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Intention to Use Sustainable Green Logistics Platforms

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Received: 11 March 2020; Accepted: 21 April 2020; Published: 24 April 2020

Abstract: Recently, logistics platforms that facilitate interaction and the exchange and transaction of information have quickly emerged in the Korean domestic market. In order to further advance the development of logistics platforms into green logistics platforms in which participation in the early stages is not active, appropriate checks and balances are needed so that service providers, users, and platform operators can grow together in green logistics platforms. The purpose of this study is to empirically verify the factors affecting participants' intentions to use green logistics platforms. Out of the 230 questionnaires distributed from 25 June to 11 July 2019, 14 were excluded from analyses due to unsatisfactory responses, while 216 responses were used for statistical processing. The structural equation model (SEM) was used to test hypotheses in this research. The results showed that the network effect and security factors influenced perceived usefulness, and trust did not affect perceived usefulness. Perceived usefulness also significantly influenced the intention to use green logistics platforms. The results of this study present strategies and directions for the future development of green logistics platforms.

Keywords: green logistics; intention to use; perceived usefulness; logistics platform

1. Introduction

As natural disasters occur globally due to abnormal temperatures caused by global warming, the perception is spreading that eco-friendly logistics is very important not only for the global environment but also for our survival. At the same time, the need for a logistics platform that promotes exchange and interaction between groups is gradually increasing [1].

For sustainable logistics Korean platforms, the percentage of cargo trucks using the cargo information network increased significantly from 10.2% in 2014 to 21.7% in 2016 [2]. In addition to the freight vehicle transportation business, platform businesses such as the international logistics platform Tradlink and the shipping logistics platform ValuelinkU are spreading to all areas of logistics.

However, the satisfaction of participants is not high. The reason lies in the fact that eco-friendly logistics is not yet sufficiently large in terms of the volume of transactions, and platform transactions play only an auxiliary role in offline-oriented markets. Activating logistics platforms and transforming them into green logistics platforms is a matter of solving the problem of how to attract more participants. Participants include carriers, forwarders, and warehouse operators from the service providers' side as well as platform operators and service users.

This study aimed to derive factors that affect consumers' perceived usefulness of and intention to use green logistics platforms. Through this, we identified business strategies and development measures for green logistics platforms.

The service proposals for the green logistics platform will end the zero-sum game without the shipping industry winning as a result of the dropping freight rate and bring a direction change to the eco-friendly era. In addition, integrated platform services such as shipping, inland transportation, and warehouse distribution are required, as it is recognized that the single service of shipping alone cannot generate profits due to the reduction of shipping demand due to protectionism and reshoring. It is expected that platform participants, such as service providers, shippers, and platform service operators, will be transformed in an era of mutual recognition and coexistence through green logistics platforms. This could be helpful to Korean logistics companies and related people who are struggling to rebuild the logistics industry, which has been in recession.

2. Literature Review

2.1. Green Logistics

Green logistics is defined as the concept of logistics that takes into account the impact of the transport and environmental sectors on the overall process of logistics activities. The narrow meaning of green logistics refers to the activities of reducing and managing pollutants, such as measures to reduce air pollution emissions and gas emissions that can occur when transporting freight. The broader concept of green logistics encompasses not only the effect on the environment of logistics activity but also the overall logistics activities covering traditional forward logistics and reverse logistics [3,4]. The dictionary definition of green logistics refers to the transportation of goods using a logistics system with less environmental load, such as suppressing CO_2 emissions and reducing packaging materials in the distribution process.

There are several ways to reduce CO_2 emissions, including modal shifts from trucks to railroads and ships and co-transportation of multiple companies' cargoes [4–6].

Characteristics of green logistics include using energy and resources as input elements to produce products and managing a series of economic activities that release pollutants and produce byproducts. Logistics is playing a role in implementing economic activities, and environmentally friendly logistics is emerging as a new competitive field in the logistics sector. The eco-friendly logistics sector affects logistics functions and supply chains that include transportation, delivery, and storage with resource savings, recycling, eco-friendly substitutes, and a reduction of waste and emissions.

In addition, the concept of sustainability in recent years has been introduced in many areas, including management, technology, and supply chains (SCs). The most accepted definition for sustainable supply chain management (SSCM) is creating, using, and recycling or disposing of all consumer products in a closed loop method [7]. Closed loop supply chain management (CLSCM) involves forward logistics in the chain (material procurement, production, and distribution), as well as reverse logistics to collect and process returned (used or unused) products and/or parts of products to ensure socio-economic and ecologically sustainable recovery [7].

