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Development of a system for parcel delivery applications for cross-provincial rail transportation

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Abstract

The transportation system is crucial to the nation regarding its economy, society, and environment. An efficient, safe, dependable, and cost-effective transport infrastructure will significantly enhance the country's business competitiveness. This research evaluates the performance of the supply chain and examines the construction of a system for parcel delivery applications in cross-provincial rail transportation. This initiative involves entrepreneurs striving for excellence in logistics management, specifically in the creation of a parcel delivery system for cross-provincial rail transport from Bangkok to Nong Khai. It entails the development of a prototype module to assess the efficiency of cross-border freight transport services provided by Thai logistics entrepreneurs, focusing on time resolution, transportation quality, transportation volume, and service quality. The examination of variables associated with rail transport service suppliers and recipients involves the collection and analysis of both qualitative and quantitative data. The outcomes of the statistical model analysis present the estimate, standard error (SE), 95% confidence intervals, standard coefficient (β), z-value, and p-value. Experimental results of different variables (CS → iOT) Estimate: 0.666, meaning iOT has a positive influence on CS (Customer Satisfaction) at a level of approximately 0.666 units. $p < .001$: The effect is statistically significant (99% confidence level). The 95% confidence interval: [0.568, 0.7628] confirms the confidence that the estimate is in this range. (iOT → System) Estimate: 0.853, meaning the System has a positive effect on iOT at a level of approximately 0.853. $p < .001$: The effect is statistically significant. The 95% confidence interval: [0.670, 1.0353] and (iOT → Notification) Estimate: -0.285, indicating a slightly negative effect of Notification on iOT. $p = .023$: The effect is statistically significant (95% confidence level). The 95% confidence interval: [-0.530, -0.0393] Conclusion: The iOT variable clearly has a significant (positive) influence on CS and System, but the effect on Notification is slightly negative. The significant p-values ($< .05$) indicate that these relationships are not due to chance.

Keywords: Android operating system, Decision making, iOT, Satisfaction.

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1. Introduction

The State Railway of Thailand currently operates a railway network spanning 4,043 kilometers throughout 47 provinces, with 3,764 kilometers of single-track, 174 kilometers of double-track, and 105 kilometers of triple-track. The transportation system is vital to the nation regarding economic, social, and environmental aspects. The evolution of the rail transport system has garnered heightened interest as an effective alternative for the conveyance of goods and parcels, owing to its capacity to manage substantial volumes of cargo simultaneously, enhanced safety, and reduced fuel costs in comparison to road transport. The demand for efficient, timely, and safe parcel delivery services is consistently rising, particularly in the context of the swift expansion of e-commerce. The creation of a parcel delivery application system connected to the inter-provincial rail transport network could efficiently address this demand. The significance of creating a parcel delivery application system the creation of a package delivery application system integrated with the rail transport network facilitates seamless management and tracking of goods for users. However, it also influences the evolution of the logistics system on a macro scale. The implementation of contemporary technology, like real-time parcel tracking, automated shipping cost calculations, and parcel status updates through smartphones, enhances transparency in the transportation process, minimizes errors associated with traditional methods, and elevates user happiness.

Furthermore, the application facilitates the promotion of rail transit as an eco-friendly infrastructure, mitigating greenhouse gas emissions and decreasing fuel energy use. Integrating rail transport with the application enhances resource management efficiency by improving transport space utilization and minimizing transportation waiting times. The objective of this research is to design and develop a parcel deposit application system for inter-provincial rail transportation. The primary objective is to enhance the user experience by addressing the requirements of the user in a variety of ways, including ease of use. creating a system that enables users to deposit and track parcels at any time and in any location; data and parcel security; utilizing contemporary technology, such as data encryption and user authentication systems; and system integration, which involves linking data between train stations, warehouse systems, and users to establish continuity in the transportation process. This research will examine the creation of an application system for parcel reception in cross-province rail transport and the development of a prototype management system that tracks the status of rail goods across provinces, aiming to enhance the efficiency and safety standards of logistics transport management through low-cost RFID sensor technology integrated with a mobile notification system. The researcher opted to create a prototype of an advanced cross-border freight transit system. The impediments to the flow of cross-border goods and transit items have resulted in a rising trend in the statistics of service providers and consumers of cross-border freight transport. This research concentrates on process control and serves as an indicator of the efficiency of cross-border freight transport operations utilizing shuttle services in conjunction with railway transit. The essential infrastructure of railway transport comprises railway tracks and freight stations, with railway tracks serving as fixed-route structures. Consequently, substantial usage is necessary to justify the establishment of a route.

