it may lead to a mismatch between the product selection and the market demand. In addition, the market is changing rapidly, the need for merchants to continue to track and adjust the selection strategy.

- Self-analysis of product selection:

In order to select suitable products in the fierce competition in the market, merchants must first self-examination, in-depth understanding of their own resources, capabilities and experience and other advantages, in order to better operate and avoid risks. However, self-analysis may be too subjective, which leads to product selection strategies deviating from the market reality. In addition, if sellers do not have enough

assessment of their own resources and capabilities, they may choose products that are beyond their capabilities, leading to operational difficulties.

- Competitor analysis for product selection:

In business competition, an in-depth understanding of competitors is the key to developing and executing effective competitive strategies. By analyzing competitors' products, prices, marketing strategies, etc., it is possible to compare and identify the strengths and weaknesses of the business itself, so as to develop a more targeted product selection strategy. However, if the blind imitation of competitors, may lead to a lack of differentiation in product selection, difficult to stand out in the competition. In addition, if the competitor's selection strategy itself has problems, blindly follow the trend may also lead to failure.

- Station Best Seller selection:

Merchants can choose products based on the ranking of hot products on the platform, which can help merchants quickly find popular products and reduce the risk of product selection. But the hot products may already have a lot of merchants in sales, competition is fierce. And the life cycle of hot products may be short, once the market is saturated or consumer demand changes, sales may decline rapidly.

3.3. Introduction of biomechanical theory for cluster analysis

3.3.1. The establishment of the selection strategy index system

To ensure the objectivity and accuracy of the cluster analysis incorporating biomechanical theory, it is necessary to develop a comprehensive and precise index system to identify the "internal" and "external forces" that truly induce stress and strain leading to the occurrence of the "state." Therefore, a clustering index system needs to be designed before cluster analysis. Given the virtual characteristics of e-commerce, consumers often rely on auxiliary information such as price, brand reputation and user evaluation to make purchase choices in the absence of physical experience. As shown in **Table 1**, this paper constructs an indicator system centered on product characteristics and consumer feedback, and selects four representative indicators to establish a cross-border e-commerce product selection indicator system.

Table 1. The main indexes that affect cross-border e-commerce product selection.

Dimension	Serial No.	Index	Reference
Commodity Properties	1	Commodity prices	Fang [27]
	2	Brand strength	Gao et al. [28]
Customer reviews	1	Product Rating	Gao et al. [28]
	2	Online Reviews	Deng [29]

3.3.2. Data collection and processing

Houyi collector is used to crawl the product data of Lazada Vietnam site. As shown in **Figure 1** the product data of Lazada Vietnam site is crawled in the time range of 20–21 January 2024, based on the hot selling degree of the product, and the crawled fields include "Title", "Price", "Origin", "Discount", "Review Count", "Sales Volume", "Brand", and "Rating", "Title Link". In order to ensure the representativeness and extensiveness of the data, 20 pages of merchandise data

information before each secondary category is captured, and about 800 pieces of data for each sub-category.