2.2. Green Logistics Platform

A platform business is defined as a combination of infrastructure and rules that facilitates the interaction of network users [8–11]. Theoretical studies on two-sided markets began to be carried out actively in the early 2000s by Caillaud and Julien [12], and Rochet and Tirole [13]. Rochet and Tirole [13] studied a two-sided platform and defined a platform business as a value-added business that links two or more customers to enable them to find partners and to offer products and services that provide value to customers [14,15]. Evans [16] argues that a platform business supports heterogeneous communities in this important industry. It was argued that platform businesses could be quite different from non-platform businesses that do not support mutual cooperation in formulating prices,

supply and demand, and investment strategies [16]. Eisenmann et al. [9] suggested that a two-sided platform provides the environment and tools to facilitate the trade of both groups. Lin [17] conducted research on the selection factors of online and television shopping platform services and service quality evaluation. Choi and Kim [18] examined two-sided markets from the platform's perspective, including production strategy, technical management, and industrial economics of the platform. Jin [19] stated that in order for a platform business to succeed, convergence between business models is necessary to establish an open business model. Gil [20] studied factors affecting the intention to participate in social manufacturing platforms and found that the conversion cost, reliability, and usefulness influenced the intention to participate. Furthermore, the cost factor should be lowered to minimize the perceived conversion cost and to ensure reliability through a transparent procedural disclosure system. Kim [21] conducted an empirical analysis of the intention to accept international logistics platforms for shippers through the technology acceptance model (TAM). Their study found that perceived usefulness, emotional value, and economic value affected the intent to accept the platform. A study by Jung and Sung [22] discovered that for the sustainable growth of the platform business model, it is necessary to clarify the role of each user without distinguishing platform participants. Chang et al. [23] compared and analyzed the competitiveness of six success factors of domestic and global platform businesses for ICT workers. Cho [24] used the theory of innovation resistance to study the acceptability of multiple carriers for online freight marketplaces. As a result of the study, a higher evaluation of the perceived relative advantage and user innovation, lower perceived complexity and risk, and lower resistance to the marketplace resulted in higher acceptance. Joo [25] modeled a logistics platform business based on a platform model for product and service transactions and presented platform strategies. Kim [26] argued that a comprehensive approach, including information technology and relations, is needed rather than a cross-sectional approach in terms of information technology through research on logistics companies' motivation and performance in participating in logistics platforms.

As the nature of the logistics sector is characterized by large volumes of energy and resource waste, which result in environmental degradation, a "sharing logistics platform" is needed for the optimization of resource use. The sharing logistics platform is a platform for sharing and buying and selling space within logistics storage and creates profits by sharing space that is not used in logistics centers or logistics warehouses [27]. Therefore, the spread of green logistics platforms that solve environmental pollution problems and dramatically reduce the waste of resources is necessary.

A logistics platform is an environment in which multiple parties are involved in the smooth use of logistics services, and this platform creates value by coordinating and combining their capabilities or resources [28]. This includes intermediary freight information networks and international transport estimation and comparison services. Such logistics platforms also provide detailed market information according to the demands of market participants [29].

Logistics platforms can be divided according to the roles of the logistics service provider and the platform operator. Logistics service providers can be divided into a carrier, forwarder, and warehouse/distribution in Table 1. Platforms in which the carrier participates as a service provider are not expected to go through forwarders but are expected to save time and money by reducing the trading stage through direct transactions between the carrier and the shipper. However, the shipper has to deal directly with the inconvenience of a number of carriers that are limited in scope or number of services available, while a carrier has less expertise than a forwarder. On the other hand, platforms in which forwarders participate as service providers have a wide and diverse range of services compared to those involving carriers, but the increased transaction phase may increase the time and cost burden. While forwarder participation platforms with a wide service scope and ease of transfer may be advantageous in the initial stage when logistics platforms are introduced, carrier participation platforms with time and cost savings will have structural competitiveness when the logistics platform industries develop and enter a period of stability.

Table 1. Classification of logistics platforms (adapted from [30]).

Service Provider	Carrier	Carrier	Freight Forwarder	Warehouse and Distribution
Service Name	Online freight forwarder	Carrier's service matching platform	Forwarder's service matching platform	Warehouse and distribution
Platform Operator's Role	Seller	Matcher	Matcher	Matcher
Platform Company	Flexport, FreightHub, Twill, iContainer	NYSHEX, ValuelinkU	Freightos, Tradlink	MyChango, Cafe24

Depending on the role of the platform operator, the logistics platform can be distinguished as a matching platform in which the platform operator performs only simple connectivity functions without participating in the sales platform and participates in the selection and pricing of services. It is common for a sales platform to have a sales margin and a matching platform as a revenue model for participants' subscription fees or transaction fees. In addition, there are platforms such as ValuelinkU that provide free matching services and value-added processes as a revenue model [31]. If the logistics platform is divided into the roles of the service provider and the platform operator, first, the carrier service is called an "online freight forwarder", similar to the offline forwarder as a model in which the platform operator purchases and sells services to the shipper to generate revenue. Some of the leading platforms include Flexport [32] in the United States, FreightHub [33] in Germany, iContainer [34] in Spain, and Twill [35] in the Netherlands. The existing forwarder's work is brought online, which is less objectionable from the perspective of shippers and the forwarder, making it the most active model, as it strives to convert the existing offline volume to an online platform.

Second, the NYSHEX [36] in the U.S. and ValuelinkU [31] in Korea are platforms that allow platform operators to match the carrier service and shipper. The two platforms have something in common in that they match the carrier and shipper, but there is a difference in business models. The NYSHEX is a prepaid futures trading platform that allows a shipper to purchase space in advance for up to six months [36]. The shipping industry has a large variance in shipping space conditions and freight rates depending on the timing, and by trading space in advance, carriers and shippers can reduce uncertainty. However, space futures trading requires accurate forecasting, as it places a burden on carriers to lower prices and incurs losses resulting from unused spaces for shippers. Currently, six shipping lines from Maersk [37], CMA-CGM, COSCO [38], Hapag Lloyd [39], HMM [40], and OOCL [41] are participating in the NYSHEX [30].