An application is proposed for the reception and dispatch of parcels transported by train across provinces, aimed at establishing a novel mode of parcel transit currently unavailable. The initial user of the application is the sender, who intends to travel across provinces, while the second user is also a sender, seeking to dispatch items on an hourly basis. For the application's parcel receiving and dispatching, the recipient must travel to collect the parcel as arranged with the sender. The sender is required to deliver the package to the recipient. Security and confidence Both the sender and recipient must register as members before to utilizing the application. The sender is required to utilize their ID card and phone number for identification verification. The sender must photograph both their face and the parcel to verify receipt of the item. A photograph of the person and the parcel must be taken to verify the delivery. Application Scope Compatible exclusively with Android. Compatible just with mobile phones equipped with GPS. It is necessary to utilize the internet for operation. Researchers will assess user requirements and examine technical constraints in the project. Evaluate the appropriateness of employing technologies such as the Internet of Things (IoT) and Artificial Intelligence (AI). This study will evaluate the preparedness of rail infrastructure and the support from pertinent agencies, while also performing an economic analysis to determine the effects on investment and operations, in order to optimize the system. The creation of a package delivery application system for inter-provincial rail travel is a crucial advancement in enhancing the efficiency and competitiveness of Thailand's freight transport system, as well as contributing to economic development and long-term sustainability.

2. Literature Review

2.1. Design of a Notification System

The design of notification systems is crucial in transportation service applications, particularly in parcel delivery systems that demand precision and punctuality. The function of notifications in logistics management Notification systems in transportation apps inform users about parcel delivery status, including confirmation, status updates, and notifications upon arrival at the destination [1]. The category of notice Notifications can be categorized into two primary types: Push notifications deliver information to users instantaneously [2]. In-application notification: Users are required to access the program to verify the message [3] Notification technology within transportation networks The utilization of technologies like Firebase Cloud Messaging (FCM) and Apple Push Notification Service (APNs) for notification development mitigates communication delays [4]. Notification design to improve user experience A clear, unobtrusive design and suitable communications diminish aggravation and enhance user pleasure [5] Notification and mitigation of delivery errors Automated notification methods diminish delivery inaccuracies. Particularly in regions where the train system operates alongside inter-provincial routes [6].

2.2. Systems Architecture

The creation of a parcel delivery application within a cross-provincial rail transport system necessitates a thorough system design methodology and the use of suitable technologies to enhance service efficiency. System Architecture The parcel delivery application system must have a cloud-based design to facilitate future scalability [7]. The integration of IoT systems in transportation, through the connection of sensors like GPS and RFID, facilitates precise real-time package tracking and minimizes errors [8]. Database Management Systems Utilize a highly secure database, such as MySQL or MongoDB, to store customer data and parcel status, hence enhancing system stability [9]. Developing an API framework for connectivity enables the application to interface with partner systems, including online payment platforms and the State Railway of Thailand [10]. Information Security Systems SSL/TLS encryption and two-factor authentication safeguard sensitive data from assaults [11].

2.3. Software Utilized for Application Development

Developing applications for inter-provincial rail transportation networks necessitates the selection of suitable tools and software to enhance productivity in development, maintenance, and support for a substantial user base, including cross-platform application development tools. Frameworks like as Flutter and React Native are favored for projects necessitating compatibility with both Android and iOS, since they diminish development time and expenses [12]. Flutter transportation frameworks and libraries are exceptionally efficient in user interface and real-time data management [13]. React Native provides supplementary tools that facilitate the creation of APIs for logistics systems [14]. Server-Side Development The utilization of Node.js and Python frameworks like Django and Flask facilitates effective data and API management [15]. Serverless systems, including AWS Lambda and Google Cloud Functions, enhance flexibility and decrease expenses [16]. Appropriate databases for transportation NoSQL databases like MongoDB and Firebase Realtime Database are optimal for the storage of real-time parcel data [9]. Notification software (Notification Systems) Firebase Cloud Messaging (FCM) and One Signal are the primary tools utilized for developing notification systems for package status updates [17].

2.4. Service Providers

The creation of a package delivery application system inside a cross-province rail transport framework necessitates an examination of the responsibilities and elements associated with service providers that influence system design, functionality, and user satisfaction. The function of service providers within the railway transportation framework Service providers are integral to the parcel transport process, overseeing deposit management, tracking system administration, and parcel delivery, necessitating seamless operations across several departments [18]. Consolidation of various service providers' systems Integrating the systems of various delivery providers, such as connecting delivery data among service providers in each province, enhances efficiency and minimizes transit time [19]. Operational issues faced by service providers Rail transport operators face issues in regulating transit durations, ensuring the quality of package status data, and addressing delays [20]. Utilizing technology to enhance the services of providers IoT solutions provide real-time parcel tracking to enhance transparency in transportation [13]. Blockchain facilitates enhanced security and transparency in interdepartmental data management [21] as well as in the interaction between service providers and users. Trust between service providers and users is established by precise information and prompt customer care. It influences satisfaction and prolonged utilization of the system [22].