Title	Title link	Thumbnail	price	hp-mod-discount	card-jfy-ra	Detail title	Brand
mua 2 thành 6 - mua 2 bình x	https://www.laz	https://img.lazc	31,000	-50%	(3282)	mua 2 thành 6 - mu	No Brand
Sữa tắm nước hoa thơm lâu, S	https://www.laz	https://img.lazc	15,600	-47%	(790)	Sữa tắm nước hoa t	No Brand
COMBO 5 Hũ đựng gia vị có	https://www.laz	https://img.lazc	49,000	-48%	(792)	COMBO 5 Hũ đựn	No Brand
Chảo nướng đá BBQ 34 cm kl	https://www.laz	https://img.lazc	45,900	-49%	(408)	Chảo nướng đá BB	No Brand
KEBETEME TWS Bluetooth	https://www.laz	https://img.lazc	34,000	-37%	(2241)	KEBETEME TWS	KEBETEME
GIÁ SỈ ĐẦY SỐ LƯỢNG - Bé	https://www.laz	https://img.lazc	17,500	-45%	(2944)	GIÁ SỈ ĐẦY SỐ L	No Brand
Máy sấy tóc tạo kiểu 2 chiều r	https://www.laz	https://img.lazc	55,000	-47%	(985)	Máy sấy tóc tạo kiể	No Brand
Quần tây nam hàn quốc dáng	https://www.laz	https://img.lazc	149,000	-57%	(817)	Quần tây nam hàn	No Brand
Airaj 12 Inch Nhựa Hộp Đựng	https://www.laz	https://img.lazc	92,000	-38%	(460)	Airaj 12 Inch Nhựa	No Brand
Ready Stock Men Sandals Nev	https://www.laz	https://img.lazc	69,000	-66%	(138)	Ready Stock Men S	OEM
Set 6 drill Taro lace m3-m10	https://www.laz	https://img.lazc	72,277	-9%	(1011)	Set 6 drill Taro lace	No Brand
Ổ Sạc Nhanh 55W 3.1A 2 Cổ	https://www.laz	https://img.lazc	100,920	-33%	(589)	Ổ Sạc Nhanh 55W	No Brand
Nước xả vải Hygiene Thái Lar	https://www.laz	https://img.lazc	60,000	-50%	(3351)	Nước xả vải Hygie	No Brand
Micro SD Card HD Memory C	https://www.laz	https://img.lazc	58,566	-48%	(302)	Micro SD Card HD	No Brand
[DÀI 2M MÉT] CÂY LAU NH	https://www.laz	https://img.lazc	64,000	-50%	(193)	[DÀI 2M MÉT] CÂ	No Brand
Lilyshoes Giày Vải Nữ Mẫu M	https://www.laz	https://img.lazc	65,000	-50%	(130)	Lilyshoes Giày Vải	No Brand
Găng tay xe máy găng tay phi	https://www.laz	https://img.lazc	39,000	-50%	(759)	Găng tay xe máy g	No Brand
Combo 5 quần đùi kẻ sọc mềr	https://www.laz	https://img.lazc	69,000	-30%	(1050)	Combo 5 quần đùi	No Brand
(Miễn phí ship 100%) #1Kg t	https://www.laz	https://img.lazc	48,000	-50%	(1673)	(Miễn phí ship 100	No Brand
DUOHANZI Autumn and win	https://www.laz	https://img.lazc	33,000	-38%	(610)	DUOHANZI Autur	DUOHANZI

Figure 1. Display of information on the platform's capture section.

Data Cleaning Process:

a) Missing Value Handling: Samples missing key information such as price, sales volume, number of reviews, ratings, or brand values were removed. While this approach may reduce the amount of data available for analysis, it ensures that each sample included in the analysis contains complete information, thereby enhancing the representativeness and credibility of the clustering results.

b) Outlier Handling: Descriptive analysis of the indicator variables revealed values that significantly deviated from the rest of the data and were deemed as outliers. For example, when the prices of most laptop models ranged between 10 million to 50 million Vietnamese Dong, a laptop priced over 100 million Vietnamese Dong was likely an error in the merchant's price setting. Such outliers were removed from the dataset.

c) Duplicate Value Handling: To increase the visibility of products and attract more potential customers, some merchants displayed slightly different styles of the same product using the same link on the same page. While this approach may visually present different options to consumers, from a data analysis perspective, these items are essentially different variations of the same product. As such, they were removed from the dataset to avoid redundancy.

d) Standardization: During the initial examination of the collected product data, it was observed that the values for product ratings and average prices significantly differed from other attributes, which could result in the disproportionate influence of these features on the overall analysis. To correct this bias, Z-score standardization using SPSS software was applied to normalize the data. The standardized value was calculated using the following formula: New Value = (Original Value−Mean)/Standard Deviation. This method effectively adjusted the dataset's mean to 0 and set the variance to 1, ensuring that the different product features had consistent magnitudes and comparability during the analysis.

Following data cleaning, further analysis was conducted to assess the balance and representativeness of the sample. First, the proportions of data across categories were

examined based on four dimensions: product price, brand strength, product ratings, and online reviews. The analysis revealed slight deviations in category distribution between the cleaned and original datasets. For instance, the proportion of products with 0–10 online reviews increased from 72.6% in the original data to 79.2% after cleaning. To mitigate the impact of imbalance on the conclusions, the study employed a random undersampling method to process the data, ensuring near-equilibrium across categories.

Second, the study compared the core statistical properties of the sample—such as mean, standard deviation, skewness, and kurtosis—before and after cleaning. The results indicated that the cleaning process had a minimal impact on the overall data distribution, thereby preserving the representativeness of the sample. This approach ensures the robustness and generalizability of the analytical conclusions.