ValuelinkU, which started its service in 2018, is a matching platform between domestic carriers and small- and medium-sized shippers, unlike other platforms that have simply converted their existing transactions online. Services that carriers cannot provide are supplemented by providing services through direct forwarder arrangements. In addition, many carriers require fare disclosure and active participation [31]. ValuelinkU's operational process is shown in Figure 1. First, when carriers provide schedule and freight information to ValuelinkU, the shipper makes a shipping reservation after comparing services and fares through ValuelinkU. Afterward, when ValuelinkU requests shipment to the carrier, the carrier provides services to the shipper, issues an original B/L (bill of lading), and settles directly with the shipper when services are completed [31].

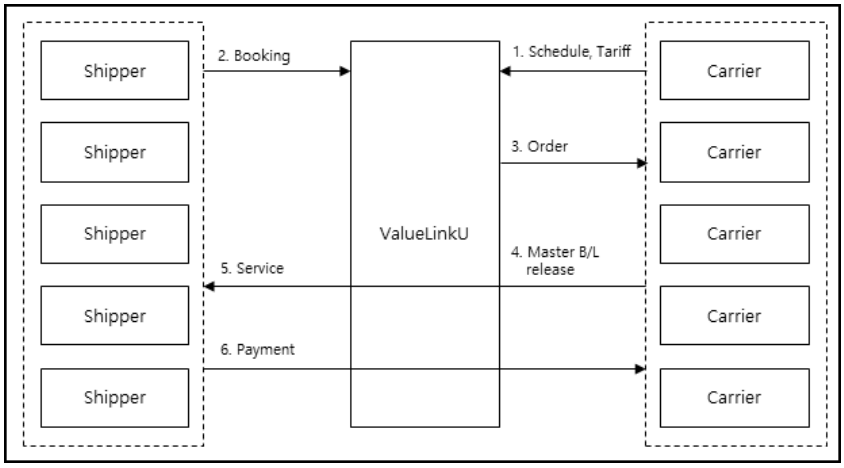

Figure 1. Business model of ValuelinkU (adapted from [30]).

Third, Hong Kong's Freightos [42] and Korea's Tradlinx [43] are platforms that allow platform operators to match forwarder services and shippers. Through the platform, the shipper can easily compare services and freight offered by forwarders and reserve shipping services, saving time and effort compared to the traditional phone and mail methods. However, the overall cost is likely to increase as transaction costs of platform operators are added at the transaction stage. Improving the cost structure is necessary to induce the active participation of small- and medium-sized shippers who are cost-sensitive. Tradlinx's operational process, launched in Korea in 2015, is shown in Figure 2. First, the forwarder adds a margin to the fare received from the carrier and provides it to Tradlinx. Tradlinx forwards the booking information from the shipper to the forwarder who requests shipping services from the carrier [43]. Once the shipment is confirmed, the carrier issues an original B/L to the forwarder along with the required services, and the forwarder issues a house B/L to the shipper. When services are completed, the shipper delivers the promised freight to the forwarder, and the forwarder pays the contracted freight charge to the carrier, excluding the margin of forwarder [30].

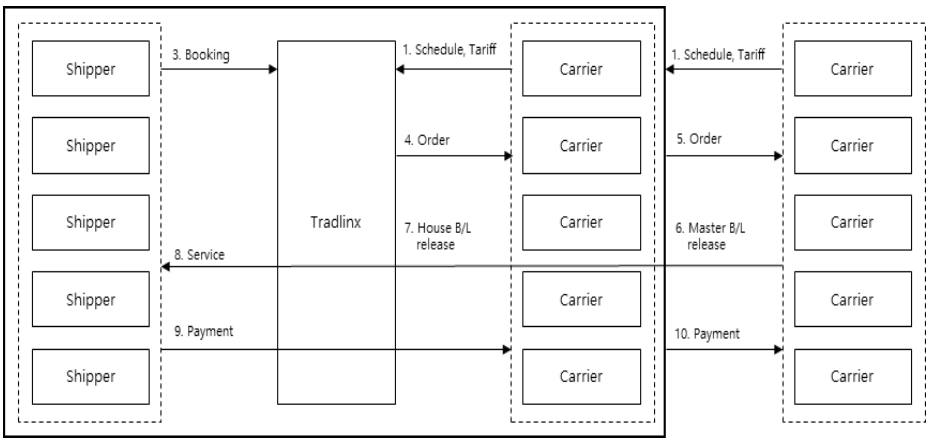

Figure 2. Business model of Tradlinx (adapted from [30]).

The green logistics platform is in the process of forming a platform market because there are not many customers. Especially due to the nature of the platform business, it is difficult to form a business if platform users are not secured. This approach to customer acq-+uisition will require a clear set of values for delivering new methods of technology to users. For logistics platforms, B2B services should focus on network formation for both individual and business users. In addition, expected users include international-trade- and logistics-related companies. These companies are accustomed to existing logistics service methods. However, providing new value to users is a way to advance

to the next step of securing users for the platform service [25]. Table 2 below shows the expanded development direction by comparing the components of the logistics platform and green logistics platform businesses.

