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Study on relationship between responsible supply chain management of fresh food E-commerce platforms in China and customer loyalty

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Abstract

This study examines how Responsible Supply Chain Management (RSCM) influences customer loyalty in China's fresh food e-commerce platforms, integrating the European Customer Satisfaction Index (ECSI) and trust to address persistent consumer experience issues. Using structural equation modeling via SmartPLS, data from 438 validated questionnaires were analyzed to test hypotheses derived from an extended ECSI framework, incorporating RSCM dimensions (platform image, perceived quality, customer expectations), perceived value, trust, satisfaction, and loyalty. The results showed that customer satisfaction, trust, and platform image directly enhance customer loyalty. Satisfaction is positively driven by perceived value, customer expectations, and perceived quality. RSCM practices indirectly bolster loyalty through trust and satisfaction pathways, while platform image significantly shapes customer expectations and trust. Demographic variables (education, income) also partially moderate loyalty. Corporate social responsibility embedded in RSCM is critical for sustaining loyalty, with big data and AI being essential for optimizing information-sharing ecosystems in fresh produce e-commerce. For future study, platforms should prioritize RSCM transparency, streamline distribution networks, deploy predictive analytics for demand forecasting, and integrate supply chains to compress intermediaries—enhancing perceived value, trust, and consumer convenience for competitive advantage.

Keywords: Corporate social responsibility, Customer loyalty, European customer satisfaction index, Fresh food E-commerce platform, Responsible supply chain management.

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1. Introduction

After years of development, the internet and mobile networks have become an inseparable part of people's work and life. E-commerce has become a new growth point in many countries [1] and online shopping has become one of the important channels to meet people's daily consumption needs, especially in the field of consumption. Online shopping provides consumers with more information and convenience to select products and compare prices [2]. E-commerce platforms are popular with consumers because they provide a shopping experience that is not limited by space, time, and product types [3]. According to the relevant authorities, the penetration rate of the online market of fresh food e-commerce market will increase significantly in the future, and there is a large room for further development in the fresh food e-commerce. At the same time, the state's support for agricultural e-commerce has also been strengthened. With the implementation of relevant policies, fresh agricultural products have gradually started to be introduced by major e-commerce platforms, which triggers both fierce competitions among e-commerce platforms and research on the fresh agricultural products supply chain.

However, in recent years, various fresh food e-commerce platforms have been frequently complained about by consumers due to problems such as product quality, pricing standards and after-sales service. Food quality complaints are common in major third-party complaint platforms. The reporter searched the Black Cat complaint platform with the keyword "fresh food quality" and got over 600 results, with 9 of the last 10 related to fresh food e-commerce [4]. Combined with China's current development of fresh produce supply chain, Luo [5] pointed out the main factors restricting the development of China's fresh supply chain, and finally puts forward the strategy to improve the development level of China's fresh supply chain. Zhao [6] discussed the problems to the current fresh produce supply chain development. She argued that it is necessary to improve the supporting services as soon as possible, establish a coordinating mechanism, standardize the distribution chain, attract social capital and technological inputs through government subsidies, and implement a response plan to deal with the risks that may occur. With the rapid development of fresh food e-commerce, the safety of fresh food has become more and more prominent, triggering the society to think about the issue of social responsibility of fresh food enterprises.

Thus, in this paper, the following questions will be studied:

1. How the classic model of customer satisfaction index affects to the customer satisfaction/loyalty of fresh food E-commerce in China?
2. How RSCM of fresh food E-commerce apply for the customer satisfaction/loyalty in China?

2. Literature Review

2.1. Basic Knowledge

2.1.1. Corporate Social Responsibility (CSR)

In the academic study of relations between business and society, Corporate Social Responsibility (CSR) is one of the earliest and most vital concepts Windsor [7]. Bowen [8], The pioneering work which contributed to the academic study of CSR raised the following vital question: "To what extent do the interests of business in the long run merge with the interests of society?" [9]. CSR are the "societal expectations of corporate behavior; a behavior that is alleged by a stakeholder to be expected by society or morally required and is therefore justifiably demanded of a business" [10].

2.1.2. Supply Chain Management (SCM)

Although the term Supply Chain Management (SCM) gained widespread popularity, both in academia and practice, there remains considerable confusion about its meaning. Some authors define SCM in operational terms, including the flow of materials and products, some regard it as a management philosophy, and some view it in terms of a management process. Mentzer, et al. [11] defined a supply chain as "a set of three or more entities (organizations or individuals) directly involved in the upstream and downstream flows of products, services, finances, and/or information from a source to a customer".

2.1.3. Responsible Supply Chain Management (RSCM)

The United Nations Global Compact [12] refers to supply chain sustainability and defines this as "the management of environmental, social and economic impacts and the encouragement of good governance practices, throughout the lifecycles of goods and services. The objective of supply chain sustainability is to create, protect and grow long-term environmental, social and economic value for all stakeholders involved in bringing products and serves to markets." These definitions are rather general and leave room for many different approaches. The well-known definitions by Opijnen and Oldenziel [13] emphasized the importance of volunteering and the cooperation between companies and their suppliers and other stakeholders. This study regards Responsible Supply Chain Management and Sustainable Supply Chain Management as synonymous terms.

2.1.4. Customer Satisfaction Index (CSI)

In 1989, to assess companies' efforts in achieving customer satisfaction, the Swedish Customer Satisfaction Barometer (SCSB) was introduced [14]. The successful experience of the SCSB has inspired the creation of the American Customer Satisfaction Index (ACSI). Many countries are conducting Customer Satisfaction Index (CSI) studies inasmuch as some researchers have argued that the CSI can serve as a predictor of companies' profitability and market value.

