Nghiên cứu tác động của chất lượng dịch vụ giao hàng chặng cuối đến sự hài lòng của khách hàng tại Bình Định khi mua sắm trên các sàn thương mại điện tử

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TÓM TẮT

Đề tài này nhằm nghiên cứu và đánh giá tác động của chất lượng dịch vụ giao hàng chặng cuối đến sự hài lòng của khách hàng tại Bình Định khi mua sắm trên các sàn thương mại điện tử. Qua việc sử dụng các kỹ thuật phân tích Cronbach's Alpha, phân tích nhân tố khám phá (EFA), phân tích nhân tố khẳng định (CFA) bằng mô hình để kiểm định giá trị tin cậy, giá trị phân biệt, hiệu lực và độ hội tụ của các thang đo, cùng với việc thực hiện phân tích mô hình cấu trúc tuyến tính (SEM) để kiểm định giả thuyết nghiên cứu và sử dụng các kỹ thuật phân tích Anova và T-Test để kiểm định có sự khác biệt trong chất lượng dịch vụ giao hàng chặng cuối đến sự hài lòng của khách hàng tại Bình Định khi mua sắm trên các sàn thương mại điện tử. Kết quả nghiên cứu đã chỉ ra rằng các nhân tố hiệu suất chi phí, sự tin cậy, phương tiện hữu hình, sự đồng cảm, sự đáp ứng sẽ góp phần đáng kể trong việc tăng cường sự hài lòng của khách hàng tại Bình Định khi mua sắm trên các sàn thương mại điện tử. Đáng chú ý, trong 5 nhân tố trên thì hiệu suất chi phí có tác động mạnh nhất đến sự hài lòng của khách hàng. Dựa trên kết quả nghiên cứu, một số hàm ý quản trị liên quan cũng được đưa ra nhằm hỗ trợ cho các doanh nghiệp giao hàng chặng cuối cải thiện chất lượng dịch vụ và nâng cao sự hài lòng của khách hàng.

Từ khóa: *Chất lượng dịch vụ, giao hàng chặng cuối, sự hài lòng, thương mại điện tử.*

Examining the Impact of Last-Mile Delivery Service Quality on Customer Satisfaction in Binh Dinh When Shopping on E-Commerce Platforms

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ABSTRACT

This study aims to examine and evaluate the impact of last-mile delivery service quality on customer satisfaction in Binh Dinh when shopping on e-commerce platforms. By utilizing Cronbach's Alpha analysis, exploratory factor analysis (EFA), and confirmatory factor analysis (CFA) to test the reliability, discriminant validity, effectiveness, and convergent validity of the measurement scales, along with structural equation modeling (SEM) to test research hypotheses, and ANOVA and T-Test techniques to assess differences in last-mile delivery service quality and customer satisfaction in Binh Dinh when shopping on e-commerce platforms. The research findings indicate that cost efficiency, reliability, tangible factors, empathy, and responsiveness significantly contribute to enhancing customer satisfaction in Binh Dinh when shopping on e-commerce platforms. Notably, among these five factors, cost efficiency has the strongest impact on customer satisfaction. Based on the study results, several managerial implications are proposed to help last-mile delivery companies improve service quality and enhance customer satisfaction.

Keywords: *Service quality, last-mile delivery, customer satisfaction, e-commerce.*

1. INTRODUCTION

Last-mile delivery is the process of transporting goods from a distribution center to the customer's location, playing a crucial role in the supply chain and e-commerce. The quality of last-mile delivery services directly affects customer satisfaction and the likelihood of repeat purchases, evaluated through criteria such as delivery time, product damage rates, flexibility, pricing, and service speed.

Vietnam is witnessing a robust boom in e-commerce, and the quality of last-mile delivery services serves as a key factor in driving this growth. A study by Nielsen indicates that the COVID-19 pandemic has led Vietnamese consumers to change their shopping habits, increasingly shifting towards online purchasing. [1] To meet customer expectations, enhance competitive capabilities, and expand market reach, Vietnam needs to pay particular attention to improving last-mile delivery service quality. Additionally, efficient delivery services help businesses differentiate their products, retain customers, and expand their market, especially in rural and remote areas. Research by McKinsey & Company has shown that over 65% of Vietnamese consumers intend to shop differently than in-store post-pandemic, particularly favoring rapid delivery services, with consumers willing to pay extra for faster delivery.[2] Consequently, e-commerce businesses are continuously investing in modern technology and management systems. According to the e-Conomy SEA 2022 report by Google, Temasek, and Bain & Company, Vietnam ranks among the top countries in Southeast Asia for online shopping growth. [3] It is projected that revenue and sales volume on B2C online retail platforms in Vietnam could reach 650 trillion VND by 2024, with the top five e-commerce platforms (including Shopee, Lazada, Tiki, Sendo, and

Tiktok Shop) potentially achieving over 310 trillion VND in 2024, representing a 35% growth compared to 2023.

However, the e-commerce boom also presents numerous challenges for last-mile delivery services. Vietnam's diverse geography, including many deep and remote areas, complicates delivery logistics, increasing transportation costs and extending delivery times. Furthermore, the logistics sector faces a severe labor shortage, estimated at around 200,000 skilled workers according to reports from Vietnam Logistics House.[4] The competitive pressure among transport providers is intensifying as customers demand faster, more reliable, and more transparent services. Technological advancements also impose higher demands on delivery management systems, yet many companies struggle to adopt advanced technologies such as artificial intelligence and big data.

Numerous studies, both domestically and internationally, have examined the impact of last-mile delivery service quality on customer satisfaction in e-commerce. These studies indicate three main factors influencing satisfaction: operational quality, relational quality, and cost performance. They also affirm the critical role of last-mile delivery experiences in overall customer satisfaction in e-commerce.