Table 2. Comparison of traditional logistics platforms and green logistics platforms (adapted from [25]).

Division	Logistics Platform	Green Logistics Platform
Value proposition	Convenience of use Accessibility to use Cost reduction	Consolidating small quantity cargo (Less Than Truck Load, LTL) Sharing logistics (pallet pool system, rental forklifts) solves environmental pollution problems, reducing waste of resources Platform for sharing or trading space within existing logistics warehouses Logistics equipment and warehouses of the shipper are shared with other companies in spare time. Users (enterprise, individual) of the logistics service also serve as providers such as logistics companies.
Customer segment	Exporter and importer Forwarder Shipping company and airline Transportation company Customs official Cargo insurance company	Exporter and importer Forwarder Shipping company and airline Transportation company Customs official Cargo insurance company
Customer relationship	Online community (direct relationship)	Online community (direct relationship)
Core partnership	Platform users	Platform users
Source of revenue	Fees Consulting	Fees Platform Entry Cost Advertising fee

3. Proposed Hypotheses

3.1. Trust and Perceived Usefulness

3.1.1. Trust

Trust is defined as the belief that another company will perform actions that will result in positive outcomes for a company, as well as not take unexpected actions that would result in negative outcomes for a company [44,45]. According to Morgan and Hunt [46], trust is defined as a willingness to rely on an exchange partner in whom one has confidence. It can be seen that trust has implications for positive outcomes and stable relationships between organizations. In recent years, relationships between companies have been oriented toward cooperation rather than competition, and the importance of trust is growing [47]. Trust is one of the most important factors in successful relationships [48]. Bensaou [49] looked at trust in terms of frequent visits, sharing benefits and risks, and specialized investments, emphasizing the importance of trust in the degree of immersion in the buyer–supplier relationship and the increased performance of the relationship.

Woo [50] stated that reliability is a major success factor in the use of the e-commerce platforms and that the reputation of the platform, recognition, and visitors' past experiences are important factors. Therefore, in this study, we defined trust as providing accurate, reliable, and abundant information on a logistics platform, trusting the platform operator, and the exclusion of opportunistic behavior.

3.1.2. Perceived Usefulness

Perceived usefulness is the degree to which an individual believes the use of a particular system will improve the performance of their work [6,51]. The usefulness of the system is determined as users make a cognitive assessment by comparing the perceived value with their experience using the system [52]. Based on this usefulness, future use of the system is selected, and the evaluation of the benefits obtained through the use of the system is performed in the evaluation process. Perceived usefulness has been demonstrated in previous studies to be a key factor affecting system acceptance and an important predictor of acceptance [53]. Sung and Ko [54] suggested that that system quality

and information quality have a significant effect on perceived usefulness through research. Perceived usefulness in decision-making contributes to the formation of an individual's preference for an object [55]. The concept of perceived usefulness was used in the technology acceptance model of Davis et al. [51] to describe behaviors related to computer technology of end users. This study suggested the trust of green logistics platforms impacts perceived usefulness as follows.

Hypothesis 1. *The trust of green logistics platforms has a positive impact on perceived usefulness.*

3.2. Network Effect and Perceived Usefulness

The network effect describes how a person's demand for a particular product is influenced by others. This is an economic phenomenon that explains how some people naturally form networks and affect other people. Schilling [56] suggested that general users choose a platform based on the number of users on the platform rather than the subjective acceptance of a platform, explaining that as the number of users on a platform increases, the value of the platform and the resulting network effects increase. Such increased network effects can be said to change the behavior of users who choose new technologies. Pontiggia and Virili [57] pointed out that existing technology acceptance models do not take into account phenomena that influence technology selection and proliferation progress, such as network effects. Oh et al. [58] found that positive feedback is generated as the utility or value of products and services increases as the number of consumers increases. Kim and Yun [59] defined the externality of the network as a phenomenon in which the utility of participants increases when the number of people in the network increases and argued that the utility can be maximized through additional complementary services. Choi [14] defined the network effect as a phenomenon in which the value increases as the number of people who use the same products and services also increases. Higher output leading to lower prices of products is called "the economics of the supply scale". The increase in efficiency as the number of users increases due to the network effect is called "the economics of the demand scale". Boudreau and Hagiu [8] stated that platform businesses are greatly affected by network effects. Therefore, based on the preceding discussion, this study assumed that the network effects of the platform affect the usefulness of new types of logistics platform services. The research hypothesis is set as follows for the network effect of green logistics platforms.

Hypothesis 2. *The network effect of green logistics platforms has a positive impact on perceived usefulness.*

3.3. Security and Perceived Usefulness

Platform security, which arises from the user's perception of the platform's security policies, refers to how secure the user's information is on the platform. Information system users are studying ways to improve their ability to respond to cyber-attacks such as hacking or leaks of information with techniques such as access controls. Platforms are improving their ability to eliminate security vulnerabilities by using various tools. Security for users in the IT environment, such as compliance with governmental guidelines, is a key issue for the recent domestic environment [21]. SERVQUAL, developed by Parasuraman, Zeithaml, and Berry [60], has been extensively modified, providing reliable and useful methods in various service industries [61]. Previous studies [62–66] include information on this component of e-service quality. In this study, the items used in leading studies related to information security were modified to fit the research context of logistics platforms. Specifically, the system security of logistics platform services was measured for four categories: stability of the service, personal information security, privacy policy, and security from the outside. Therefore, this study proposed the following hypothesis.