2.5. Individuals

Participants in the inter-provincial rail package delivery system significantly influence the application's success, since their happiness and usage patterns directly impact the system's popularity and efficiency. Consumer conduct and requirements Users desire a convenient, user-friendly, and transparent system for monitoring package progress, including precise status updates and delivery time notifications [23]. Determinants influencing the adoption of application utilization Usability and Perceived Utility Confidence in the system [8, 24]. User Experience (UX) Effective UX/UI design minimizes usability faults and enhances satisfaction by employing suitable color schemes and organizing menus for effortless navigation [25]. Safeguarding and preservation of personal information Users express apprehension regarding the safeguarding of personal information, including name, address, and payment details, and the enhancement of security solutions, such as encryption, is crucial [26]. Establishing confidence through superior service, prompt resolution of issues or grievances, and offering transparent information regarding delivery. It enhances user confidence [27].

3. Research Objectives

An examination of the formulation of a system for parcel delivery applications inside cross-provincial train transit. The researcher aims to investigate the underlying issues affecting rail transportation in Nong Khai Province, to devise a parcel delivery application system for the Bangkok-Nong Khai rail route, and to facilitate parcel delivery services for customers while assessing the satisfaction levels of both service providers and recipients in utilizing rail transport for parcel dispatch.

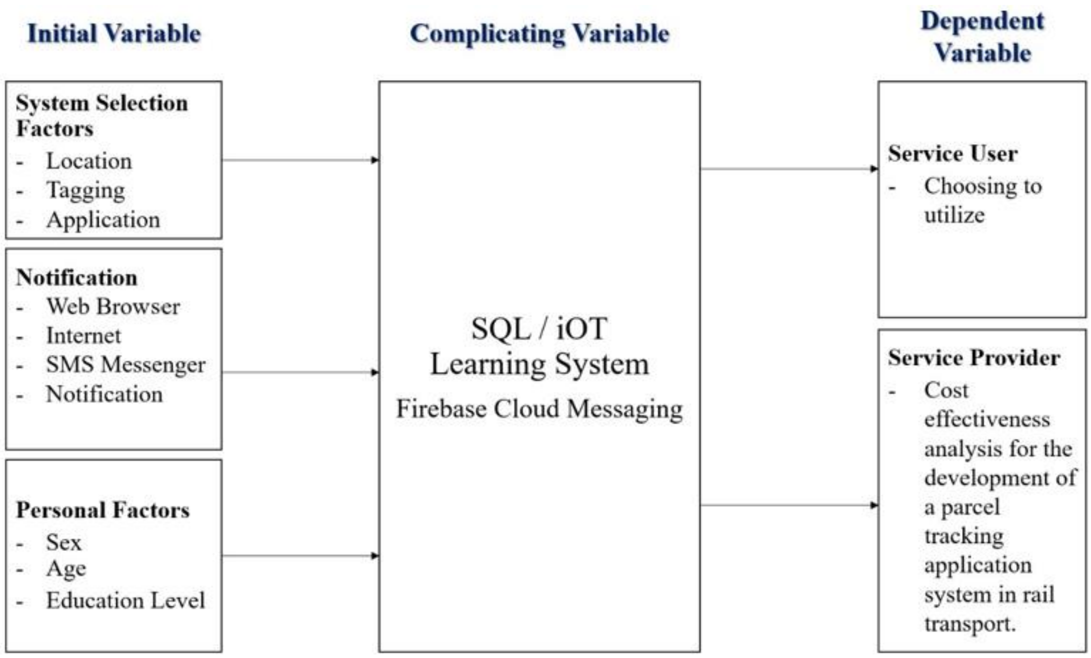

Figure 1.
Conceptual framework.

4. Conceptual Framework

4.1. Research Hypothesis

The proposition of creating a parcel delivery system utilizing inter-provincial rail transport pertains to the advancement of logistics and transport management aimed at enhancing efficiency in public transport systems, particularly through the optimal utilization of existing rail infrastructure. Research in this domain frequently encompasses the following elements. The hypothesis of this research are as follows.

Hypothesis 1 System Selection factor influences the Learning System
Hypothesis 2 Notification factor selection influence the Learning System
Hypothesis 3 Personal factor influences the Learning System
Hypothesis 4 Learning system influences the Service User
Hypothesis 5 Leaning system influence the Service Provider

5. Research Methodology

The research on developing a parcel delivery system for cross-provincial rail transportation outlines explicit research and development protocols to enhance system efficiency and fulfill the requirements of both service users and providers. It is a hybrid research methodology that gathers and analyzes both qualitative and quantitative data. The process will commence with qualitative research through in-depth interviews, which will subsequently be integrated with the findings from quantitative research in the following phase, involving survey research aimed at developing a model for road freight movement over the Bangkok-Nong Khai border. The researcher outlined the primary issues as follows.