Last-mile delivery significantly impacts customers shopping on e-commerce platforms in Vietnam. However, companies providing last-mile delivery services nationwide often operate on a relatively small scale, with limited infrastructure and resources, while the e-commerce explosion continues to grow. The question for many companies is how to overcome this situation and ensure that last-mile delivery businesses remain competitive in the market amid the e-commerce boom while meeting customer satisfaction. Although many studies have indicated that last-mile delivery impacts customer satisfaction, there is still a notable gap in this field, particularly concerning the Vietnamese market. Most current research focuses on basic logistics factors or the service quality of delivery companies without delving into customer psychology and needs in the context of rapidly evolving e-commerce. In Vietnam, factors such as consumer culture and consumer psychology may lead to differences in delivery experiences and customer satisfaction. However, no studies have specifically addressed these factors. Additionally, there remains a gap in researching new initiatives and technologies in last-mile delivery. Walker and colleagues emphasized that adopting technologies like AI and big data can enhance the delivery experience for customers, thereby increasing satisfaction.[5] However, few studies have indicated how these technologies are applied in practice within the Vietnamese context and their impact on consumer satisfaction. Moreover, the diversity of consumer behavior among Vietnamese consumers presents a significant challenge for research. According to a study by Phan and colleagues, unlike consumers in developed countries, Vietnamese consumers tend to prioritize price and promotions over delivery service quality.[6] This underscores the need for deeper research into the behavior and needs of Vietnamese consumers in the rapidly developing e-commerce context to better understand the impact of last-mile delivery on satisfaction. Therefore, to propose solutions to enhance last-mile delivery service quality and improve customer satisfaction when shopping on e-commerce platforms in Vietnam, the research team has chosen the topic "The Impact of Last-Mile Delivery Service Quality on Customer Satisfaction in Binh Dinh When Shopping on E-Commerce Platforms: Building a Model and Research Hypotheses." This research is conducted to construct a model and research hypotheses to facilitate subsequent research measuring the impact of last-mile delivery service quality on customer satisfaction in Binh Dinh when shopping on e-commerce platforms..

2. THEORETICAL FRAMEWORK

2.1. Concepts

Last-Mile Delivery: Throughout the process of transporting goods to consumers, last-mile delivery can be understood as the final stage of the supply chain. The activity of last-mile delivery has been around for a long time in the transportation of goods, but in recent years, with the robust development of e-commerce, it has garnered significant attention from businesses, both large and small. Numerous studies have defined "last-mile delivery," but it can be understood as the final stage of delivery service,

beginning from the last distribution point to the consumer.

Service Quality: Long considered one of the key factors for the success of any business, especially in the context of the booming e-commerce industry, service quality has become a strategic direction to enhance competitiveness, attract, and serve customers. Based on existing research, "service quality" is understood as the ability to meet the needs and expectations of customers of a particular service through factors such as reliability, accuracy, and service quality.

Last-Mile Delivery Service Quality: The effectiveness of last-mile delivery operations is a factor that directly affects customer satisfaction and the likelihood of returning to purchase from e-commerce channels. Last-mile delivery service quality can be evaluated based on criteria such as on-time delivery rates, product damage rates, delivery service flexibility, service pricing, and service speed. Based on existing concepts, "last-mile delivery service quality" is understood as the extent to which delivery services meet or exceed customer expectations (effectiveness) in the final phase of the supply chain.

Customer Satisfaction: Numerous studies have defined customer satisfaction; however, these concepts are abstract and somewhat vague as customer satisfaction is viewed as the fulfillment of their needs and desires. Definitions of customer satisfaction emphasize the relationship between initial expectations and actual outcomes after using a product or service. Satisfaction not only reflects customer experience but also serves as a basis for businesses to retain current customers and expand their market.

Relationship between Last-Mile Delivery Service Quality and Customer Satisfaction: Many studies on customer satisfaction in the service industry have been conducted. Some authors argue that there is an overlap between service quality and customer satisfaction, and thus the two concepts can be used interchangeably. They assert that service quality leads to customer satisfaction, with service quality serving as a basis for evaluating customer satisfaction.[7,8] Therefore, to enhance customer satisfaction, service providers must further improve their service quality. These two factors are closely related and interact with each other, where service quality precedes customer satisfaction. However, numerous studies have shown that service quality and customer satisfaction are distinct concepts. Argue that there are differences between service quality and customer satisfaction, with the distinction being a "causal" issue.[9] Customer satisfaction is seen as the result, while service quality is viewed as the cause, with satisfaction being predictive and expected, and service quality as an ideal standard. Customer satisfaction is a general concept reflecting their satisfaction when using a service, while service quality focuses on specific components of the service.[10]

2.2. Theoretical framework

SERVQUAL Model: The SERVQUAL model was developed in 1985 a widely used tool for measuring service quality in various fields.[11,12] This model measures service quality based on the gap between customer expectations and their perceptions after using the service. Specifically, service quality = Perceived Level – Expected Value. The SERVQUAL model consists of 10 components: Tangibles, Reliability, Assurance, Responsiveness, Courtesy, Credibility, Security, Access, Communication, and Understanding Customers. In 1988, after conducting research and practical testing, the authors refined the model to focus on five core factors based on similarities and overlaps among the initial factors, making the model more concise and focused, helping organizations easily assess, implement, and improve service quality.

(1) Tangibles: The physical appearance of facilities, equipment, transportation means, product packaging, and the appearance and uniforms of delivery personnel.

(2) Reliability: Reliability indicates the ability to provide services accurately, on time, and at the right location, ensuring consistency and credibility in the delivery process, and respecting commitments to customers.

(3) Assurance: This factor instills trust and comfort in customers, perceived through communication style, politeness, professionalism, and high expertise of delivery personnel..

(4) Responsiveness: This criterion measures the ability to promptly respond to and resolve issues, being ready to assist customers. In

other words, responsiveness is the feedback from service providers regarding customer requests.

(5) Empathy: Empathy is the concern, understanding, and care for customers, flexibly supporting them with delivery time or location to meet their individual needs. This empathy enhances satisfaction and creates goodwill among customers.

SERVPERF model: This model is a variant of the SERVQUAL model aimed at assessing service quality based on actual performance experienced by customers rather than measuring the gap between expectations and perceptions.[8] According to the SERVPERF model, service quality = Perceived Level. The SERVPERF measurement scale also uses 22 questions but does not require measuring expectations, simplifying the complexity compared to the SERVQUAL model, reducing the number of survey questions, making data collection easier and more economical; it directly focuses on the actual customer experience, measuring service quality more clearly and accurately. The SERVPERF measurement scale also includes five basic components: Tangibles, Reliability, Assurance, Responsiveness, and Empathy.

Logistics Service Quality Assessment Model, this model builds on the SERVPERF model by adding cost performance as a component to measure logistics service quality. [13]

3. RESEARCH METHODOLOGY

3.1. Research method

Building upon the results of qualitative research with established models, research hypotheses, and measurement scales, the research team conducted quantitative research in two phases: preliminary quantitative research and formal quantitative research. To test the constructed questionnaire, the research team conducted preliminary quantitative research by surveying a sample of 50 customers who used e-commerce services. The collected data were analyzed using SPSS 22 software to statistically assess the sample, evaluate the reliability of the measurement scales (Cronbach's Alpha – CA), and conduct exploratory factor analysis (EFA). After analyzing and discussing the research results, the research team will refine and finalize the survey questionnaire to proceed with the formal research.