2.2. Hypotheses

2.2.1. Factors Affect Customer Loyalty

Han, et al. [15] argued that there is an intrinsic link between customer satisfaction, corporate image and customer loyalty, thus verifying that an increase in customer satisfaction can directly affect customer loyalty. CSR behavior also communicates a company's values to customers, and Park, et al. [16] found that incorporating ethical principles into a company's strategic decisions increases trust in the company among all stakeholders, including consumers. Trust is often considered to be a core element in maintaining successful relationships. Because of the risks and uncertainties in the marketplace, the level of trust consumers place in a brand becomes an important factor in influencing their purchase decisions. In a trusting relationship, both parties show mutual dependence and are willing to make modest sacrifices. Ji [17] study concluded that CSR and service quality leads to higher customer satisfaction and trust in services. Therefore, the following hypotheses have been raised:

$H_{1a:}$ Customers satisfaction on fresh food e-commerce in China has a positive effect on customer loyalty.

$H_{1b:}$ Trust on fresh food e-commerce in China has a positive effect on customer loyalty.

$H_{1c:}$ Platform image of responsible supply chain in fresh food e-commerce in China has a positive effect on customer loyalty.

2.2.2. Factors Affect Trust

The trust of all stakeholders, including consumers, will be increased by demonstrating the company's efforts to increase social welfare through CSR, communicating the company's internal characteristics and values to consumers, and injecting a responsible brand image into the company's strategic management process. Trust contributes to the effectiveness of CSR implementation, as consumers have a high level of trust in CSR-compliant companies, and this trust is gradually transformed into commitment over time [18]. According to this view, the fulfillment of CSR can have a positive impact on a company's brand reputation, which, in turn, enhances consumers' trust in the company. Therefore, the following hypotheses have been raised:

$H_{2a:}$ Customers satisfaction on fresh food e-commerce in China has a positive effect on trust.

$H_{2b:}$ Platform image of responsible supply chain management in fresh food e-commerce in China has a positive effect on trust.

2.2.3. Factors Affect Customer Satisfaction

Customers' perception of good quality is an important prerequisite for forming customer satisfaction, and there is a positive influence effect between perceived quality and customer satisfaction. Gounaris, et al. [19] argues that perceived quality is a comprehensive judgment of customers based on their own consumption experience and the surrounding environment, which then forms the perceived value of this consumption and customer satisfaction based on consumption costs. Wang and Wu [20] pointed out that customer expectations have a critical impact on consumer experience and customer satisfaction. This study concludes that the higher the customer's expectation of the fresh food supermarket in the new retail model, the stronger the desire to have a good outcome for the fresh food they want to purchase or the service process they enjoy, which propels the higher actual perceived quality and perceived value at the end of the purchase process, and the customer satisfaction level. Perceived value not only has a direct effect on customer satisfaction but also varies according to customer expectations and perceived quality. Fornell [14] also suggested in his study that perceived value positively contributes to customer satisfaction. McMullan and Gilmore [21] showed the positive effect of perceived value on customer satisfaction. Therefore, the following hypotheses have been raised:

H_{3a} Perceived value of fresh food e-commerce in China has a positive effect on customer satisfaction.

$H_{3b:}$ Customer expectation of responsible supply chain management in China has a positive effect on customer satisfaction.

$H_{3c:}$ Perceived quality of responsible supply chain management in China has a positive effect on customer satisfaction.

$H_{3d:}$ Platform image of responsible supply chain management in China has a positive effect on customer satisfaction.

2.2.4. Factors Affect Perceived Value

If consumers' real experience after consumption in fresh food e-commerce platforms is equal to or higher than their pre-purchase expectations, then it naturally increases consumers' satisfaction with the platform. For fresh food e-commerce platforms in the context of new retail, the degree of consumer expectation confirmation is reflected in two levels; the first is in the degree of expectation confirmation for online shopping and the second is in the degree of expectation confirmation for offline physical stores [22, 23]. CSR can have a positive impact on consumer behavior, and this perspective, based on consumer expectations, requires that CSR be implemented in accordance with consumer wishes and understood as “strategic and forward-looking management that integrates stakeholder concerns and transforms into increased perceived value for consumers. Qiu, et al. [24]” Since the perceived value of consumers is considered to be "a trade-off between gain and sacrifice," CSR can effectively enhance the perceived value of the goods provided by the company to the stakeholder groups represented by consumers [25]. Therefore, the following hypotheses have been raised:

$H_{4a:}$ Customer expectation of responsible supply chain management in China has a positive effect on perceived value.

$H_{4b:}$ Perceived quality of responsible supply chain management in China has a positive effect on perceived value.

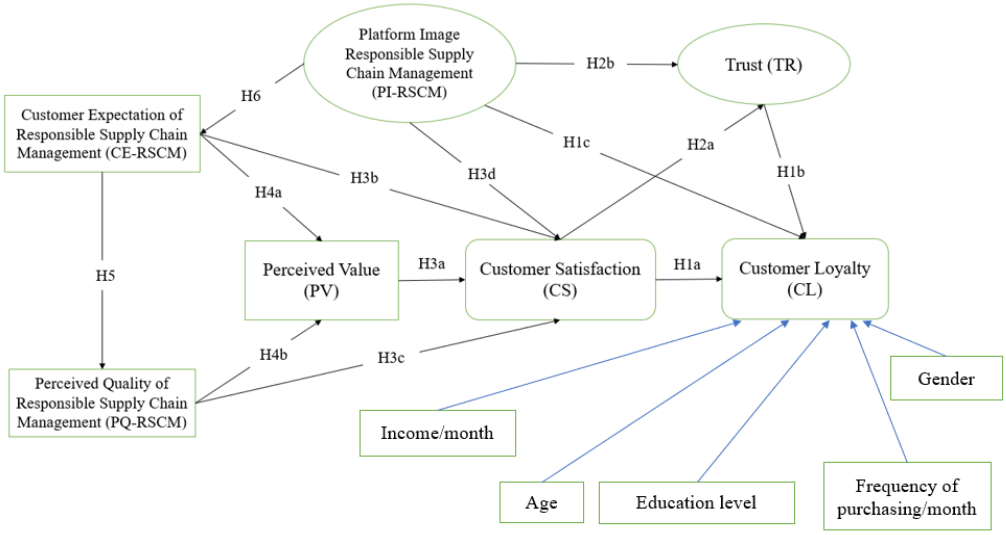

Figure 1.
Conceptual Model.