After cleaning and analysis, the dataset consisted of 93,721 samples.

3.3.3. Clustering model construction with the introduction of biomechanical theory

The product selection strategy is modeled as a dynamic system, with key variables in the strategy being analogized using core concepts from mechanical theory to reveal patterns of variation in distance, thereby providing a scientific foundation for the strategy. First, the product selection strategy is defined as the "state variables" within a mechanical system. External forces can represent external factors influencing the product, such as customer ratings or reviews, while internal forces may refer to intrinsic product factors, such as price and brand influence. Subsequently, the most recent sample data collected from the Lazada platform is analyzed.

The following **Table 2** presents the descriptive statistical analysis of the sample data of Lazada platform:

Table 2. Descriptive statistics of Lazada sample data.

Variable	Categories	Frequency	Percentage
Commodity prices	0–20	59,371	63.3%
	20–50	17,807	19.0%
	50–200	11,246	12.0%
	200–1000	3769	4.0%
	> 1000	1528	1.6%
Brand strength	Brand	54,378	58.0%
	Non-brand	39,343	42.0%
Product Rating	1	462	0.5%
	2	297	0.3%
	3	2801	3.0%
	4	15,931	17.0%
	5	74,206	79.2%
Online Reviews	0–10	70,301	75.0%
	10–100	20,611	22.0%
	100–500	2155	2.3%
	> 500	654	0.7%

It can be found that in terms of commodity prices, commodities priced at $0–$50 accounted for 82.3% of the total number of valid commodities, indicating that the prices of commodities on the platform are predominantly low to medium. In terms of brand strength, Lazada's commodities have more branded commodities than non-branded commodities. In terms of product ratings, nearly 80% of products have a rating of 5. And in terms of the number of product reviews, most products do not have a high number of reviews.

In terms of category structure, the **Table 3** below shows the results of the number of Lazada first-level categories:

Table 3. Lazada first-level category product statistics results.

First-level category	Frequency	Percentage
Women's fashion and Accessories	10,976	11.7%
Home and Lifestyle	10,491	11.2%
Electronic devices	9754	10.4%
Groceries and Pets	9509	10.1%
Babies and Toys	9497	10.1%
Health and Beauty	9132	9.7%
TV and Home appliances	7747	8.3%
Men's fashion and Accessories	5634	6.0%
Sports and Tourism	5609	6.0%
Cars and Motorcycles	5384	5.7%
Electronic accessories	5202	5.6%
Kid's fashion and Accessories	4786	5.1%

According to the category statistics, Lazada has a total of 12 primary categories and 128 secondary categories. The categories with the highest number of items are Women's Fashion and Accessories, Home and Lifestyle, and Electronic Devices, while the categories with the lowest number of items are Children's Fashion and Accessories, Electronic Accessories, and Cars and Motorcycles.

4. Results

After completing the standardization of the data, the dataset was grouped using the 12 first-level categories as the basis for labeling the cases. The key step in cluster analysis is to determine the optimal number of clusters *k*. In this paper, the elbow rule is used. As shown in **Figures 2** and **3** below, using SPSS software, the number of clusters *k* was set to start from 2 and gradually increase to 10. A cluster analysis was performed for each value of *k* and the corresponding SSE was recorded. these data were then plotted as a line graph, where the y-axis represents the sum of squared errors and the x-axis represents the value of *k*. The data were then plotted as a line graph. By observing the downward trend of the line graph, it was possible to identify the value of *k* at which the rate of SSE reduction began to slow down significantly, thus determining the number of clusters, and hence the final division into four cluster centers.

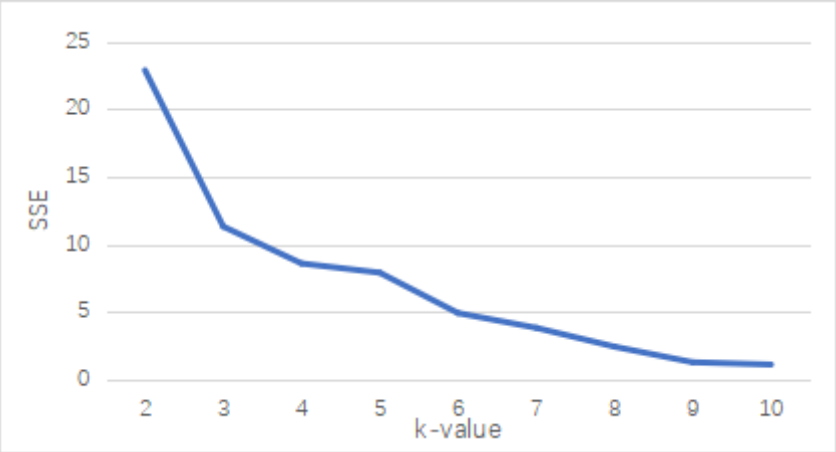

Figure 2. Diagram of the number of clusters.