The formal quantitative research phase will be conducted through a survey of a sample of 340 customers who have shopped on e-commerce platforms. The collected data will be analyzed using multivariate statistical techniques in SPSS, including analyzing the sample, assessing the reliability of the measurement scales (CA), conducting exploratory factor analysis (EFA), and running confirmatory factor analysis (CFA) data for further analysis in AMOS to check the suitability of the research model. With the support of AMOS, in addition to CFA analysis, the structural equation modeling (SEM) will also be used to test complex theoretical models and measure relationships between observed variables and latent constructs.

3.2. Model and research hypotheses

3.2.1. Research model

Based on previous studies on customer satisfaction, the research team proposes a model to investigate the impact of last-mile delivery service quality on customer satisfaction, combining the SERVPERF model and the logistics service quality assessment model, along with the following research hypotheses: [13]

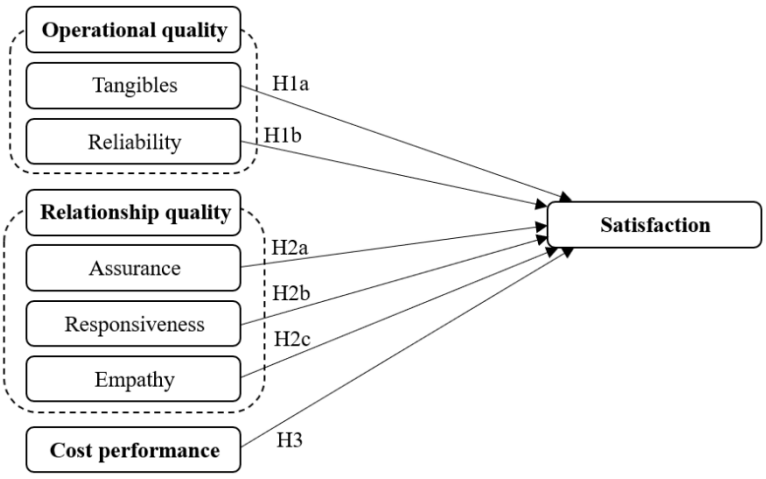

Figure 1. Research model of the impact of last-mile delivery service quality on customer satisfaction

(Source: Proposed by the research team)

3.2.2. Research hypotheses

H1: Operational quality and customer satisfaction when shopping on e-commerce platforms have a positive relationship (+)

H1a: Tangibles and customer satisfaction when shopping on e-commerce platforms have a positive relationship (+)

H1b: Reliability and customer satisfaction when shopping on e-commerce platforms have a positive relationship (+)

H2: Relational quality and customer satisfaction when shopping on e-commerce platforms have a positive relationship (+)

H2a: Assurance and customer satisfaction when shopping on e-commerce platforms have a positive relationship (+)

H2b: Responsiveness and customer satisfaction when shopping on e-commerce platforms have a positive relationship (+)

H2c: Empathy and customer satisfaction when shopping on e-commerce platforms have a positive relationship (+)

H3: Cost performance and customer satisfaction when shopping on e-commerce platforms have a positive relationship (+)

3.2.3. Measurement scale development

The measurement scales developed by the research team were built upon related studies and also received input from experts and customers after group discussions.[11,14,13] The measurement scale consists of four groups with five components and 32 observed variables. The Operational Quality group includes Tangibles with four observed variables (HH1, HH2, HH3, HH4) and Reliability with five observed variables (TC1, TC2, TC3, TC4, TC5); the Relational Quality group includes Assurance with five observed variables (DB1, DB2, DB3, DB4, DB5), Responsiveness with six observed variables (DU1, DU2, DU3, DU4, DU5, DU6), and Empathy with five observed variables (DC1, DC2, DC3, DC4, DC5); the Cost Performance group includes four observed variables (CP1, CP2, CP3, CP4); group of customer satisfaction derived from various studies, with three observed variables (HL1, HL2, HL3).[15-17]

Table 1. Measurement scale for the impact of last-mile delivery service quality on customer satisfaction in Binh Dinh when shopping on e-commerce platforms

Measurement scale	Symbol	Statement	Reference
Operational quality			
Tangibles	HH1	Delivery personnel are adequately prepared with a motorcycle, phone, and box for deliveries.	Parasuraman et al,[11] Tran et al,[14] authors' proposal.
	HH2	Delivery personnel wear neat uniforms.	
	HH3	Motorcycles and delivery boxes are new and clean.	
	HH4	Delivery personnel have modern motorcycles, phones, and delivery boxes.	

Reliability	TC1	The delivery unit completes deliveries on time as promised.	Parasuraman et al,[11] Tran et al,[14] authors' proposal.
	TC2	The delivery unit is always ready to assist customers.	
	TC3	The delivery unit securely protects customer information.	
	TC4	The delivery unit delivers the correct goods on the first attempt.	
	TC5	Information about the delivery person (name, appearance) and motorcycle (license plate) is accurately provided.	
Relationship quality			
Assurance	DB1	Staff always respect customers.	Parasuraman et al,[11] Tran et al.[14]
	DB2	Customers feel safe when being served.	
	DB3	Staff possess sufficient expertise to answer customer inquiries.	
	DB4	Staff have the skills and flexibility to handle difficult situations.	
	DB5	The delivery unit ensures the integrity of the goods.	
Responsiveness	DU1	Staff provide services quickly.	Parasuraman et al,[11] Tran et al.[14]
	DU2	The delivery unit fulfills orders without regard to contract size.	
	DU3	The delivery unit promptly handles urgent and unexpected orders.	
	DU4	Delivery personnel enthusiastically assist customers with inquiries or unexpected requests.	
	DU5	Delivery personnel provide specific notifications on when the goods will be delivered.	
	DU6	Delivery personnel have a very professional working demeanor.	
Empathy	DC1	The delivery unit makes customers feel cared for.	Parasuraman et al.[11]
	DC2	Staff pay attention to each customer.	
	DC3	Staff understand the specific needs of each customer.	
	DC4	Staff can adequately answer customer questions.	
	DC5	Delivery personnel arrive at a time convenient for the customer.	
Cost performance			
Cost performance	CP1	Delivery services are reasonably priced.	Stank et al,[13] authors' proposal
	CP2	Delivery services are more competitively priced compared to other platforms.	
	CP3	Free or discounted shipping programs encourage customers to purchase on e-commerce platforms.	
	CP4	I am completely confident about the delivery costs of this e-commerce business.	
Customer satisfaction			
Satisfaction	HL1	I am satisfied with the last-mile delivery service.	T.W Andreassen, B. Lindestad,[15] R.L. Oliver,[16] U. Tandon.[17]
	HL2	I will continue to choose this last-mile delivery service.	
	HL3	I will recommend the last-mile delivery service I am using.	