3. Methodology

3.1. Samples and Data Collection

3.1.1. Target Population Identification

The target respondents are supposed to be those who have experience of buying fresh food from any of the online platforms. According to two reports by Ariadne and Econet Qianfan, fresh food e-commerce users are mainly young people with a high level of education. Therefore, the main respondents of this study were university students and working people.

3.1.2. Data Collection

The questionnaires will be distributed in two ways, namely random sampling and snowball sampling. The only purpose is to guarantee higher rate of collecting questionnaires.

One of the random ways is that the emails will be sent to those supply chain managers of fresh food E-commerce platforms. Another important way is through the internet technology, i.e. Wenjuanxing (www.sojump.com), a website which is professional for the investigation in China. This research is to cooperate the website by applying its charge service to guarantee the higher level of questionnaires completing.

One of the snowball methods is to utilize some online customer groups of fresh food E-commerce platforms. I will contact my friends who are in such groups to help me in distributing the questionnaires. Further, the members in such kind of groups will enlarge their distribution of my questionnaires to more related groups or E-communities.

3.2. Measurements

The study will develop the questionnaires from three main aspects, namely endogenous variables (customer satisfaction, perceived value and customer loyalty) [16, 26-37], exogenous variables (platform image of responsible supply chain management, customer expectation of responsible supply chain management, and perceived quality of responsible supply chain management) [15, 17, 20, 30, 38-40] and additional variables of trust [18, 26, 28] plus control variables. Besides, there are demographic variables namely gender, age, income/monthly, education level, frequency of purchasing /monthly [41-45]

3.3. Estimation Method

A statistical method of PLS-SEM will be applied for measuring the reliability and validity of the construct, hypotheses testing, mediating effects and moderating effects of demographic variables. There are several reasons for employing PLS-SEM in this study. Firstly, this study is an exploratory study that proposed a new framework to predict the loyalty of customers on the supply chain management of fresh food E-commerce platforms around China. The proposed framework is not proposed by other studies to the best of our knowledge, thereby PLS-SEM is more suited to assess exploratory research with a purpose of prediction and theory development. Secondly, it was impossible to contact all customers of fresh food E-commerce platforms around China. However, PLS-SEM analysis requests 10 times the largest construct with the largest number of indicators (Marcoulides and Saunders [46], making it better choice for this study. Therefore, SmartPLS 3.2.9 [47] was applied to investigate this study.

3.4. Ethics

The key ethical issues are primarily whether the research is justifiable in terms of the balance of possible benefits and harms for the research subject and, if it is justifiable, whether the subjects properly consent to participation [48]. Ethical

principles have been debated for centuries; historically they reflected philosophical and religious thoughts, advances in science, historical events, political orientation, morality, and many other considerations [49]. This research has ensured the whole process meet the standard of ethics without any violation.

4. Data Analysis

4.1. Basic Characteristics of the Sample

The demographic characteristics and consumption behavior analysis of the sample in this study showed that the main user group of fresh food e-commerce platforms is as the following table.

Table 1.
Frequency Distribution of Basic Information.

Items	Categories	N	Percent (%)
age	Under 18 years old	27	6.16
	18--25 years old	73	16.67
	26-30 years old	112	25.57
	31-35 years old	114	26.03
	36-40 years old	45	10.27
	41-45 years old	38	8.68
	Over 50 years old	29	6.62
gender	Male	153	34.93
	Female	285	65.07
Profession	Student	51	11.64
	Teacher	125	28.54
	Personnel of enterprises and institutions	126	28.77
	Civil servants	65	14.84
	Private business owner	51	11.64
	other	20	4.57
Education	Undergraduate	259	59.13
	master	151	34.47
	PhD	28	6.39
Monthly income before tax	Below 3000 yuan	19	4.34
	3001-5000 Yuan	84	19.18
	5001-8000 Yuan	168	38.36
	8001-10000 Yuan	103	23.52
	10000 and above	64	14.61
Frequency of shopping on fresh food e-commerce platforms in a year	1-5 times	107	24.43
	6-10 times	172	39.27
	11-15 times	86	19.63
	16-20 times	48	10.96
	More than 20 times	25	5.71
Average amount spent on shopping on fresh food e-commerce platforms	100 yuan or less	83	18.95
	101-200 Yuan	177	40.41
	201-300 Yuan	95	21.69
	301-500 Yuan	51	11.64
	500 yuan or more	32	7.31
Fresh food e-commerce platforms commonly used in the past year	JD.com Home Delivery	247	56.39
	Dingdong Shopping	242	55.25
	Pu Pu	279	63.70
	Yonghui Life	230	52.51
	Meituan Best Selection	232	52.97
	Hema	288	65.75
	other	206	47.03

4.2. One-Way Common Method Bias Test

Kock [50] proposed a method to diagnose and alleviate common method bias (CMB) through factor analysis. He suggested using a single factor model for testing and pointed out that if the variance explained by the first factor is less than 50%, it can be considered that there is no serious common method bias in the data [50]. This criterion can be used to assess whether the data is significantly affected by CMB. In this study, the data were first subjected to KMO (Kaiser-Meyer-

Olkin) and Bartlett sphericity tests to assess whether the data are suitable for factor analysis. The judgment criterion for the KMO value is greater than 0.7, and the KMO value of this study is 0.933, indicating that the data has a high correlation. At the same time, the Chi-Square value of the Bartlett sphericity test is 12327.874, and the significance level (*p* value) is close to 0, which further confirms that the data is suitable for factor analysis.