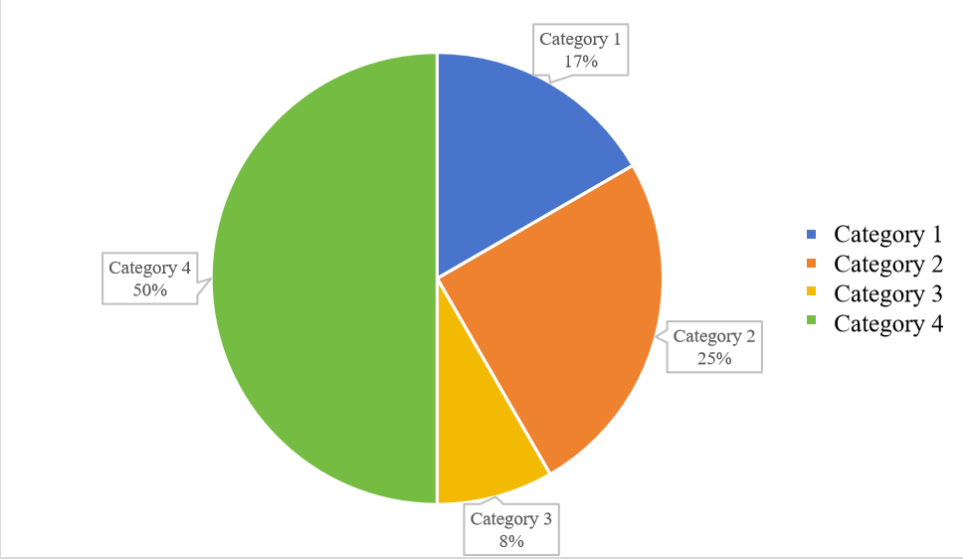

Figure 3. Graph of the number of clusters as a percentage.

The clustering results show that the fourth category contains six samples, a number that accounts for half of the total number of samples. In comparison, the second and first categories contained 3 and 2 samples, respectively. The third category had the lowest number of samples with only one.

The following **Table 4** demonstrates an overview of the cluster centers obtained after the cluster analysis was completed.

Table 4. Final cluster center.

Index/Cluster Group	**1**	**2**	**3**	**4**
Commodity prices	−0.63682	1.02252	1.82182	−0.60262
Brand strength	0.13161	0.63990	1.49310	−0.61267
Product Rating	1.31344	−0.92144	1.50766	−0.22837
Online Reviews	0.21136	0.91329	−0.63794	−0.42077

It can be seen that the third group is stronger than the other groups in three aspects: average price, brand strength, and number of reviews, while the second group has the highest index of product ratings, and the fourth group has a mediocre performance.

The distribution of cases in each group is shown in the **Table 5** below.

Table 5. Categories within each group and representative category.

Group	Number of categories	Categories name	Representative category
Group 1	2	Health and Beauty, Men's fashion and Accessories	Health and Beauty
Group 2	3	TV and Home appliances, Cars and motorcycles, Electronic accessories	TV and Home appliances
Group 3	1	Electronic devices	Electronic devices
Group 4	6	Women's fashion and Accessories, Home and Lifestyle, Grocery and Pets, Baby and Toys, Sports and Travel, Kid's fashion and Accessories	Women's fashion

The representative category is the category with the highest frequency of products in the group.

From the **Table 6** below, it can be seen that both "external forces" and "internal forces" affect the state variables, which means that all the variables contribute significantly to the clustering results, but their influence on the clustering results has a hierarchical nature. Among them, "internal forces" have the greatest influence on the state variables, brand strength and average price are more significant in the cluster analysis, while product ratings and number of reviews, although less important, are also factors that cannot be ignored. This shows that Vietnamese consumers on the Lazada platform place more importance on brand and product price.