1. Research Design use applied research methodologies to create practical systems and utilizes developmental research for the design and evaluation of application systems.

2. Literature Review on the Research and Development Process Examine literature pertaining to rail transportation systems, parcel management, and application development. Examine the requirements of service consumers and suppliers via data surveys, data gathering, target demographics, including the general public and small enterprises, as well as service providers within the transportation sector. Instruments for data acquisition Utilize surveys and conduct in-depth interviews. Methods of data collection Random selection of service consumers and interviews with logistical specialists. Analysis of Requirements Examine user needs and system functionality employing UML (Unified Modeling Language) methodologies, including Use Case Diagrams and Activity Diagrams, to design system architecture. Application Design and Development Employ Agile or Iterative Development methodologies to enhance flexibility and facilitate system improvements based on feedback. Choose suitable programming languages and technologies, such as Flutter for application development or Firebase. System Testing for databases employs Functional Testing and Usability Testing to assess the system's performance and user satisfaction through real user interactions. The evaluation assesses the system via surveys and interviews to gauge satisfaction, convenience, and accuracy. Statistical metrics, like mean and standard deviation, are employed to analyze the data.

3. Instruments and methodologies employed in research Technologies for programming languages, like Flutter and React Native, and database systems such as Firebase and MySQL. Data analysis employs SPSS or Python for the examination of quantitative data. Content Analysis is employed for qualitative data. The assessment of system performance employs Key Performance Indicators (KPIs) including processing speed, data accuracy, and user satisfaction. Research

Study Area Scope The railway transport system in Thailand, exemplified by the State Railway of Thailand Sample cohort: 400 users and 20 service providers. The system development duration is typically 6 to 12 months. Establish a cohesive transportation and logistics framework. The system's educational component will utilize the Google Maps API to retrieve map data for display within the application, alongside the Google Distance Matrix API, which calculates distances in kilometers and journey durations in minutes. Examine the Firebase Firestore API facilitates real-time data storage, automatically updating the application as data changes occur. The Maps JavaScript API facilitates the development of JavaScript applications for Google Maps, enabling functionalities such as the display of city names on the map.