To test the influence of common method bias (CMB), this study used the Harman single-factor test. The results showed that a total of 7 factors were extracted, of which the eigenvalue of the first factor was 12.119, explaining 31.08% of the total variance. In addition, the cumulative variance ratio (including the first 3 factors) did not reach the threshold of 50%. According to the criteria proposed by Kock [50], when the variance explanation ratio of the first factor is less than 50%, it can be considered that there is no serious common method bias in the data. Therefore, the results of this study show that the potential impact of common method bias on the data is not significant.

Table 2.
Harman's Single-Factor Test.

Eigenvalues (Initial)	% of Variance (Initial)	% of Cum. Variance (Initial)
12.119	31.08%	31.08%
3.497	8.97%	40.04%
3.299	8.46%	48.50%
2.977	7.63%	56.13%
2.634	6.75%	62.89%
2.41	6.18%	69.07%
1.452	3.72%	72.79%
KMO	0.933	
Bartlett's Test of Sphericity (Chi-Square)	12327.874	
df	741	
p	0	

4.3. Variable Descriptive Statistics

The descriptive statistics of each variable include the central tendency, degree of dispersion, distribution pattern and other relevant statistical information of the variable. This study involves statistical indicators such as mean, standard deviation, kurtosis and skewness of numerical variables. The details are as following:

Table 3.
Descriptive Statistics of Variables and Normality Test.

Structures	Mean	Std. Deviation	Kurtosis	Skewness
CL	3.465	0.849	-0.268	-0.499
CS	3.546	0.906	-0.444	-0.368
PV	3.61	0.926	-0.966	-0.223
CE	3.774	0.893	-0.807	-0.44
TR	3.516	0.874	-0.123	-0.433
PQ	3.51	0.908	-0.483	-0.324
PI	3.5	0.828	-0.405	-0.525

Note: CL(Customer Loyalty); CS(Customers Satisfaction); PV(Perceived Value); CE(Customer Expectation of Responsible Supply Chain Management); TR(Trust); PQ(Perceived Quality of Responsible Supply Chain Management); PI(Platform Image of Responsible Supply Chain Management).

4.4. Measurement Model Reliability and Validity Test

This research model contains 7 first-order reflective constructs, and the model is relatively complex. Based on this, the PLS-SEM method based on partial least squares is used to verify the model. The reliability and validity test of the reflective model in this study is evaluated by Cronbach's α, composite reliability, average variance extraction, and cross loading. The comparison method of AVE square root and correlation coefficient between constructs proposed by Fornell and Larcker [51] and HTMT as a discriminant validity test proposed by Kock [50] are used as the test criteria for discriminant validity. In addition, Cross Loadings is used to test whether each measurement item is only loaded on the construct to which it belongs, which helps to evaluate discriminant validity. Specifically, the comparison method of AVE square root and correlation coefficient between constructs calculates the AVE square root of each construct and compares it with the correlation coefficient between other constructs. If the AVE square root is greater than the correlation coefficient, the construct has good discriminant validity. HTMT is a ratio that measures the correlation between two constructs. A low HTMT value means that the two constructs have good discriminant validity in measurement. Usually, HTMT values less than 0.85 or 0.90 are considered to have good discriminant validity. In Cross Loadings, if the loading of a measurement item on its construct is higher than that on other constructs, then the measurement item is considered to have good discriminant validity. Factor Loadings should be greater than 0.7, indicating that the measurement item has a strong explanatory power for the construct [52]. Cronbach's Alpha (CA) and composite reliability (CR) are usually required to have a value greater than 0.7, representing good reliability [51, 52]. AVE values greater than 0.5 usually indicate good convergent validity and that the measurement items of the construct effectively reflect the latent variables.

The measurement model results of the constructs in this study showed that all constructs had good reliability and validity: the combined reliability (CR) was between 0.899 and 0.949, all higher than the threshold standard of 0.7, indicating that the measurement model had high internal consistency; Cronbach's α coefficient (CA) was distributed in the range of 0.850-0.932; the factor loading of each item was greater than the minimum standard of 0.7 (range 0.798-0.899), and the average variance extracted (AVE) exceeded the critical value of 0.5 (range 0.689-0.787), indicating that the measurement model had good convergent validity.

Table 4.
Reliability and Convergent Validity of Constructs.

Structures	Item	Loading	CA	CR	AVE
CE	CE1	0.899	0.932	0.949	0.787
	CE2	0.894			
	CE3	0.888			
	CE4	0.878			
	CE5	0.876			
CL	CL1	0.821	0.926	0.94	0.692
	CL2	0.833			
	CL3	0.828			
	CL4	0.844			
	CL5	0.821			
	CL6	0.824			
	CL7	0.852			
CS	CS1	0.883	0.928	0.943	0.735
	CS2	0.863			
	CS3	0.879			
	CS4	0.831			
	CS5	0.855			
	CS6	0.832			
PI	PI1	0.84	0.888	0.917	0.69
	PI2	0.833			
	PI3	0.821			
	PI4	0.834			
	PI5	0.825			
PQ	PQ1	0.852	0.925	0.943	0.769
	PQ2	0.884			
	PQ3	0.884			
	PQ4	0.87			
	PQ5	0.893			
PV	PV1	0.839	0.85	0.899	0.689
	PV2	0.837			
	PV3	0.837			
	PV4	0.807			
TR	TR1	0.869	0.932	0.945	0.712
	TR2	0.866			
	TR3	0.837			
	TR4	0.842			
	TR5	0.855			
	TR6	0.837			
	TR7	0.798			

Note: CL(Customer Loyalty); CS(Customers Satisfaction); PV(Perceived Value); CE(Customer Expectation of Responsible Supply Chain Management); TR(Trust); PQ(Perceived Quality of Responsible Supply Chain Management); PI(Platform Image of Responsible Supply Chain Management).