Table 6. Variance test table.

	Clustering		Deviation			
	Mean Square	**Degree of freedom**	**Mean Square**	**Degree of freedom**	***F***	**Significance**
Commodity prices	3.149	3	0.194	9	16.205	0.001
Brand strength	1.915	3	0.657	9	22.915	0.000
Product Rating	1.354	3	0.867	9	11.561	0.000
Online Reviews	2.861	3	0.302	9	9.471	0.000

5. Discussion

This study introduces a biomechanical perspective by drawing analogies between the principles of biomechanics and the key elements of product selection strategies, thereby revealing a new product selection strategy for Lazada. However, product-related data is constantly changing, and analyzing the selection strategy based solely on data from a specific point in time on the Lazada platform may result in a lag in responsiveness. To enhance the scientific nature and dynamic adaptability of the product selection strategy on the Lazada platform, a feedback control model from biomechanics can be applied, constructing a closed-loop selection strategy based on "intervention-response-adjustment". This mechanism allows for real-time analysis and adjustment of feedback signals, enabling precise intervention in clustering results and thus dynamically optimizing the selection strategy.This study identifies that "internal forces," namely product price and brand strength, significantly influence the

classification outcomes. As platform data evolves, product classifications are subject to change, leading to corresponding adjustments in product selection strategies.

Following a market performance clustering analysis of various product categories on the platform based on biomechanical theory and a further segmentation study of popular categories, the following recommendations can be made:

- Pricing Strategy

Products on the Lazada platform are primarily priced at mid-to-low levels. However, considering factors such as product cost, quality, and logistics, merchants should adhere to the principle of reasonable pricing when selecting products. Given that users place importance on brand strength, merchants are advised to prioritize branded products. If non-branded products are chosen, the production or procurement costs should be considered to ensure product quality. In addition to understanding market pricing, attention should also be paid to competitors' pricing strategies. Merchants can employ pricing tables, templates, or automated pricing tools to assist in setting competitive prices.

When selecting popular categories, such as women's apparel and home goods with high traffic keywords, merchants should first analyze the pricing of similar products in the market, understand the price range within the industry, and closely monitor competitors' pricing strategies, especially those for high-selling, highly rated products. Pricing should be set within an effective exposure range, establishing a competitive pricing advantage and avoiding arbitrary pricing. For higher-priced products, merchants should focus on promoting product quality and brand, ensuring that the price reflects the product's value. Higher prices can be set to reflect the product's uniqueness, quality, or added value, and a differentiated pricing strategy should be formulated.

- Category Strategy

When selecting products, merchants should first consider their own resources and experience, prioritizing categories they are familiar with. This enables better understanding of product characteristics, market positioning, and consumer demand, while fostering trust with consumers and improving conversion rates. Before entering the market, merchants can research market trends to understand current and future consumer preferences and demand changes.

Lazada has high market penetration in certain countries and regions, and merchants should prioritize popular categories in these areas. In Vietnam, for example, best-selling categories tend to be retail items that are easy to transport, such as clothing accessories and food products. Merchants should select categories based on their own supply chain and logistics capabilities, ensuring the stable supply and timely delivery of products to consumers. Given the challenges of international shipping, many new merchants entering the market may prefer categories such as men's apparel and health and beauty, as competition is less intense than in other categories. It is important to analyze competitors' sales and category choices on the Lazada platform, identifying their strengths and weaknesses, to avoid choosing identical categories and reduce competitive pressure.

Merchants with strong brand channel resources may consider selecting products from the second and third groups. It is crucial to avoid excessively high-priced or poor-

quality products, as this could negatively affect store reputation and sales. Enhanced after-sales service should be prioritized, and merchants should closely monitor consumer feedback to understand their shopping experiences and evolving needs. Based on consumer feedback, product selection plans should be adjusted to meet consumer demands.

Once a merchant is established in the market, periodic adjustments to categories should be made to continuously optimize the product mix and inventory management. Product selection plans should be adjusted based on market changes and evolving consumer needs, removing poorly performing categories and introducing promising new ones.