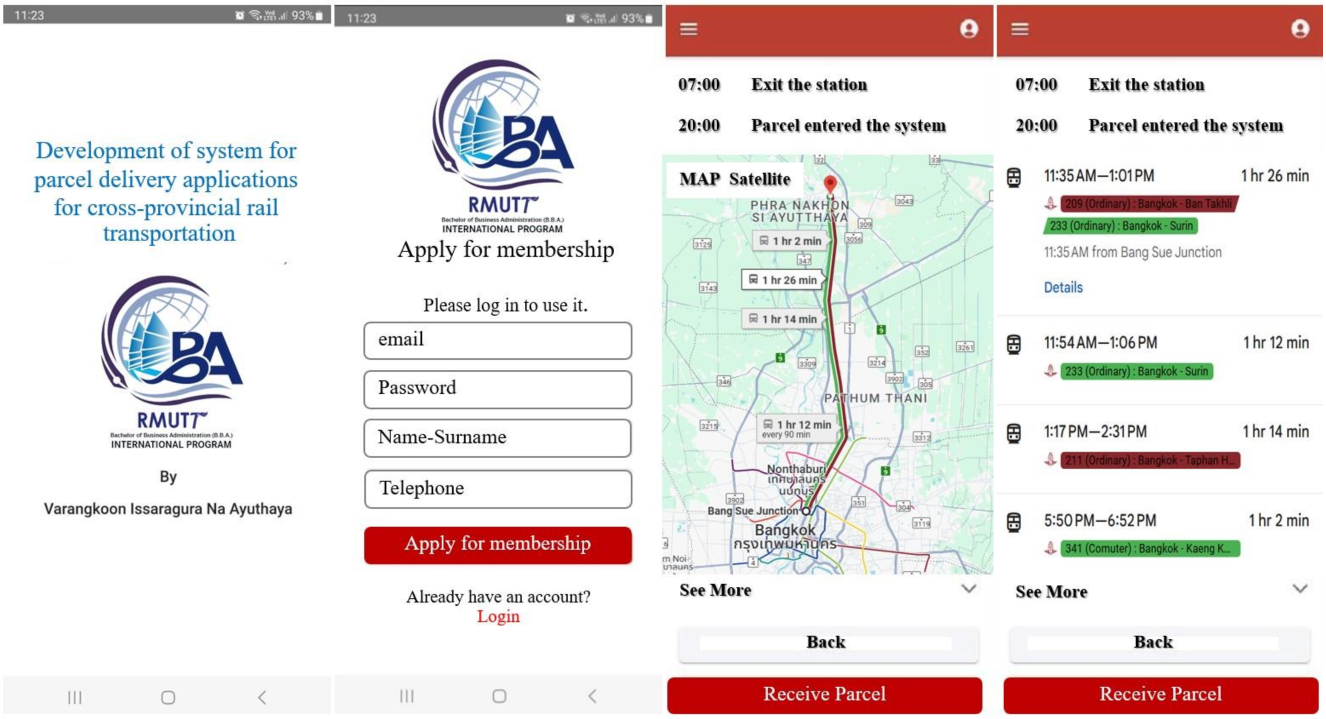

Figure 2.
Access the parcel dispatch page. The sender may adhere to the procedures to designate the origin and destination stations, specify the parcel type (packing dimensions), input the parcel weight, the recipient's name, and contact telephone number, and monitor the transportation path.

Complete the information in the form and click the Next button. An illustration of transporting a parcel internationally by rail, from Bangkok to Nong Khai, with a type C package shape weighing 20 kg. Navigate to the confirmation page to verify the accuracy of the information. Activate the Confirm button. The parcel has been successfully created. Press the parcel number icon to duplicate it to the subsequent parcel list. If the parcel has arrived at the destination station, press the Receive Parcel button. The Application page will provide confirmation of successful shipment receipt.

4. Anticipated Results: The application system is capable of facilitating the efficient receipt and monitoring of shipments. The system satisfies the requirements of customers and service providers while minimizing the costs and duration of the transportation system.

6. Research Findings

The study on the creation of a parcel delivery system for interprovincial rail travel employs a mixed-methods approach, integrating both qualitative and quantitative data collection and analysis. The process will commence with qualitative research through in-depth interviews to amalgamate the responses with the findings of quantitative research. In the subsequent phase, the researcher will utilize the research findings to create road freight transport models. The researcher analyzed the primary issues identified in the survey research and gathered data from the questionnaire. The sample group comprises 400 cross-border road freight transport operators from the Bangkok-Nong Khai checkpoint. The outcomes are encapsulated in each dimension as follows:

Table 1.

Measurement used in the study.

Variable	Measurement		Adapted from
Initial variable	Q1	In terms of entrepreneurial characteristics	Personal factors
	Q2	In terms of the company's management structure	
	Q3	In terms of the main types of goods used for transportation	
Initial variable	Notification 1	Load Management Alert System	Notification factors
	Notification 2	Real-time train location alert system	
	Notification 3	Vehicle route recording notification system	
	Notification 4	Emergency shutdown notification system	
	Notification 5	Device Malfunction Alert System	
	Notification 6	Speed warning system	
	Notification 7	Departure warning system	
	Notification 8	Accident warning system	
	Notification 9	Energy usage alert system	
	Notification 10	Train status update notification system	
Initial variable	System 1	Train position detection sensor system	System selection factors
	System 2	Intelligent alert system	
	System 3	Product weight checking system	
	System 4	Cross-border freight service user data analysis system	
	System 5	Transportation Data Analysis System	
	System 6	Container Safety Management System	
	System 7	Transportation route monitoring system	
	System 8	Humidity detection system inside the container	
	System 9	Transportation Data Analysis System	
	System 10	Container weight checking system	
	System 11	Train GPS tracking system	
	System 12	Container vibration sensor	
Complicating variable	iOT 1	Contingency plans for emergencies and potential hazards	SQL / iOT learning system firebase cloud messaging
	iOT 2	Security of product delivery	
	iOT 3	Providing services in the area of insurance for possible damages	
	iOT 4	Special precautions when delivering goods	
Dependent variable	EFFI1	The company's vehicles used for transportation are of good standard.	Service user and service provider
	EFFI2	The equipment and tools used for work are modern and ready for use.	
	EFFI3	The staff can deliver the goods to the destination on time.	
	EFFI4	Employees are able to use equipment to move goods correctly.	
	EFFI5	The staff are skilled in providing service and solving problems.	
	EFFI6	The company has a simple service process that makes it easy to understand the transportation service.	
	EFFI7	The company is located in a community, convenient for using the service.	
	EFFI8	The company provides services that can be accessed at any time.	
	EFFI9	Easy-to-understand shipping document formats	
	EFFI10	The staff are knowledgeable about the service formats and can provide information.	
	EFFI11	The staff is able to communicate with customers about service.	
	EFFI12	There are several ways to contact the company.	
	EFFI13	The company works systematically and has good communication and coordination.	
	EFFI14	The company has printed media to disseminate information to customers.	
	EFFI15	Customers can contact the company to check the information of the transported goods.	
	EFFI16	The company provides services that are credible in the eyes of	

Variable	Measurement		Adapted from
		customers.	
	EFFI17	The company delivers products in accordance with all contractual terms.	
	EFFI18	The company delivers products to the correct location and on time.	
	EFFI19	The company is well-known and well-established in the freight forwarding industry.	