Hypothesis 3. *Green logistics platform security has a positive impact on perceived usefulness.*

3.4. Perceived Usefulness and Intention to Use

Intention is an intermediate variable between the user's attitude and behavior and represents the subjective state of the user [67]. Therefore, the intention to use can be defined as the user's belief and willingness to form an attitude toward a certain object and express it as a specific future behavior.

Intention to use is important because existing customer retention is very critical in the long run. Existing research shows that retaining existing customers in other industries is more valuable than attracting new customers [68]. Existing customer retention costs are only 20% of the cost of attracting new customers. Therefore, it is more cost-effective to retain existing customers than to attract new customers, and the time it takes to earn revenue from existing customers is shorter than that for new customers [52,57,69]. Oliver [70] demonstrated that user satisfaction affects user attitudes and continues to have a direct positive impact on future potential behaviors, such as the intention to use.

A study of Internet websites conducted by Reichheld and Schefter [71] found that the usefulness and ease of use for users increased the intention to continue using a particular site.

Hypothesis 4. *The perceived usefulness for users increases the intention to use the green logistics platform.*

Four hypotheses were formulated as displayed in Figure 3.

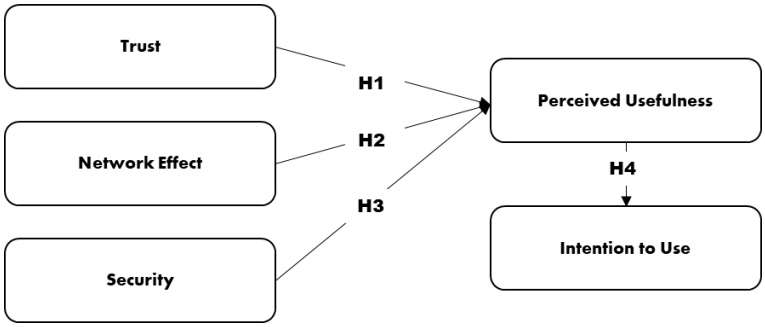

Figure 3. Research model.

4. Method

4.1. Data Collection

The study used a survey method for data collection. The questionnaire measured trust, network effect, security, perceived usefulness, and intention to use. The variables used in hypotheses testing were based on data from a questionnaire that used a Likert 7-point scale. Questionnaire questions included personal characteristics of the survey respondents such as gender, age, job position, number of employees, and annual turnover of the company. The sample was purposefully selected, and data were collected through face-to-face interviews and Google surveys of employees in their 20s and 30s who were aware of logistics platform services in Seoul, Gyeonggi, and Incheon. The reasons for sampling Koreans in their 20s and 30s are as follows. South Korea's digital industry has witnessed rapid development to the extent that the world relies on South Korea for digital products. The demand for high-tech digital devices has spread rapidly, and the market response is fast, making it a testbed for global IT companies. In South Korea, consumers in their 20s and 30s are the most enthusiastic for digital technology, which makes them a good testbed for the digital industry, and digital product perspective and adaptability are evaluated as competitive compared to young people in other developed countries [72]. Out of the 230 questionnaires distributed from 25 June to 11 July 2019, 14 were removed from analyses due to unsatisfactory responses, and 216 were used for statistical processing.

To verify the research hypotheses, survey data were analyzed using the SPSS Win 17.0 program. The statistical significance level was set at $p < 0.05$, and the common factors of measurement tools were identified before hypotheses were tested. A factor analysis was conducted to test the validity

of variables, and a correlation analysis was performed to verify the reliability and validity of results. First, frequency analysis was conducted to identify the demographic characteristics of respondents. In addition, path analysis was conducted using the structural model to verify the research hypotheses. The items for each variable were prepared according to previous studies. The operational definitions and measurement items of variables and the contents of preceding studies are shown in Table 3.

Table 3. Operational definitions and measures of variables.

Variables	Operational Definition of Variables	Reference
Reliability	① Provide accurate information ② Provide reliable information ③ Provide professional and rich information ④ Trust the platform manager ⑤ Protect your personal information well ⑥ Protect useful information	[46,48,49,73–75]
Network Effect	① Likely to be used by many ② Increase in value when users increase ③ Increased utilization when increasing users ④ Increased utility when users increase	[8,14,56,57,59]
Security	① Logistics platform is stable ② Have no fear of leaking information ③ Privacy is strictly protected from the outside world ④ Logistics platform efforts to protect personal information	[60,62,63,65,66]
Perceived Usefulness	① Logistics platform helps to use related services ② Logistics platform helps me ③ Low-cost services available on logistics platform ④ Logistics platform can save you money compared to existing facilities ⑤ Logistics platforms are generally useful	[51–53]
Intention to Use	① Willing to use logistics platform in future ② Use logistics platform when relevant information is needed ③ Willing to book services on a logistics platform ④ Logistics platform to recommend to others ⑤ Explain the positive aspects of a logistics platform to others ⑥ I will recommend the platform to the people around me	[67–69,71,76]

4.2. Sample

As a result of analyzing the general characteristics of survey respondents, as shown in Table 4, 40.3% were male, and 59.7% were female. The age of respondents comprised 18.5% from 20 to 29 years old, 77.8% from 30 to 39 years old, 3.2% from 40 to 49 years old, and 0.5% from 50 to 59 years old. The proportion of job positions was 16.2% for deputy managers, 81.9% for staff, 0.5% for managers, 0.69% for general managers, and 0.5% for CEOs. Although the proportion of respondents in their 20s and 30s was relatively high, the majority of consumers who use the logistics platform smoothly were under 40.