- Market Segmentation Strategy

The optimization of market segmentation strategies in product selection is crucial for ensuring that sellers can accurately target their markets, improve sales efficiency, and meet consumer needs. Merchants can utilize market research and data analysis to deeply explore consumer purchasing behavior, interests, preferences, and actual demands, identifying differentiated needs among various consumer groups to provide customized products and services. For instance, considering the tropical climate of Southeast Asia, merchants could focus on materials that are heat-resistant, breathable, and sweat-absorbing when selecting products.

Merchants should define the dimensions of market segmentation, taking into account consumer needs, product characteristics, and regional factors, to ensure that these dimensions can clearly delineate target markets and help develop targeted marketing strategies. Given Southeast Asia's cultural diversity and highly localized features, merchants should deeply understand local consumption preferences, social and cultural traditions, and religious beliefs. Additionally, they should keep track of local festivals, social events, and popular trends in Southeast Asia. By conducting in-depth market research, merchants can more accurately target the right markets and tailor product selection strategies to meet the specific needs of local consumers, thus gaining a competitive edge in the market.

Merchants can approach segmentation from various angles, such as using social media, emails, or other means to establish interactive channels with consumers. By encouraging feedback and suggestions, they can better understand consumer needs and expectations, allowing them to refine segmentation strategies. Furthermore, merchants should build long-term partnerships with reliable suppliers, ensuring stable product supply and gaining valuable insights into product characteristics and market trends. Working with suppliers, merchants can jointly analyze market trends and consumer needs, and collaboratively develop market segmentation and product strategies.

6. Conclusion

With the continuous development of cross-border e-commerce platforms, conducting cross-border e-commerce through overseas e-commerce platforms has become the primary choice for Chinese foreign trade enterprises to transform. As an important economic region of the "Belt and Road" strategy, the Southeast Asian market has strong development potential and lower competition intensity compared to

domestic e-commerce, with a high success rate of entry. Among them, the Lazada platform is also one of the primary choices for many small and medium-sized foreign trade enterprises. In today's mature cross-border e-commerce landscape, it is essential to incorporate biomechanical theory to drive new innovations.

This study focuses on the Lazada platform's Vietnam site as the research object, collecting consumer purchase data from 128 secondary categories on the platform. It employs a clustering algorithm based on biological theories to analyze the platform's various products, using the concepts of stress-strain relationships and dynamic equilibrium to explore the dynamic adjustment mechanism of product selection strategies under the combined influence of "internal forces" and "external forces." A systematic operational framework is proposed to assist novice sellers in making more informed and effective decisions during the product selection process. The research findings indicate that biomechanical theory, combined with k-means clustering analysis, can quantify the intrinsic patterns of product category changes and propose selection strategies that break through the limitations of traditional research approaches.

The main product type on the Lazada platform is retail products, with a focus on providing high cost-effectiveness, convenient logistics, and good brand reputation for retail products. Consumers are highly satisfied with the products, and most products have good sales performance. From the perspective of biomechanical theory, it is recommended that sellers focusing on the popular category of the fourth type prioritize products with high sales but relatively low market competition. This strategy helps to avoid the common pitfalls of product homogenization and price wars. For non-popular product categories, merchants can choose electrical products from the second and third groups.

The share of cross-border e-commerce in China's trade has been steadily increasing, and academic research in the field of cross-border e-commerce has been deepening. Researchers are incorporating perspectives from various fields, with biomechanics theory offering a new lens for studying cross-border e-commerce. Compared with the domestic e-commerce market and the European and American cross-border e-commerce market, the Southeast Asian e-commerce market started relatively late, and the competition is relatively less intense, which is more conducive to the entry of small and medium-sized e-commerce enterprises and domestic manufacturing enterprises. Due to the special nature of cross-border transportation, most small and medium-sized enterprises tend to choose small, lightweight, and easy-to-transport daily retail products when selecting products. The large number of enterprise entries has made the competition in this category increasingly fierce, resulting in severe product homogenization and making it difficult for enterprises to sustain profits.

Based on the clustering analysis using biological theory, this study recommends health and beauty categories, men's fashion and accessories categories, electronic equipment categories, and household appliance categories to novice sellers. Small and medium-sized enterprises can refer to their own capabilities and market differences to select products. Due to the limitations of personal abilities and data, this study did not include factors such as price trends and profits, which also have an impact on product selection. Therefore, further in-depth analysis is needed, combined with enterprise

applications, to provide more realistic and effective product selection recommendations.

Ethical approval: Not applicable.

Conflict of interest: The author declares no conflict of interest.

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