Table 2.
Displays the quantity and proportion of general information regarding the company.

Overview of the organization	Q1	Q2	Q3
N	400	400	400
Quantity	113	102	185
Mean	2.78	2.04	2.56
Std. error mean	0.0494	0.0476	0.0619
95% CI mean lower bound	2.69	1.95	2.43
95% CI mean upper bound	2.88	2.13	2.68
Median	3.00	2.00	2.00
Mode	3.00	2.00	2.00
Sum	1113	816	1022
Standard deviation	0.989	0.952	1.24
Variance	0.978	0.906	1.53
Range	4	3	4
Skewness	0.0720	0.551	0.344
Std. error skewness	0.122	0.122	0.122
Kurtosis	-0.314	-0.664	-0.950
Std. error kurtosis	0.243	0.243	0.243
Shapiro-Wilk W	0.905	0.844	0.892
Shapiro-Wilk p	< .001	< .001	< .001
75th percentile	3.00	3.00	4.00

Note: The CI of the mean assumes sample means follow a t-distribution with N - 1 degrees of freedom.

Table 2 illustrates the parameters influencing the notification system for the operations of cross-border freight transport operators utilizing rail transit on the Bangkok-Nong Khai line. The summary table of data for 10 distinct notifications, ranging from NOTIFICATION 01 to NOTIFICATION 10, indicates that each notification comprises a sample population of 400 items (N=400) with no missing values. The table presents diverse statistical metrics for each notification, including the mean, standard error of the mean, 95% confidence interval (CI) for the mean (lower and upper bounds), median, standard deviation, and lowest and maximum values. Critical Information: All alerts possess an identical sample size (N=400) and there are no absent data. The mean varies from 3.75 (NOTI 07) to 4.14 (NOTI 10). The median remains constantly at 4.00 for all notifications. The standard deviations range from a minimum of 0.755 (NOTI 02) to a maximum of 0.982 (NOTI 09). The minimum value is 1.00 and the highest value is 5.00 for all alerts. It is important to note that the confidence interval of the mean presupposes that the sample mean adheres to a t-distribution with N-1 degrees of freedom. This information may be beneficial for comparing warnings across various statistical metrics.

Table number 4 was presenting the statistical details of measurements for 12 distinct systems (SYSTEM) (SYS01 to SYS12), each comprising a random sample of 400 individuals, with no missing data in any system. The statistical details for each system are as follows: N (Sample Size): In all systems (SYS01 - SYS12), the sample size is 400 units. No data is missing across all platforms. The mean of the analyzed variables varies from 3.95 to 4.18 across each system. Standard error of the mean (SEM): It indicates the standard error associated with the mean. The values range from 0.0326 to 0.0530, with a 95% confidence interval for the mean defined by the lower and upper bounds. The lower bound signifies the lower limit of the mean with 95% confidence, while the upper bound denotes the top limit of the mean with 95% confidence. Both indicate the assurance that the population mean in each system will reside within this interval. Median: Every system exhibits a median of 4.00. Standard deviation: Indicates the dispersion of the data, with values ranging from 0.653 to 1.06. Minimum and Maximum: Display the minimum and maximum values recorded in each system. In all systems, the minimum is 1 and the maximum is 5. The confidence interval for the mean is determined using the t-distribution with N−1 degrees of freedom.

Table 3.
Determinants influencing the notification system of rail transport freight forwarders on the Bangkok-Nong Khai Route.

This section is the result of the analysis of factors affecting the efficiency and notification operations of cross-border rail freight operators on the Bangkok-Nong Khai route. The results are analyzed by each factor with details of the mean, standard deviation, storage and freight transport factors as follows:

Notification	**NOTI 01**	**NOTI 02**	**NOTI 03**	**NOTI 04**	**NOTI 05**	**NOTI 06**	**NOTI 07**	**NOTI 08**	**NOTI 09**	**NOTI 10**
N	400	400	400	400	400	400	400	400	400	400
Missing	0	0	0	0	0	0	0	0	0	0
Mean	4.00	4.06	4.01	3.95	4.01	3.94	3.75	3.90	4.02	4.14
Std. error mean	0.0403	0.0377	0.0453	0.0478	0.0451	0.0454	0.0477	0.0459	0.0491	0.0392
95% CI mean lower bound	3.92	3.99	3.92	3.86	3.93	3.85	3.66	3.81	3.92	4.07
95% CI mean upper bound	4.08	4.14	4.10	4.04	4.10	4.03	3.84	4.00	4.11	4.22
Median	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Standard deviation	0.806	0.755	0.907	0.956	0.901	0.909	0.954	0.918	0.982	0.783
Minimum	1.00		1.00		1.00	1.00	1.00	1.00	1.00	1.00
Maximum	5.00		5.00		5.00	5.00	5.00	5.00	5.00	5.00

Note: The CI of the mean assumes sample means follow a t-distribution with N - 1 degrees of freedom.