The following table shows the results of the first-order construct discriminant validity test based on the HTMT (Heterotrait-Monotrait Ratio) criterion. The results show that the HTMT values between all constructs are significantly lower than the conservative standard of 0.85 (range 0.244-0.553), and the correlation between perceived value (PV) and customer loyalty (CL) is the highest (HTMT=0.553), but it is still far below the discrimination threshold, indicating that each construct has good discriminant validity.

Table 5.
HTMT Criterion of Constructs.

	CE	CL	CS	PI	PQ	PV	TR
CE							
CL	0.341						
CS	0.352	0.341					
PI	0.342	0.327	0.251				
PQ	0.327	0.359	0.382	0.279			
PV	0.458	0.553	0.401	0.447	0.42		
TR	0.381	0.346	0.301	0.244	0.357	0.477	

Note: CL(Customer Loyalty); CS(Customers Satisfaction); PV(Perceived Value); CE(Customer Expectation of Responsible Supply Chain Management); TR(Trust); PQ(Perceived Quality of Responsible Supply Chain Management); PI(Platform Image of Responsible Supply Chain Management).

The following table shows the discriminant validity test results of constructs based on the Fornell-Larcker criterion. The bold values on the diagonal are the AVE square roots of each construct, and the non-diagonal values are the correlation coefficients between constructs. The results show that the AVE square roots of all constructs (between 0.830 and 0.887) are greater than the correlation coefficients of their rows and columns, meeting the requirements of the Fornell-Larcker criterion, further confirming the discriminant validity of the measurement model. The results are consistent with the conclusions of the HTMT test, and together support the discriminant validity of the measurement model.

Table 6.
Discriminant Validity of Constructs.

	CE	CL	CS	PI	PQ	PV	TR
CE	**0.887**						
CL	0.319	**0.832**					
CS	0.329	0.318	**0.857**				
PI	0.312	0.297	0.229	**0.831**			
PQ	0.306	0.332	0.355	0.254	**0.877**		
PV	0.409	0.491	0.359	0.388	0.376	**0.83**	
TR	0.356	0.327	0.284	0.222	0.331	0.425	**0.844**

Note: CL(Customer Loyalty); CS(Customers Satisfaction); PV(Perceived Value); CE(Customer Expectation of Responsible Supply Chain Management); TR(Trust); PQ(Perceived Quality of Responsible Supply Chain Management); PI(Platform Image of Responsible Supply Chain Management).

4.5. Path Effect Evaluation

The f^2 value is an indicator used to evaluate the size of the path effect in the PLS-SEM model. It reflects the degree of change in the explanatory power of an independent variable (or construct) on the dependent variable (or other construct). Hair, et al. [53] believed that small effect ($F^2 \leq 0.02$): When the F^2 value is small, it means that the path has a very small impact on the dependent variable and can be almost ignored. Medium effect ($0.02 < F^2 \leq 0.15$): When the F^2 value is within this range, it means that the path has a certain impact on the dependent variable, but the influence is moderate. Large effect ($F^2 > 0.15$): When the F^2 value is large, it means that the path has a strong impact on the dependent variable and is an important influencing factor in the model.

Table 7.
Effect Size of Exogenous Latent Constructs.

Relationships	f-square	Outcome
CE -> CS	0.029	Middle
CE -> PQ	0.103	Middle
CE -> PV	0.125	Middle
CS -> CL	0.044	Middle
CS -> TR	0.064	Middle
PI -> CE	0.109	Middle
PI -> CL	0.05	Middle
PI -> CS	0.002	Small
PI -> TR	0.029	Middle
PQ -> CS	0.051	Middle
PQ -> PV	0.091	Middle
PV -> CS	0.032	Middle
TR -> CL	0.046	Middle
Age -> CL	0.001	Small
Education level -> CL	0.029	Middle
Frequency of purchasing -> CL	0.002	Small
Gender -> CL	0.005	Small
Income -> CL	0.016	Small

Note: CL(Customer Loyalty); CS(Customers Satisfaction); PV(Perceived Value); CE(Customer Expectation of Responsible Supply Chain Management); TR(Trust); PQ(Perceived Quality of Responsible Supply Chain Management); PI(Platform Image of Responsible Supply Chain Management).

4.6. Model Explanatory Power Test

The R^2, adjusted R^2 and Q^2 prediction values were used to evaluate customer expectations (CE), customer loyalty (CL), customer satisfaction (CS), perceived value (PV), perceived quality (PQ), trust (TR) and customer expectations of responsible supply chain management (CE). The R^2 value represents the proportion of variance explained by the model for each constructed variable, the adjusted R^2 takes into account the complexity of the model by penalizing unnecessary predictors, and the Q^2 prediction value reflects the predictive relevance of the model. The results show that the model as a whole has good explanatory and predictive abilities.

Table 8.
R^2 and Q^2 Value of Endogenous Latent Constructs.

Construct	R-square	R-squared adjusted	Q^2predict
CE	0.098	0.096	0.093
CL	0.238	0.224	0.112
CS	0.213	0.205	0.041
PQ	0.093	0.091	0.039
PV	0.236	0.233	0.082
TR	0.107	0.103	0.043

Note: CL(Customer Loyalty); CS(Customers Satisfaction); PV(Perceived Value); CE(Customer Expectation of Responsible Supply Chain Management); TR(Trust); PQ(Perceived Quality of Responsible Supply Chain Management); PI(Platform Image of Responsible Supply Chain Management).

4.7. Hypothesis Testing

The direct path results show in the following table.

Table 9.
Direct Path Hypothesis Testing.