(Source: Compiled and proposed by the authors)

4. RESEARCH RESULTS

Preliminary research helps identify important variables, build the survey tool, and minimize risks, creating a solid foundation for formal research. The survey was conducted on 50 subjects, yielding 50 valid responses, of which 54% were female and 46% were male. The age group of 18-24 was the most represented (64%), with students accounting for 52%. Geographically, participants were primarily from Quy Nhơn (19,7%), while 4% outside the research scope were excluded, leaving 48 valid responses.

The research measurement scale comprises 31 observed variables, demonstrating high reliability (Cronbach's Alpha > 0,8). However, the variable "DC5" was removed due to its low correlation with the total variable (0,089 < 0,3). EFA analysis revealed that the data was suitable: KMO index = 0,642 (> 0,5), and Bartlett's test was statistically significant (sig < 0,05). The total variance extracted was 78,823% (> 50%), with 28 independent variables divided into six groups, and all Eigenvalues were > 1 (the smallest being 1,841), ensuring convergent and discriminant validity. The analysis of dependent variables also met the required criteria: KMO = 0,754 (> 0,5), and Bartlett's test was significant (sig < 0,05). The total variance extracted = 88,122% (> 50%), with three factors having Eigenvalues > 1. All three observed variables achieved loading factors > 0,5, confirming that the measurement scale was suitable for assessing customer satisfaction.

After conducting preliminary research to test the feasibility of the hypotheses and refine the survey for formal research, the main objective of the formal research is to further assess and analyze the impact of last-mile delivery service quality factors on customer satisfaction in Binh Dinh when shopping on e-commerce platforms. The results of the formal analysis include the following steps:

4.1. Sample description

The study surveyed 340 customers in Binh Dinh who have shopped on e-commerce platforms. Of these, 56,5% were female and 43,5% were male. The age group 18-24 accounted for the highest percentage at 43,2%. In terms of occupational structure, students and pupils accounted for the highest proportion at 64,4%. Among the total sample, Phù Mỹ district had the highest number of participants, accounting for 27,6%. The survey was conducted online via Google Forms.

The research utilized various analytical techniques in SPSS 22.0 to process the data and address the research objectives, including statistical analysis of the sample, reliability assessment of the measurement scales (CA), exploratory factor analysis (EFA), and CFA for subsequent analysis and model fit evaluation. Additionally, ANOVA and T-Test were conducted to assess whether there were differences in satisfaction levels between different customer groups based on demographic factors such as gender, age, occupation, and residence.

4.2. Reliability assessment of the measurement scale (CA)

The measurement scales were analyzed based on the Cronbach's Alpha coefficient, and those variables with a total variable correlation coefficient less than 0,3 were removed. Scales were accepted as reliable if they had a Cronbach's Alpha of 0,6 or higher. The results of the Cronbach's Alpha coefficients for the measurement scales are presented in Table 2:

Table 2. Reliability of measurement scales

Observed Variable	Scale mean if item deleted	Scale variance if Item deleted	Corrected Item-total correlation	Cronbach's Alpha if item deleted
Scale "Tangibles (HH)"			**Cronbach's Alpha = 0,879**	
HH1	11,19	4,946	0,750	0,841
HH2	11,11	4,878	0,739	0,845
HH3	11,15	4,710	0,789	0,825
HH4	11,14	5,280	0,679	0,867
Scale "Reliability (TC)"			**Cronbach's Alpha = 0,858**	
TC1	15,17	12,407	0,597	0,847
TC2	15,26	11,356	0,694	0,823
TC3	15,29	11,416	0,628	0,840
TC4	15,22	10,450	0,751	0,807
TC5	15,33	10,946	0,702	0,820
Scale "Assurance (DB)"			**Cronbach's Alpha = 0,892**	

DB1	14,43	9,337	0,744	0,867
DB2	14,41	9,411	0,726	0,871
DB3	14,43	9,214	0,727	0,871
DB4	14,37	9,466	0,726	0,871
DB5	14,34	9,528	0,762	0,864
Scale "Responsiveness (DU)"			**Cronbach's Alpha = 0,885**	
DU1	18,66	11,911	0,759	0,855
DU2	18,63	13,238	0,575	0,884
DU3	18,61	13,047	0,655	0,872
DU4	18,63	12,299	0,707	0,864
DU5	18,54	12,084	0,748	0,857
DU6	18,53	12,132	0,746	0,857
Scale "Empathy (DC)"			**Cronbach's Alpha = 0,897**	
DC1	15,32	7,422	0,762	0,871
DC2	15,34	7,489	0,685	0,888
DC3	15,36	7,352	0,694	0,886
DC4	15,26	7,371	0,801	0,863
DC5	15,21	7,131	0,795	0,863
Scale "Cost performance (CP)"			**Cronbach's Alpha = 0,869**	
CP1	10,96	4,797	0,686	0,847
CP2	11,04	4,364	0,806	0,798
CP3	11,01	4,755	0,721	0,834
CP4	11,09	4,614	0,678	0,852
Scale "Satisfaction (HL)"			**Cronbach's Alpha = 0,894**	
HL1	7,69	3,872	0,783	0,855
HL2	7,60	3,651	0,807	0,835
HL3	7,70	3,964	0,785	0,854

(Source: Extracted from data processing results)

The results from Table 2 indicate that the measurement scale in the research model is represented by 31 observed variables, demonstrating high reliability (all values exceed 0,8). Furthermore, most observed variables exhibit good correlation with the overall scale (with total variable correlations greater than 0,3). Therefore, the measurement scale has been constructed with high quality and is entirely suitable for conducting exploratory factor analysis (EFA) as well as subsequent analytical steps.

4.3. Exploratory factor analysis (EFA)

The research team employed Principal Component Analysis (PCA) for the exploratory factor analysis. To perform PCA, the team conducted factor analysis using Principal Components with Varimax rotation for 28 independent variables related to the quality factors of last-mile delivery services impacting customer satisfaction in Binh Dinh when shopping on e-commerce platforms.