Table 4. Sample characteristics.

Division		Frequency	Percent (%)	Division		Frequency	Percent (%)
Gender	Male	87	40.3	job position	Staff	35	81.9
	Female	129	59.7		Deputy Manager	17	16.2
Age	20s	40	18.5		Manager	1	0.5
	30s	168	77.8		General Manager	2	0.69
	40s	7	3.2		CEO	1	0.5
	50s	1	0.5				

Table 4. *Cont.*

Division		Frequency	Percent (%)	Division		Frequency	Percent (%)
Number of employees	10 or less	59	27.3	turnover	0–10 billion	55	25.5
	10–50	26	12.0		10–100 billion	37	17.1
	50–100	18	8.3		100–1000 billion	44	20.4
	100–300	24	11.1		1000 billion–1 trillion	32	14.8
	300 or more	89	41.2		More than 1 trillion	48	22.2
Total		216	100			216	100

4.3. Validity and Reliability Analysis

In this study, we first conducted a feasibility and reliability analysis, followed by a confirmatory factor analysis (CFA) for the measurement model. First, to verify the convergent validity between constructs, we examined whether there was a significant path coefficient between constructs and indicators [77]. As a result of the confirmatory factor analysis, the relationships between constructs and all measurement indices were all significant, indicating that there was no problem in convergent validity. As a next step, the average variance extracted values were measured to verify discriminant validity. Comparing the squared correlation coefficient between the study variables and the average variance extraction (AVE) of each study variable confirmed the discriminatory validity. The variance extraction value of the two compared variables was not lower than the square value of their correlation coefficient, thus ensuring discriminant validity. In addition, it can be assumed that each research unit satisfied the criterion of 0.5 or more and thus had overall discriminant validity [77]. Since each result was between 0.41 and 0.99, it exceeded the value of 0.7 suggested by Nunnally [78] in terms of composite reliability. Therefore, the reliability of each construct was secured. Reliability was evaluated using Cronbach's α value. As shown in Table 5, the Cronbach alphas of the five constructs included in the study model were all above 0.87, exceeding the baseline of 0.7. Therefore, it was confirmed that the measurement model used in this study model had sufficient reliability and composite validity.

Table 5. Results of reliability and validity analysis.

Construct/Items	Standardized Loadings
Reliability (Cronbach's a = 0.928, AVE = 0.93632, CR = 0.98877)	
Provide accurate informationProvide reliable information	0.816
Provide professional and rich information	0.815
Trust the platform manager	0.793
Protect your personal information well	0.805
Protect useful information	0.865
	0.873
Network Effect (Cronbach's a = 0.890, AVE = 0.94499, CR = 0.890)	
likely to be used by many	0.860
Increase in value when users increase	0.833
Increased utilization when increasing users	0.875
Increased utility when users increase	
Security (Cronbach's a = 0.919, AVE = 0.93986, CR = 0.98422)	
Logistics platform is stable	0.812
Have no fear of leaking information	0.851
Privacy is strictly protected from the outside world	0.921
Logistics platform efforts to protect personal information	0.868
Perceived Usefulness (Cronbach's a = 0.870, AVE = 0.93358, CR = 0.97675)	
Logistics platform helps to use related services	0.762
Logistics platform helps me	0.868
Low-cost services available on logistics platform	0.860
Logistics platform can save you money compared to existing facilities	0.872
Logistics platforms are generally useful	

Table 5. *Cont.*

Construct/Items	Standardized Loadings
Intention of Use (Cronbach's a = 0.920, AVE = 0.95442, CR = 0.98431)	
Willing to use logistics platform in future	0.860
Use logistics platform when relevant information is needed	0.893
Willing to book services on a logistics platform	0.922
$\chi 2 = 305.949$(df = 148, $p = 0.000$), $\chi 2$/df = 2.067, RMSEA = 0.066, CFI = 0.956, TLI = 0.944, IFI = 0.957	

Table 5 presents the means, standard deviations, and correlation coefficients of all the variables. The results of the correlation analysis were found to be significant between all variables [79]. AVE—average variance extraction.

As a result of evaluating the discriminant validity, the square root of the mean variance extraction value of each construct was compared with the correlation coefficient between the construct and the other constructs, as shown in Table 6. The variance was greater than the variance shared with other constructs. Therefore, the measurement items of this study had appropriate discriminatory validity.

Table 6. Correlation.