H	Direct Path	β	Standard Error (SE)	*P*	Decision
H1a	CS—CL	0.195	0.045	0	Supported
H1b	TR—CL	0.199	0.045	0	Supported
H1c	PI—CL	0.203	0.045	0	Supported
H2a	CS—TR	0.247	0.045	0	Supported
H2b	PI—TR	0.165	0.05	0.001	Supported
H3a	PV—CS	0.188	0.05	0	Supported
H3b	CE—CS	0.17	0.051	0.001	Supported
H3c	PQ—CS	0.221	0.047	0	Supported
H3d	PI—CS	0.046	0.044	0.296	Not Supported
H4a	CE—PV	0.324	0.043	0	Supported
H4b	PQ—PV	0.276	0.045	0	Supported
H5	CE—PQ	0.306	0.045	0	Supported
H6	PI—CE	0.313	0.045	0	Supported
-	Age—CL	0.026	0.044	0.554	Not Supported
-	Education level—CL	0.15	0.041	0	Supported
-	Buying Frequency—CL	0.035	0.044	0.428	Not Supported
-	Gender—CL	0.124	0.092	0.179	Not Supported
-	Income—CL	0.115	0.044	0.008	Supported

Note: CL(Customer Loyalty); CS(Customers Satisfaction); PV(Perceived Value); CE(Customer Expectation of Responsible Supply Chain Management); TR(Trust); PQ(Perceived Quality of Responsible Supply Chain Management); PI(Platform Image of Responsible Supply Chain Management)

The mediation effect results show in the following table.

Table 10.
Mediation Path Hypothesis Testing.

H	Direct Path	β	Standard Error (SE)	*P*	Decision
H7	CE -> CS -> CL	0.033	0.013	0.008	Supported
H8	PI -> CS -> CL	0.009	0.009	0.308	Not Supported
H9	PI -> TR -> CL	0.034	0.013	0.012	Supported
H10	PQ -> CS -> CL	0.043	0.014	0.002	Supported
H11	PV -> CS -> CL	0.037	0.015	0.013	Supported
H12	CS -> TR -> CL	0.05	0.015	0.001	Supported

Note: CL(Customer Loyalty); CS(Customers Satisfaction); PV(Perceived Value); CE(Customer Expectation of Responsible Supply Chain Management); TR(Trust); PQ(Perceived Quality of Responsible Supply Chain Management); PI(Platform Image of Responsible Supply Chain Management).

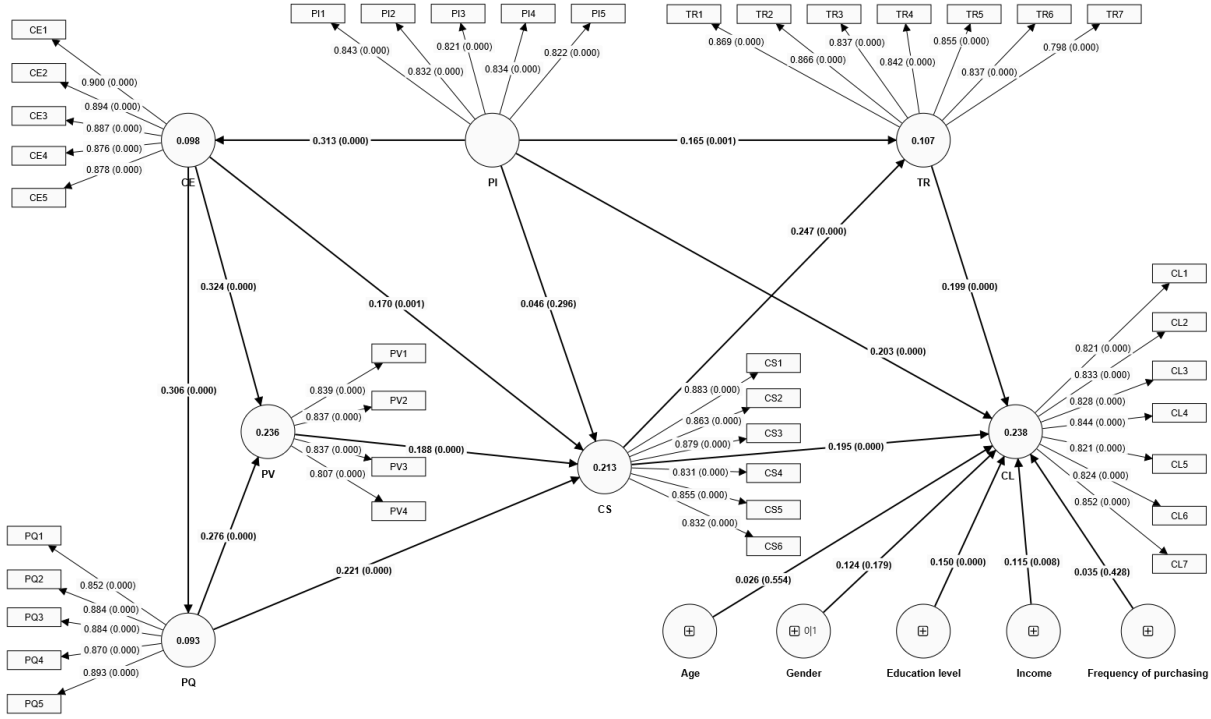

Figure 2.
Path Coefficient and outer loadings of Structural Model.