Table 3. KMO and Bartlett's test for independent variables of quality factors impacting satisfaction

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0,838
Bartlett's Test of Sphericity	Approx. Chi-Square	6412,621
	df	406
	Sig.	0,000

(Source: Author's analysis based on collected data)

The results show that the research data are entirely suitable for conducting exploratory factor analysis (EFA). Specifically, the Kaiser-Meyer-Olkin (KMO) index reached a value of 0,838, exceeding 0,5, indicating that the observed variables are closely correlated. Additionally, Bartlett's test achieved statistical significance (sig < 0,05), meaning that the variables are correlated

within the factor. This demonstrates that the data used for exploratory factor analysis is appropriate. The initial 28 observed variables were divided into 6 groups, and the total variance extracted was 69,286%, which meets the requirement of being greater than 50%, indicating that these 6 factors explain 69,286% of the data variance. The Eigenvalues for all factors exceed 1, with the lowest Eigenvalue for the sixth factor being 1,495. The factor loading coefficients for all variables were greater than 0,5, and the difference in loading coefficients between the two extracted factors was less than 0,3. Therefore, the measurement scale meets the required standards.

Similarly, the research proceeded to analyze the three dependent variables related to customer satisfaction in Binh Dinh when shopping on e-commerce platforms using principal component analysis.

Table 4. KMO and Bartlett's test for dependent variables related to customer satisfaction

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0,749
Bartlett's Test of Sphericity	Approx. Chi-Square	598,087
	df	3
	Sig.	0,000

(Source: Author's analysis based on collected data)

The results in Table 4 indicate that the research data meet the requirements with a KMO index of 0,749 (greater than the threshold of 0,5), showing that the observed variables are closely correlated. Furthermore, Bartlett's test achieved statistical significance (sig < 0,05), indicating that the variables are correlated within the factor. The total variance extracted also met the requirement, with a cumulative percentage of 82,492% (greater than 50%), indicating that these three factors explain 82,492% of the data variance. The Eigenvalues for all factors exceeded 1, and all three observed variables met the requirement, as each variable had a loading coefficient greater than 0,5. Thus, the measurement scale used to assess factors related to customer satisfaction has met the necessary standards. These results are incorporated for further detailed analysis in subsequent research steps.

4.4. Confirmatory factor analysisnh (CFA)

After conducting exploratory factor analysis (EFA) to filter and eliminate observed variables that do not meet the study's standards, only those observed variables with high suitability and reliability were selected for the next phase of analysis. These variables were then subjected to confirmatory factor analysis (CFA), which allowed for the identification and confirmation of unidimensionality and high convergent validity of the component variables, ensuring that they yield the best and most accurate results.

The results yielded a KMO index that met the requirement, exceeding 0,5 (with a value of 0,842), and Bartlett's test achieved statistical significance (sig < 0,05), confirming that the data used for factor analysis is appropriate and that the variables are correlated. A total of 31 observed variables were divided into 7 groups, with a total variance extracted of 70,708% (greater than 50%), and all Eigenvalues for the factors were greater than 1, with the lowest Eigenvalue for the seventh factor being 1,405. Thus, these 31 factors explain 70,708% of the variance in the data for the 31 observed variables. Following the CFA analysis, the loading coefficients for all observed variables were greater than 0,5 and converged into 7 groups, with no observed variable simultaneously loading onto two factors with similar loading coefficients. Therefore, the factors ensured convergent validity and there was no overlap between factors. Consequently, when performing factor analysis, the factors were retained, confirming that the developed measurement scale is entirely appropriate. In total, 31 observed variables met the necessary standards following CFA analysis and were subsequently analyzed using Amos 22 software. The results confirmed that the measurement scales for last-mile delivery service quality factors impacting satisfaction had Composite Reliability (CR) values greater than 0,8, indicating that the measurement scales are reliable.

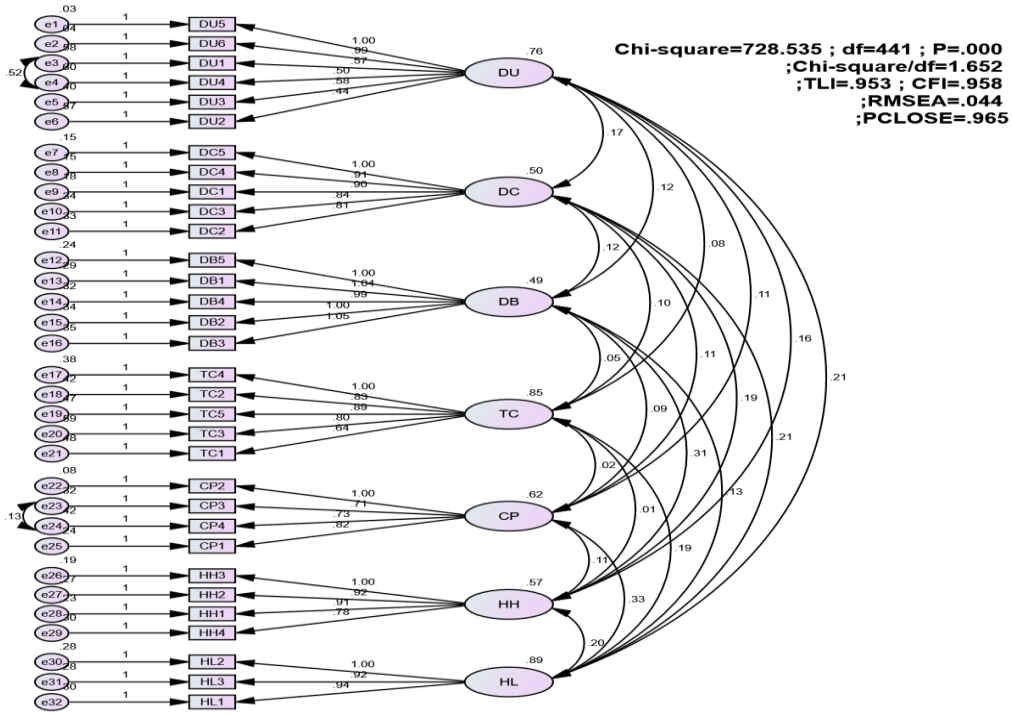

Figure 2. Results of model fit evaluation

(Source: Data processing results)

The results from Figure 2 indicate that the model has 441 degrees of freedom, with a Chi-square value of 728,535 and a P-value of 0,000. The CMIN/df (Chi-square/df) ratio is 1,652 (less than the threshold of 2), demonstrating that the model is good and suitable. Both indices, Tucker-Lewis Index (TLI) at 0,953 and Comparative Fit Index (CFI) at 0,958 (both exceeding 0,9), are acceptable, indicating that the model has relatively good fit. Additionally, the RMSEA index is 0,044 (less than 0,08) and the PCLOSE index is 0,965 (greater than 0,05), indicating that the model fits well. In summary, all assessment indices indicate that this model is adequately fitting and compatible with market data.