	Reliability	Network Effect	Security	Perceived Usefulness	Intention to Use
Reliability	1				
Network Effect	0.890 (***)	1			
Security	0.691 (***)	0.644 (***)	1		
Perceived Usefulness	0.737 (***)	0.844 (***)	0.621 (***)	1	
Intention to Use	0.677 (***)	0.784 (***)	0.516 (***)	0.825 (***)	1

***: $p < 0.001$.

5. Results

In this study, a structural equation model was used to test the hypotheses. The p-values for CFI, RMSR, and NFI were used to evaluate the fit of the study model. Results found 472.535 degrees of freedom (df) = 245, p-value = 0.000, CFI = 0.950, IFI = 0.951, TLI = 0.939, RMSEA = 0.066, NFI = 0.902. The results of analyzing the significance of the paths to verify our four hypotheses are shown in Table 7.

Table 7. Hypothesis verification results.

Hypothesis				Estimate	S.E.	C.R.	*p*
H1	Perceived Usefulness	←	Reliability	−0.182	0.137	−1.258	0.208
H2	Perceived Usefulness	←	Network Effect	0.843	0.167	4.963	***
H3	Perceived Usefulness	←	Security	0.137	0.064	1.997	0.046 (**)
H4	Intention to Use	←	Perceived Usefulness	0.847	0.07	14.058	***

**: $p < 0.05$, ***: $p < 0.001$.

First, hypothesis 1 that the trust of the green logistics platform has a positive impact on perceived usefulness was not supported (standardized path coefficient = 0.182, $p > 0.50$). According to studies by Morgan and Hunt [46] and O'Connor [80], trust is a descriptive factor for both information technology and relationships. However, in this study, it was found that unlike previous research results, trust did not affect the usefulness of the platform. On the other hand, Wen et al. [81], who conducted research concerning trust in the technology acceptance model, confirmed that trust does not directly affect technology acceptance decision-making. In view of this, it can be seen that users participated in the logistics platform due to the introduction of simple information technology. Users tended to consider the green logistics platform, cargo information network, and information system as the same. This is because the green logistics platform was provided as an evolved form of the existing service, so it could be considered similar in terms of utility compared to existing services.

Second, hypothesis 2 was supported in that the network effect provided by green logistics platforms affected perceived usefulness to users (path coefficient = 0.843 (***), $p < 0.5$). This is consistent with the findings identified by Boudreau and Hagiu [8], Kim and Yun [59], and Choi [14], who argued that the platform business was greatly affected by network effects. It can be said that users participating in green logistics platforms thought that participating in the green logistics platform was the formation of a network, that is, the relationship. This means that the larger the participation, the greater the usefulness, and the green logistics platform was affected by the network effect of participation. It can be said that a larger perceived network associated with a platform resulted in stronger perceived usefulness. Therefore, in order to encourage users to participate in green logistics platforms, it is necessary to present the advantages of introducing the platform.

Third, hypothesis 3 was supported in that security of the green logistics platform had a positive impact on perceived usefulness to users (path coefficient = 0.137 (**), $p < 0.5$). Therefore, a more secure platform resulted in stronger perceived usefulness of that platform. These findings on security are consistent with Kim's [26] study, which showed that security is critical for user satisfaction. Since the platform operator collects important personal information of users, if personal information or corporate information is leaked, a company may experience a crisis. It can be said that it is essential to strengthen security measures that prevent hacking.

Fourth, hypothesis 4 was supported (path coefficient = 0.847 (***), $p > 0.50$) that postulated that the perceived usefulness of green logistics platforms affects the intention to use. Therefore, greater perceived usefulness of the platform resulted in a stronger intention to use the platform. These results are consistent with the results of David [51] on the perceived ease of use. The network effect had the greatest impact on the perceived usefulness of the logistics platform, followed by security. Therefore, in order to increase the intention to use logistics platforms, the network effect and security need to be continuously strengthened.

Discussion

This study was designed to analyze the perspective of relationship participation in logistics platforms based on the technology acceptance model. In the case of the technology acceptance model, which has been widely adopted in research on network platforms, the explanatory power of the model is only about 40% [82], and attempting to expand and integrate the model is important in the case of the acceptance of green logistics platforms. This model included trust, the network effect, security, and perceived usefulness, which were expected to affect platform participation, and further analyzed how the perceived usefulness of the platform affected the intention to use. To achieve these research objectives, a survey was conducted on logistics companies and potential companies participating in logistics platforms to measure their perceived usefulness and intention to use, and structural equation model (SEM) analysis was conducted using measured data. The results of this study are as follows.

First, the theoretical aspects of the green logistics platform were presented. This research is meaningful in that the factors were drawn from a systematic review process of relevant prior studies influencing the sustainable use of logistics platforms by users. These factors included reliability, network effects, security, perceived usefulness, and intent to use. The results showed statistically significant results except for reliability, and the network effect was the most influential, followed by security.

Second, in practical terms, marketing strategies can be established through the results of this study. The relationship between variables of the logistics platform was identified, and measurement items for the definition, reliability, and validity of each variable were presented. This created a foundation for enabling empirical research in this field and is expected to contribute to the establishment of green logistics platforms and marketing strategies by green logistics platform operators as strategic tools for business.