5. Discussion

5.1. The Factors Affect Customer Loyalty on Fresh-food E-commerce Platform

In online environments where consumers cannot physically interact with products or services, purchasing decisions predominantly rely on satisfaction derived from individual transactions, which critically influences repurchase intentions and loyalty cultivation. As repurchase frequency increases, e-commerce platforms must prioritize sustained customer satisfaction, given that a single unsatisfactory transaction may lead to severe customer attrition [54, 55]. E-commerce platforms serve as the primary interface connecting service providers and consumers, where consumer perceptions directly influence attitudes and purchasing behaviors, with customer satisfaction emerging as a critical performance metric. Previous studies [45, 56-58] demonstrate that higher customer satisfaction significantly enhances the likelihood of repeat purchases and generates greater economic returns for enterprises. Consumer trust in e-commerce platforms and merchants holds paramount importance, as a credible online shopping environment enables consumers to conduct transactions with greater reassurance, thereby boosting consumer confidence and enhancing purchasing willingness [59]. Enhancing customer satisfaction constitutes the fundamental prerequisite for strengthening customer loyalty, as heightened product satisfaction directly amplifies brand trust and allegiance while increasing customers' propensity to share positive shopping experiences within their social networks.

5.2. The Factors Affect Customer Satisfaction on Fresh-Food E-Commerce Platform

The functional layout of e-commerce platforms negatively impacts customer satisfaction, primarily due to standardized website designs and templated functional configurations that induce aesthetic fatigue among consumers. A platform's functional architecture critically shapes users' initial impressions of pharmaceutical e-commerce platforms (hereafter "platforms"), with critical determinants of continued patronage including website color schemes, pharmaceutical product categorization, interactive experiences, and operational convenience [2]. Service quality and perceived value exert direct positive effects on customer satisfaction, indicating that actual user experience constitutes the primary determinant of platform satisfaction. Most scholars [60-62] conceptualize perceived value as consumers' comparative assessment between the total benefits derived from products/services and the monetary costs incurred during acquisition. With accelerating lifestyles and changing purchasing habits among younger generations, online fresh produce shopping has become a prevailing trend. Key factors [63, 64] influencing customer satisfaction include product selection and sourcing, shopping convenience, product quality, and logistics service quality. Service quality has been empirically validated as the secondary determinant influencing customer satisfaction. This finding indicates that when agricultural e-commerce platforms meet or exceed consumers' anticipated service levels during product acquisition, substantial enhancements in satisfaction toward the platform can be achieved.

5.3. The Factors Affect Customer Trust on Fresh-food E-commerce Platform

Trust is operationally defined as one party's perceived reliability of another within specific exchange relationships. Securing customer trust proves critical for commercial success, given customers' dual capacity as brand advocates or detractors. Yu, et al. [18] emphasize that trust fundamentally operates through relational bonds. Enterprises cultivating

intimate customer relationships—via premium product quality, innovation, and responsive demand fulfillment—effectively safeguard consumers' fundamental rights. Park, et al. [16] analyzing customer trust through the lens of digital marketing, identified webpage design, product quality, user reviews, and individual consumption levels as critical influencing factors.

5.4. The Factors Affect Perceived Value on Fresh-food E-commerce Platform

Within agricultural e-commerce environments, empirical evidence reveals that perceived value and service quality exert significant impacts on customer satisfaction, with perceived value demonstrating stronger predictive power. The findings [61, 65] suggest that when agricultural e-commerce platforms align with consumers' value systems and consumption philosophies, particularly through utilitarian value realization, significant enhancements in customer satisfaction can be achieved. This satisfaction-loyalty paradigm underscores the strategic importance of value co-creation in digital agricultural marketplaces. The researchers [63, 66] consequently define e-service quality as "customers' evaluative judgment regarding both process quality and outcome quality derived from interactions with service providers through electronic channels." Liu, et al. [60] posit that customer value constitutes a comparative perception between benefits and sacrifices, where benefits extend beyond mere quality considerations and sacrifices encompass more than just price.

6. Implications

6.1. Customer Loyalty of Fresh-food E-commerce Platform

Given the fresh produce e-commerce market's high concentration and intense competition, investigating CSR [67] in competitive environments presents a promising research direction. Furthermore, rapid internet technology development has enabled continuous market expansion, with platforms establishing hybrid offline stores that combine retail operations with online distribution hubs. Future research could explore how CSR adoption influences decision-making [62] in these "in-store + home-delivery" supply chain models, particularly examining the operational dynamics and value co-creation mechanisms in such innovative retail formats. This extension would provide insights into CSR's role in emerging omnichannel fresh produce distribution systems. As corporate social responsibility (CSR) levels increase, market prices decline while preservation efforts, consumer surplus, market demand, and social welfare all rise. Therefore, from the perspectives of stimulating demand, stabilizing prices, and enhancing social welfare, supply chain members should actively undertake social responsibilities. When fresh produce suppliers assume CSR, their profits decrease while e-commerce platform profits increase [68-70].

6.2. Platform Image of Fresh-food E-commerce Platform

In the internet era, consumers prioritize service experience and product diversity, meaning that the service quality and product variety offered by e-commerce platforms elevate perceived utility levels [71]. Consequently, factors ranging from service sophistication to packaging specifications critically shape purchasing decisions. Enriching product display information and ensuring its authenticity are essential. Merchants should provide objective and detailed product descriptions, including weight, sweetness, and packaging, along with clear and comprehensive explanations of promised services. Simultaneously, various regulatory bodies must actively fulfill their supervisory roles. Through technological means such as big data and QR codes, consumers can trace the origins of fresh agricultural products. Products should be reasonably priced, and orders should be dispatched promptly after purchase. This approach significantly reduces uncertainty during online purchases of fresh agricultural products, consequently lowering perceived risks.

6.3. Customer Trust of Fresh-food E-commerce Platform

Platform quality, perceived quality, and consumer trust all exert significant positive effects on repurchase behavior in fresh produce e-commerce, with consumer trust serving as a mediating factor between platform quality/perceived quality and repurchase behavior. Most fresh-food E-commerce platforms are comprehensive with amassed a substantial user base of high loyalty while attracting numerous merchants [72]. Its competitive advantage lies in providing extensive online retail services characterized by a diverse range of fresh products, establishing it as the predominant channel for consumers purchasing perishables online. Concurrently, clearly displaying third-party certification logos and strengthening supplier partnerships can reduce perceived risks, thereby boosting purchase intention and satisfaction.