Regarding convergent validity of the measurement scales, as shown in Table 5, all Average Variance Extracted (AVE) indices are greater than 0,5 (ranging from 0,507 to 0,738) and all Composite Reliability (CR) indices are greater than 0,7 (ranging from 0,848 to 0,899). Therefore, it can be concluded that the developed measurement scales achieve reliability and ensure convergent validity.

Table 5. Composite reliability and average variance extracted of factors

	CR	AVE	MSV	ASV	HH	DU	DC	DB	TC	CP	HL
HH	0,880	0,648	0,348	0,108	**0,805**						
DU	0,848	0,507	0,078	0,046	0,246	**0,712**					
DC	0,899	0,642	0,120	0,068	0,347	0,279	**0,801**				
DB	0,893	0,625	0,348	0,087	0,590	0,202	0,242	**0,791**			
TC	0,859	0,551	0,049	0,015	0,021	0,097	0,147	0,081	**0,743**		
CP	0,862	0,614	0,194	0,053	0,190	0,155	0,193	0,171	0,028	**0,784**	
HL	0,894	0,738	0,194	0,087	0,285	0,254	0,308	0,200	0,221	0,440	**0,859**

(Source: Data processing results))

Regarding discriminant validity, Table 5 also shows that the MSV index is smaller than the AVE index, ensuring that discriminant validity is met. Additionally, the square root of the AVE (highlighted numbers) is greater than the correlation coefficient between that variable and

other variables in the model (the correlation coefficients are located below the bolded diagonal), thus ensuring the discriminant validity of the conceptual constructs in the model.

4.5. Structural equation modeling (SEM)

After conducting CFA to reaffirm the convergent and discriminant validity of the measurement scales, the research transitioned from the CFA model to the structural equation modeling (SEM) to analyze the impact of last-mile delivery service quality components on customer satisfaction, while also validating the relationships between them. The results of the structural model analysis showed that the CFI coefficients reached 0,958 (all exceeding 0,9), TLI equaled 0,953, CMIN/df (Chi-square/df) is 1,652 (less than the threshold of 2), P-value equals 0,000. and RMSEA was 0,044 (less than 0,08). Additionally, the PCLOSE index was 0,965 (greater than 0,05), indicating that the model fits well. In summary, all evaluation indices indicate that this model is appropriate and compatible with survey data.

To assess the statistical significance of the regression coefficients and examine the importance of the impact relationships, we must use the p-value (sig). If the p-value is less than 0,05, the regression coefficient or impact relationship is considered statistically significant. Conversely, if the p-value is greater than 0,05, the regression coefficient or impact relationship is not considered statistically significant.

Table 6. Impact level of quality components on customer satisfaction

Relationship			Impact Coefficient	Error	Test Value	P-value
HL	<---	DU	0,118	0,058	2,033	0,042
HL	<---	DC	0,178	0,079	2,271	0,023
HL	<---	DB	- 0,026	0,093	- 0,281	0,779
HL	<---	TC	0,184	0,056	3,265	0,001
HL	<---	CP	0,441	0,067	6,568	0,000
HL	<---	HH	0,188	0,091	2,062	0,039

(Source: Data processing results from Amos software)

From the results in Table 6, it is evident that five factors have P-values less than 0,05 (ranging from 0,000 to 0,042), indicating that these relationships are significant. These factors influencing "Satisfaction" (HL) include "Responsiveness" (DU), "Empathy" (DC), "Reliability" (TC), "Cost Performance" (CP), and "Tangibles" (HH). Additionally, most regression coefficients for the impact relationships are positive, suggesting that the impacts in the model are favorable (except for DB). The only factor "Assurance" (DB) has a P-value greater than 0,05 (0,791), indicating that DB is not statistically significant and does not impact HL. Thus, the hypothesis related to the relationship between DB and HL will be rejected.

Among the hypotheses proposed by the research team, the rejected hypothesis is H2a: "Assurance and customer satisfaction when shopping on e-commerce platforms have a positive relationship," while the remaining hypotheses are accepted.

4.6. Testing differences based on demographic characteristics

ANOVA and T-Test analytical techniques were employed to examine the differences in last-mile delivery service quality impacting customer satisfaction in Binh Dinh when shopping on e-commerce platforms. Specifically, these techniques were used to determine whether there are differences in satisfaction levels among different customer groups based on demographic factors such as gender, age, occupation, and residence.

To carry this out, the research team utilized SPSS version 22 to create representative variables for these factors. The representative variables were calculated by averaging the specific observed variables belonging to each factor. The results of the study not only clarify the degree of differences in delivery service quality but also provide detailed insights into customer satisfaction across various demographic groups.

Furthermore, this research helps identify the most important factors influencing customer satisfaction, thereby providing practical suggestions for managers and businesses to improve and enhance delivery service quality. This will not only elevate the shopping experience for customers but also contribute to strengthening the reputation and competitiveness of e-commerce platforms in the market. The information gathered from the research also aids

in shaping strategies for future delivery service development, ensuring better alignment with customer needs and expectations.

Table 7. Representative variables for observed variables

No	Observed Variable	Factor	Representative variable
1	HH1, HH2, HH3, HH4	Tangibles (HH)	F_HH
2	TC1, TC2, TC3, TC4, TC5	Reliability (TC)	F_TC
3	DB1, DB2, DB3, DB4, DB5	Assurance (DB)	F_DB
4	DU1, DU2, DU3, DU4, DU5, DU6	Responsiveness (DU)	F_DU
5	DC1, DC2, DC3, DC4	Empathy (DC)	F_DC
6	CP1, CP2, CP3, CP4	Cost performance (CP)	F_CP
7	HL1, HL2, HL3	Customer satisfaction (HL)	C_HL

(Source: Data processing results)

For variables with only two values, such as gender (male and female), the research team used the Independent-Samples T-Test to analyze the differences in observed variables based on gender. For variables like age, occupation, and residence that have more than three groups, the research team employed One-way ANOVA.

4.6.1. Testing differences based on gender

Table 8 shows that all observed variables have F-test significance levels greater than 0,05, indicating no variance differences between the male and female groups, and the results of the significance level (two-tailed) under the "Assuming equal variances" row are used.