Table 4.
Determinants influencing the operational system of rail-based cross-border freight transport operators on the Bangkok-Nong Khai Route.

SYSTEM	**SYS01**	**SYS02**	**SYS03**	**SYS04**	**SYS05**	**SYS06**	**SYS07**	**SYS08**	**SYS09**	**SYS10**	**SYS11**	**SYS12**
N	400	400	400	400	400	400	400	400	400	400	400	400
Missing	0	0	0	0	0	0	0	0	0	0	0	0
Mean	4.16	4.17	4.01	4.10	3.95	4.09	4.06	4.18	3.99	4.07	4.08	4.08
Std. error mean	0.0464	0.0464	0.0441	0.0385	0.0530	0.0469	0.0479	0.0479	0.0423	0.0326	0.0414	0.0455
95% CI mean lower bound	4.07	4.07	3.92	4.02	3.84	4.00	3.97	4.09	3.91	4.01	4.00	3.99
95% CI mean upper bound	4.25	4.26	4.09	4.18	4.05	4.18	4.15	4.28	4.08	4.13	4.16	4.16
Median	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Standard deviation	0.927	0.927	0.883	0.769	1.06	0.938	0.958	0.957	0.845	0.653	0.828	0.909
Minimum	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Maximum	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00

Note: The CI of the mean assumes sample means follow a t-distribution with N - 1 degrees of freedom.

Table 5.
Efficiency and satisfaction of cross-border freight transport operators on the Bangkok-Nong Khai Route

	EFFI1	EFFI2	EFFI3	EFFI4	EFFI5	EFFI6	EFFI7	EFFI8	EFFI9	EFFI10	EFFI11	EFFI12	EFFI13	EFFI14	EFFI15	EFFI16	EFFI17	EFFI18	EFFI19
N	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400
Missing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mean	4.22	4.40	4.41	4.46	4.42	4.28	4.16	4.38	4.42	4.49	4.50	4.38	4.26	4.45	4.47	4.44	4.47	4.38	4.41
Std. error mean	0.0354	0.0411	0.0413	0.0335	0.0366	0.0423	0.0428	0.0410	0.0405	0.0336	0.0323	0.0415	0.0374	0.0349	0.0343	0.0351	0.0343	0.0416	0.0355
95% CI mean lower bound	4.16	4.32	4.33	4.40	4.35	4.19	4.08	4.30	4.34	4.42	4.44	4.30	4.19	4.38	4.40	4.37	4.40	4.30	4.34
95% CI mean upper bound	4.29	4.48	4.49	4.53	4.49	4.36	4.25	4.46	4.50	4.55	4.56	4.47	4.33	4.51	4.53	4.51	4.53	4.46	4.48
Median	4.00	5.00	5.00	5.00	5.00	4.00	4.00	5.00	5.00	5.00	5.00	5.00	4.00	5.00	5.00	5.00	5.00	5.00	5.00
Standard deviation	0.708	0.823	0.827	0.671	0.731	0.846	0.856	0.820	0.810	0.671	0.645	0.830	0.748	0.699	0.686	0.702	0.686	0.832	0.709
Minimum	1.00	2.00	2.00	2.00	2.00	2.00	1.00	2.00	2.00	2.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00
Maximum	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00

Note: The CI of the mean assumes sample means follow a t-distribution with N - 1 degrees of freedom.

Table 6.
Standard factors of the internet of things in cross-border road freight transport systems.
This section delineates the findings of the analysis concerning the standard IoT factors within the cross-border road freight transport system. The outcomes of the analysis are as follows.