6.4. Supply Chain Management of Fresh-food E-commerce Platform

In the digital economy era, fresh produce e-commerce has faced criticism regarding delivery efficiency, product quality, and safety issues, all of which negatively impact consumer shopping experiences and demand. If fresh produce e-commerce platforms fail to optimize their supply chains for better product selection, integrate sales channels, and streamline logistics, they risk escalating costs and losing customers. Therefore, enhancing consumer experience and loyalty by offering diversified and convenient options, thereby effectively boosting consumption and value, remains a long-term priority for the industry [67, 73]. Moreover, against the backdrop of rapid internet development and rising disposable incomes in China, consumer self-awareness has strengthened. The focus of consumption has shifted beyond price to emphasize the overall shopping experience. The supply chain system of fresh food e-commerce enterprises plays a vital role in ensuring product quality and safety. Covering all links from production to sales, including suppliers, warehousing, logistics, and distribution, establishing a sound supply chain system is crucial for the stable development of fresh food e-commerce platforms. Meanwhile, digitalization and intelligentization of the supply chain represent future trends.

7. Recommendation

7.1. Improve Platform Image of Fresh-food E-commerce Platform

The development of big data and artificial intelligence technologies is essential for constructing and refining the information-sharing ecosystem within fresh produce e-commerce. This system integrates resources from farmers, platforms, and consumers, enabling the digital networking of agricultural data and platform services. By leveraging big data analytics to examine consumer order frequency, volume, transaction values, and temporal purchasing patterns, the system achieves predictive insights into fresh produce consumption behaviors across cities, regions, and timeframes. Such analytics enable precise demand forecasting, real-time consumer behavior tracking, and end-to-end quality control, ensuring optimal alignment between supply and demand for diverse products in varied urban contexts. For e-commerce platforms, the system enhances operational efficiency by predicting market prices, regulating procurement volumes, and minimizing storage losses through data-driven inventory management [74, 75]. Producers benefit from transparent price signals and demand trends transmitted directly from end-consumers, bypassing traditional intermediaries like wholesalers to achieve supply chain symmetry. Consumers gain access to personalized services by submitting customized product requests through the platform, which are then relayed to producers, eliminating redundant distribution layers and achieving demand-supply optimization. This tripartite integration fosters a responsive, waste-minimized ecosystem where data transparency empowers all stakeholders.

7.2. Improve Quality of Fresh-food E-commerce Platform

Efforts should focus on enhancing service quality, where efficiency and transaction fulfillment play pivotal roles. To meet efficiency requirements, agricultural e-commerce platforms must ensure operational simplicity, enabling customers to effortlessly locate desired products or content, thereby increasing retention rates and engagement duration. Clear website architecture with logical information hierarchies enhances usability and encourages continued browsing and purchasing. Platforms should deliver targeted, diverse content tailored to specific customer segments, coupled with timely updates to align with evolving needs [37]. As website accessibility initiates the e-commerce journey, these optimized experiences facilitate intuitive and efficient product evaluation and selection. Transaction fulfillment primarily manifests through order delivery and logistics management, necessitating strict adherence to promised delivery terms and accurate product representation that matches visual descriptions. Timely logistics delivery within reasonable timeframes remains critical, particularly given agricultural products' regional and seasonal characteristics [76]. While large enterprises often maintain proprietary logistics systems, most agricultural e-commerce operators rely on third-party logistics partnerships. To ensure delivery punctuality, businesses should strategically leverage third-party capabilities under collaborative frameworks to strengthen competitive advantages, while adopting innovative models like crowdfunding or online pre-sales to optimize supply chain efficiency.

7.3. Improve Customer Trust of Fresh-food E-commerce Platform

Fresh agricultural product providers must focus on enhancing delivery service trustworthiness and reducing perceived logistics risks to foster repeat purchase intentions [73, 77]. Rural e-commerce platforms can implement post-purchase service quality rating features, allowing consumers to evaluate their experiences, thereby accumulating service credibility. Positive trust-related reviews and experience-based evaluations displayed on platforms incentivize subsequent purchases by demonstrating reliability. Furthermore, transparently showcasing detailed and secure logistics processes—such as real-time tracking, temperature-controlled transportation, and handling protocols—within platform interfaces helps mitigate perceived delivery risks. This visibility into operational safeguards aligns consumer expectations with service realities, effectively boosting purchase intent and reinforcing platform loyalty through demonstrated accountability.

7.4. Improve Supply Chain Management of Fresh-food E-commerce Platform

Building an integrated industrial chain is essential for fresh produce e-commerce platforms, whose value stems from two main aspects: compressing intermediate distribution links and providing convenient consumption channels for consumers [78-80]. To achieve long-term development, these platforms must implement integrated management across the industrial chain, streamline each stage of fresh agricultural product circulation, reduce operational costs by optimizing commercial distribution processes, and ultimately realize profitability. On one hand, it is necessary to establish direct connections between producers and consumers, continuously reducing intermediate distribution links; on the other hand, the logistics network system must be constantly optimized. One approach involves achieving mutual benefits through collaboration with third-party logistics providers, while another entails establishing a self-built logistics system to complete the industrial chain framework and form a closed-loop circulation. The perishable nature of fresh agricultural products complicates logistics operations and makes quality assurance in delivery challenging. China has numerous third-party logistics providers specializing in distribution, yet effective oversight remains difficult [81]. Therefore, fresh produce e-commerce companies must strategically leverage the capabilities of third-party logistics while simultaneously strengthening their own competitive advantages. Alternative models such as community-based delivery, crowdfunding, and online pre-sales can also be employed to optimize supply chain efficiency.

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