Table 8. Testing differences based on gender

Observed Variable		F-Test	Significance	T-Test	df	Two-Tailed Significance
F_HH	Assuming equal variances	3,130	0,078	0,978	338	0,329
	Assuming unequal variances			0,962	293,500	0,337
F_TC	Assuming equal variances	0,146	0,703	-0,423	338	0,672
	Assuming unequal variances			-0,421	309,184	0,674
F_DB	Assuming equal variances	2,431	0,120	0,112	338	0,911
	Assuming unequal variances			0,110	298,588	0,912
F_DU	Assuming equal variances	2,492	0,115	-0,116	338	0,908
	Assuming unequal variances			-0,114	287,166	0,910
F_DC	Assuming equal variances	1,974	0,161	-1,813	338	0,071
	Assuming unequal variances			-1,779	290,258	0,076
F_CP	Assuming equal variances	4,10	0,036	-1,114	338	0,266
	Assuming unequal variances			-1,089	285,649	0,277
F_HL	Assuming equal variances	1,600	0,207	-0,578	338	0,564
	Assuming unequal variances			-0,570	297,355	0,569

(Source: Data processing results from software)

The significance levels of the F-test for most observed variables are greater than 0,05, indicating no variance differences between the male and female groups. Only the variable F_CP is less than 0,05, suggesting that F_CP shows a variance difference between the male and female groups.

In terms of two-tailed significance, variables with significance levels greater than 0,05 based on the F-test are evaluated under the "Assuming equal variances," while those below 0,5 are assessed under the "Assuming unequal variances." All variables have two-tailed significance levels greater than 0,05, indicating no average differences in "Tangibles," "Reliability," "Assurance," "Responsiveness," "Empathy," "Satisfaction," and "Cost Performance" between respondents of different genders.

4.6.2. Testing differences based on age

For observed variables with significance levels greater than 0,05, further analysis will be conducted in the ANOVA table; otherwise, the Robust Tests of Equality of Means will be used.

Table 9. Testing homogeneity by age

Observed Variable	Levene's Test	df 1	df 2	Significance
F_HH	2,629	5	334	0,024
F_TC	1,366	5	334	0,237
F_DB	1,463	5	334	0,201
F_DU	0,638	5	334	0,671
F_DC	1,614	5	334	0,156
F_CP	1,503	5	334	0,188
F_HL	1,372	5	334	0,234

(Source: Data processing results)

The results from Table 9 indicate that most variables have significance levels greater than 0,05, suggesting no variance differences among the age groups. Only the variable F_HH has a significance level less than 0,05, indicating a difference among the age groups.

Table 10. ANOVA Test by age

Observed variable		Sum of squares	df	Mean square	F-Test	Significance
F_TC	Between groups	1,180	5	0,236	0,342	0,887
	Within groups	230,317	334	0,690		
	Total	231,498	339			
F_DB	Between groups	2,436	5	0,487	0,851	0,515
	Within groups	191,323	334	0,573		
	Total	193,760	339			
F_DU	Between groups	0,603	5	0,121	0,245	0,942
	Within groups	164,454	334	0,492		
	Total	165,057	339			
F_DC	Between groups	0,121	5	0,024	0,053	0,998
	Within groups	151,752	334	0,454		
	Total	151,872	339			
F_CP	Between groups	1,064	5	0,213	0,428	0,829
	Within groups	166,149	334	0,497		
	Total	167,213	339			

(Source: Data processing results)

The results in Table 10 show that the significance levels for the observed variables F_TC, F_DB, F_DU, F_DC, and F_CP are all greater than 0,05, indicating no average differences among the observed variables across different age groups.

Table 11. Testing equality of means by age

Observed variable	Test value	df 1	df 2	Significance
F_HH	1,233	5	52,863	0,307

(Source: Data processing results)

Table 11 shows that the observed variable F_HH has a significance level greater than 0,05, indicating no statistical significance, meaning there is no average difference among the observed variable across different age groups.

4.6.3. Testing differences based on occupation

Table 12. Testing homogeneity by occupation

Observed variable	Levene's Test	df 1	df 2	Significance
F_HH	0,238	4	335	0,917
F_TC	1,424	4	335	0,226
F_DB	1,671	4	335	0,156
F_DU	0,700	4	335	0,592
F_DC	2,294	4	335	0,059
F_CP	0,579	4	335	0,678
F_HL	2,480	4	335	0,044

(Source: Data processing results)

Table 12 indicates that most variables have significance levels greater than 0,05, suggesting no variance differences among the occupational groups regarding customer satisfaction in Binh Dinh concerning last-mile delivery service quality when shopping on e-commerce platforms. Only the variable F_HL has a significance level less than 0,05, indicating that "Satisfaction" differs among the occupational groups.

Table 13. ANOVA Test by occupation

Observed variable		Sum of squares	df	Mean square	F-Test	Significance
F_HH	Between groups	1,247	4	0,312	0,586	0,673
	Within groups	178,114	335	0,532		
	Total	179,361	339			
F_TC	Between groups	0,390	4	0,097	0,141	0,967
	Within groups	231,108	335	0,690		
	Total	231,498	339			
F_DB	Between groups	1,514	4	0,378	0,660	0,621
	Within groups	192,246	335	0,574		
	Total	193,760	339			
F_DU	Between groups	1,392	4	0,348	0,712	0,584
	Within groups	163,665	335	0,489		
	Total	165,057	339			
F_DC	Between groups	1,788	4	0,447	0,998	0,409
	Within groups	150,084	335	0,448		
	Total	151,872	339			
F_CP	Between groups	0,118	4	0,030	0,059	0,993
	Within groups	167,094	335	0,499		
	Total	167,213	339			

(Source: Data processing results)

The results in Table 13 indicate that the significance levels of the observed variables are all greater than 0,05, suggesting no average differences among the observed variables across different occupational groups.

Table 14. Testing equality of means by occupation

Observed variable	Test value	df 1	df 2	Significance
F_HL	2,338	4	35,279	0,074

(Source: Data processing results)

Table 14 shows that the observed variable F_HL has a significance level greater than 0,05, indicating no statistical significance, meaning there is no average difference among the observed variable across different occupational groups regarding customer satisfaction in Binh Dinh concerning last-mile delivery service quality when shopping on e-commerce platforms.

4.6.4. Testing differences based on residence

Table 15. Testing homogeneity by residence

Observed variable	Levene's Test	df 1	df 2	Significance
F_HH	3,299	10	329	0,000
F_TC	2,421	10	329	0,009
F_DB	1,327	10	329	0,215
F_DU	0,711	10	329	0,714
F_DC	1,492	10	329	0,141
F_CP	1,664	10	329	0,088
F_HL	1,314	10	329	0,221

(Source: Data processing results)

From Table 15, it can be seen that most variables have significance levels greater than 0,05, suggesting no variance differences among the groups based on residence. The variables F_HH and F_TC have significance levels less than 0,05, indicating differences among the groups based on residence.