Third, network effects require the expansion of logistics platforms. Among the factors that affect the perceived usefulness of platforms, network effects were found to be the most important. This finding

indicates that network effects play an important role for users of the platform. The network effect showed that the scalability of logistics platforms was important. To overcome the limits of networks, it is necessary to make service providers and users provide value, i.e., not all services will be provided by platform operators. The Korean domestic logistics industry, which lacks network scalability, experiences difficulty in succeeding as a platform business. In order for smaller logistics platforms to compete with large companies, the platform participants need to create value for themselves. If forwarding or SC management areas are targeted in global markets, there is a good chance that even small businesses can succeed. The platform could focus only on creating a means for operators to open a "field" where platform participants can gather and share information. Participants go beyond simple consumer roles and add value to the platform by creating additional services [83]. As a result, participants play a role in bringing other participants into the platform. Platform participants are customers, but they also become producers who help expand the platform ecosystem.

Fourth, the second most significant impact on the perceived usefulness of logistics platforms was shown to be security. It is essential to strengthen security against hacking of personal or corporate information. When looking for ways to improve the reliability of the platform through the protection of personal information, the degree of collection of personal information varies depending on the usage policy of each platform operator, but the function for withdrawal of membership should also be provided [21]. In addition, most logistics platform operators have a "chat" function in the platform, and setting an expiration date for conversations could be a way to increase the trust relationship between the platform operator and users [21].

Fifth, in order to develop a green logistics platform, attention, reputation, and influence should be exchanged as well as logistics services [6]. We need to establish a transparent service by utilizing blockchain technologies. There is a need for transparent services provided by blockchain technology for future green logistics platforms. Unmanaged information about the origin and shipment status of goods through the blockchain is needed. This can be used to add transparency to complex supply chains and further maximize logistics efficiency. Blockchain technologies can further increase the transparency of the trade transaction process for manufacturers, exporters, importers, and distributors. They also create error-free automated processes, enabling significant cost savings. The flow of the trade process with the introduction of blockchain technology provides digital information on the status of customs documents and bills of lading among stakeholders across the supply chain. This is information that cannot be forged, enhancing trust between stakeholders [30].

This study expects that platform participants such as service providers, shippers, and platform service operators will turn into an era of mutual recognition and coexistence through green logistics platforms. It can be helpful to Korean logistics companies and related people who are struggling to rebuild the logistics industry, which has been in recession [84,85].

6. Conclusions

The logistics sector is providing shippers with information asymmetry through traditional platforms and is trying to increase its effectiveness through network effects and sharing. Logistics platforms, however, have limited participation in their early stages. To grow from a logistics platform to a green logistics platform, appropriate checks and balances are needed so that the service provider, users, and platform operators can grow together in a green logistics platform, and the securing of users and generation of revenue must be done simultaneously to create a virtuous cycle. Therefore, the implications for a green logistics platform were derived as follows.

First, the functions of the logistics platform continue to expand, from matching-oriented logistics platforms to risk-monitoring functions that have progressed one step further. This is developing in a form that can be used to increase the accuracy of forecast information by utilizing big data and, at the same time, facilitating pre-emptive responses based on predictive information. This information includes not only basic information such as the estimated time of departure (ETD) and estimated time

of arrival (ETA) but also analyzes port congestion to predict arrival times and helps dramatically in examining the global logistics control systems and cargo.

Second, the logistics platform needs to consider ways to form partnerships with forwarders as a strategy to increase user participation. Since forwarders are concerned about maintaining close relationships with customers, this should be taken into account when establishing a logistics strategy for logistics platform providers. Meanwhile, freight trucking companies need an easy-to-use technical environment to introduce logistics platforms. Due to the relatively small size of enterprises and low training opportunities, the freight trucking industry needs to provide a user interface (UI) that can be easily used.

Third, it is necessary to build a sharing logistics platform. Currently, pallet pool systems and rental forklifts are representative equipment, but the sharing of logistics robots, drones, 3D printers, self-driving cargo trucks, and unmanned storage vessels is also expected to occur in the future. Participants in the logistics platform service will act as both service users and providers. If the trend expands further, shippers will also provide delivery services and storage services by sharing logistics equipment and warehouses with other companies.

The role of a green logistics platform will be to enhance the efficiency of logistics activities such as reducing traffic jams, reducing greenhouse gas emissions, and reducing logistics costs. The distribution of various promotional materials for the spread of green logistics platforms and education of relevant agencies to change their perception of green logistics will be needed.

In addition, it will be necessary to diagnose obstacles that impede the activation of green logistics platforms and to prepare institutional improvements.

Limitations

This study was an initial empirical study on the important factors perceived by users of green logistics platform services and their intention to use them. However, there are several limitations, and it is believed that further research should be carried out to overcome these shortcomings in the future.

Most survey respondents for this study were in their 20s or 30s. Therefore, this study did not examine the recognition of green logistics platform services for various age groups. The reason for sampling people aged in their 20s to 30s in Korea was that this group features a high degree of digital competence and is a good testbed for the digital industry. Subsequent studies should include a more diverse respondent distribution to enhance the generalizability of results.

Author Contributions: Conceptualization and methodology—S.-Y.K., W.-S.C., G.-A.S., S.-G.Y.; data collection and analysis—S.-Y.K.; writing—S.-Y.K., W.-S.C.; review and commentary—G.-A.S., S.-G.Y. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Acknowledgments: The authors wish to thank all the participants that took part in this study.

Conflicts of Interest: The authors declare no conflict of interest.

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