Table 16. ANOVA Test by residence

Observed variable		Sum of squares	df	Mean square	F-Test	Significance
F_DB	Between groups	9,331	10	0,933	10,664	0,088
	Within groups	184,429	329	0,561		
	Total	193,760	339			
F_DU	Between groups	7,282	10	0,728	1,518	0,131
	Within groups	157,775	329	0,480		
	Total	165,057	339			
F_DC	Between groups	4,226	10	0,423	0,942	0,495
	Within groups	147,646	329	0,449		
	Total	151,872	339			
F_CP	Between groups	6,131	10	0,613	1,252	0,257
	Within groups	161,082	329	0,490		
	Total	167,212	339			
F_HL	Between groups	15,123	10	1,512	1,698	0,080
	Within groups	292,987	329	0,891		
	Total	308,110	339			

(Source: Data processing results)

The results in Table 16 indicate that the significance levels of the observed variables are all greater than 0,05, suggesting no average differences among the observed variables across different residence groups.

Table 17. Testing equality of means by residence

Observed variable	Test value	df 1	df 2	Significance
F_HH	2,686	10	57,997	0,009
F_TC	3,190	10	58,371	0,003

(Source: Data processing results)

From Table 17, it is evident that the observed variables F_HH and F_TC have significance levels less than 0,05, indicating statistical significance, which suggests that there are average differences in the observed variables among respondents from different residences.

5. CONCLUSION AND RECOMMENDATIONS

The research results indicate that factors such as cost efficiency, reliability, tangibles, empathy, and responsiveness significantly contribute to enhancing customer satisfaction in Binh Dinh when shopping on e-commerce platforms. All

statistically significant factors have a positive impact, meaning that improvements in these factors lead to increased customer satisfaction. Notably, among these five factors, cost efficiency has the strongest impact on customer satisfaction. This emphasizes that customers in Binh Dinh are highly sensitive to delivery cost, especially in the context of intense competition among e-commerce platforms. The research model successfully validated the hypothesis that last-mile delivery service quality plays a crucial role in shaping customer satisfaction. Based on the research findings, the authors propose several policy implications for businesses operating in the last-mile delivery service sector to enhance customer satisfaction in Binh Dinh when shopping on e-commerce platforms.

Regarding Tangibles: Companies providing last-mile delivery services need to ensure that their employees are adequately uniformed, allowing customers to easily distinguish between different delivery service providers and thereby minimize instances of fraud. Delivery containers should bear branding that represents the company, ensuring that the packaging is undamaged, clean, and hygienic for customer orders. Investments should be made in waterproof packaging to prevent damage from adverse weather conditions. The authors suggest that last-mile delivery companies provide electronic identification cards for their employees, incorporating QR codes that allow customers to easily verify the identity of the delivery personnel against the information in their orders, thus preventing fraud.

Regarding Reliability: Companies need to enhance reliability by measuring average delivery times and implementing methods to shorten delivery durations, thus ensuring faster delivery of goods. Employees should be encouraged to strictly adhere to security protocols, always prioritizing customer interests. Implementing two-factor authentication for both internal staff and customers when logging into the system will enhance safety. Clear disclosure of security policies on the company's website or application is essential. It is crucial to ensure that customer information is not shared with third parties without consent.

Regarding Assurance: Improving the quality of delivery personnel can be achieved by training employees on customer service attitudes through a customer conduct code. A reward/penalty system based on customer feedback on employee attitudes after each delivery should be implemented. Employees should be trained to possess sufficient expertise to answer customer inquiries and to handle delivery issues effectively (e.g., damaged goods, customers not at home, customers refusing delivery, etc.). Optimal and careful transportation methods should be employed for fragile items, avoiding upside-down handling. Delivery vehicles should be equipped with shock absorption systems, and items should be organized appropriately: fragile items separately, heavy items at the bottom, and lighter items at the top. Cameras should be installed on delivery trucks to monitor the delivery process, allowing for the detection and correction of any procedural violations, such as throwing packages. Integrating vibration sensors on delivery vehicles can help check for excessive shaking during transit. The delivery and receipt process should be controlled, with clear and reasonable compensation procedures for goods damaged during transport.

Regarding Responsiveness: Improvements in delivery notifications are necessary, including applications that display the delivery personnel's location on a map and provide accurate updates on delivery times. If there are changes (e.g., traffic jams, adverse weather), the estimated delivery time should be updated accordingly. Customers should be supported in changing delivery times or addresses while the order is en route to minimize delivery failures while meeting customer requests. Establishing collection points in densely populated areas, such as Quy Nhơn city, An Nhơn town, and Hoài Nhơn, can allow the system to select the nearest warehouse for order fulfillment rather than shipping from afar, thus reducing delivery times and costs. A reserve delivery team (including collaborators, ride-hailing drivers, students, etc.) should be established to assist when the number of orders surges during peak seasons, holidays, and flash sales, ensuring that customers do not experience delays in receiving their orders and providing emergency delivery support 24/7 to meet urgent customer needs while alleviating pressure on regular delivery personnel.

Regarding Empathy: A loyalty program for frequent customers should be established, offering personalized service. An automated system to identify regular customers can provide certain delivery privileges, such as expedited delivery, allowing customers to choose their preferred delivery personnel and receive attentive consultations and support from the delivery team, fostering a sense of appreciation and care, thereby enhancing customer retention. A mechanism

should be established such that delivery personnel contact customers via phone or confirm via text at least 30 minutes prior to delivery, allowing customers to reschedule if they are busy, promoting proactive customer engagement and minimizing disruptions to their activities, thus creating a professional, customer-centric service experience. Customers should receive personal profiles of delivery personnel, enabling them to opt for a different delivery person if they had a negative experience previously.

Regarding Cost Performance: One of the key methods to enhance cost performance is to improve operational processes. Businesses can leverage modern technologies such as artificial intelligence (AI), machine learning, and GPS systems for smart deliveries to minimize transportation time and costs while increasing operational efficiency. Appropriate product packaging not only helps protect goods but also reduces shipping costs (as most delivery companies charge based on the weight of the order). Using lightweight, environmentally friendly materials and designing packaging that fits the product size will save space and weight during transport. Furthermore, strategically locating warehouses near densely populated areas or major distribution centers will shorten delivery times. The "micro-fulfillment center" model is being adopted by many businesses to quickly meet customer demands. Data plays a crucial role in devising cost optimization strategies. Companies must establish comprehensive data collection and analysis systems, encompassing delivery history, customer behavior, and the performance of each delivery driver. This enables timely evaluation and improvement of issues such as late deliveries, return rates, and unexpected costs. Utilizing big data and predictive analytics also assists businesses in forecasting seasonal demand, allowing for appropriate resource allocation and waste avoidance.

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