Internet of Thing	iOT1	iOT2	iOT3	iOT4
N	400	400	400	400
Missing	0	0	0	0
Mean	4.11	4.37	4.36	4.42
Std. error mean	0.0457	0.0417	0.0431	0.0357
95% CI mean lower bound	4.02	4.29	4.27	4.35
95% CI mean upper bound	4.19	4.45	4.44	4.49
Median	4.00	5.00	5.00	5.00
Standard deviation	0.914	0.834	0.861	0.714
Minimum	1.00	2.00	2.00	2.00
Maximum	5.00	5.00	5.00	5.00

Note: The CI of the mean assumes sample means follow a t-distribution with N - 1 degrees of freedom

Summary of statistical data regarding the "Internet of Things" (IoT), categorized into four segments: iOT1, iOT2, iOT3, and iOT4, with each column presenting the statistical information pertinent to its own category. N: Each group has 400 data points (no missing data). No data is absent in any category. The mean score for each category ranges from 4.11 to 4.42, with iOT4 exhibiting the highest mean. The standard error of the mean indicates the variability in the mean. Each category has comparable values, ranging from 0.0357 to 0.0457, with the 95% confidence interval's lower and upper bounds indicating that the mean of each category will reside within this range. The median is the central value of the data within each group, either 4 or 5. The standard deviation indicates the dispersion of data from the mean, with iOT1 exhibiting the greatest dispersion at 0.914 and iOT4 displaying the least dispersion at 0.714. The minimum and maximum represent the lowest and highest values of the data within each category. Each column is designated from EFFI1 to EFFI9, presumably denoting a performance metric or index in a specific domain, with a categorization in the adjacent column (EFFI10) that delineates subgroups, ranging from Group 0 to Group 9. The sample size (N) for each indicator in the EFFI1 - EFFI9 column is 400, signifying that 400 samples were utilized in this analysis, with no missing data (Missing = 0). The mean of each indicator has a maximum value of around 4.50 and a minimum value of 4.16, reflecting the performance or satisfaction level in each domain. The standard deviation denotes the dispersion of scores relative to the mean. Elevated numbers signify greater dispersion. The standard deviation values for several variables range from 0.64 to 0.85, indicating that the data exhibits little dispersion and is predominantly clustered around the mean. The standard deviation of the mean (standard error mean) indicates the variability of the mean for each indicator. The values vary between columns by around 0.03 to 0.04, which is deemed minimal, suggesting that the derived results are consistent. The lowest value assigned by respondents in the survey typically ranges from 1.00 to 2.00, indicating that some respondents provided the lowest scores on some issues. The 95% confidence interval for the mean (lower bound and upper bound) displays the interval of means with 95% confidence that each indicator's mean resides within that interval.

Table 7.
Confirmatory factor analysis of the model factors influencing performance.

Item Reliability Statistics	Mean	SD	Item-rest correlation	If item dropped	
				Cronbach's α	McDonald's ω
NOTI01	4.01	0.724	0.824	0.964	0.967
NOTI02	3.95	0.817	0.673	0.967	0.970
NOTI03	4.08	0.756	0.655	0.967	0.970
System01	4.11	0.749	0.811	0.964	0.967
System02	4.07	0.846	0.822	0.964	0.967
System03	4.05	0.742	0.839	0.964	0.967
SQL01	4.11	0.914	0.779	0.965	0.968
SQL02	4.37	0.834	0.865	0.963	0.966
SQL03	4.36	0.861	0.809	0.964	0.967
SQL04	4.42	0.714	0.776	0.965	0.968
EFFICA1	4.38	0.679	0.920	0.962	0.965
EFFICA2	4.35	0.717	0.910	0.962	0.965
EFFICA3	4.41	0.623	0.889	0.963	0.965
EFFICA4	4.42	0.670	0.835	0.964	0.966

The table presents data pertinent to the reliability analysis of the questionnaire items, utilizing statistics such as Cronbach's Alpha and McDonald's Omega, along with associated values for mean, standard deviation (SD), and item-rest correlation for each question item in the questionnaire. Clarification of essential components in the Mean and Standard

Deviation table: The mean value denotes the average of the responses for each item. The Standard Deviation (SD) quantifies the dispersion of data relative to the mean. If the values are closely aligned, the standard deviation is minimal. Item-rest Correlation: indicates the relationship between a certain question and the aggregate scores of all other questions, except that particular question. A high value signifies a strong correlation of the query to the remainder. An optimal value should exceed 0.3 (generally). Cronbach's Alpha (if an item is excluded): It assesses the internal consistency of the questionnaire. The removal of a question resulting in a fall in value signifies the item's significance for the questionnaire's reliability. An optimal value typically exceeds 0.7. McDonald's Omega is an alternative index employed to assess dependability, taking into account the interrelationships across variables over a broader spectrum than Cronbach's Alpha. A number exceeding 0.7 signifies strong dependability of the questionnaire.

The analysis of the table indicates that SQL02 possesses the highest Item-rest Correlation value (0.865) and the lowest Cronbach's Alpha if removed (0.963), signifying that this item is crucial for sustaining the reliability of the questionnaire. NOTI03 exhibits the lowest Item-rest Correlation (0.655), indicating a minimal relationship with other items. Consideration may be afforded to enhancing or revising the questions. The Cronbach's Alpha and McDonald's Omega scores for the entire question set are elevated (>0.96), signifying a commendable degree of consistency in the questionnaire.

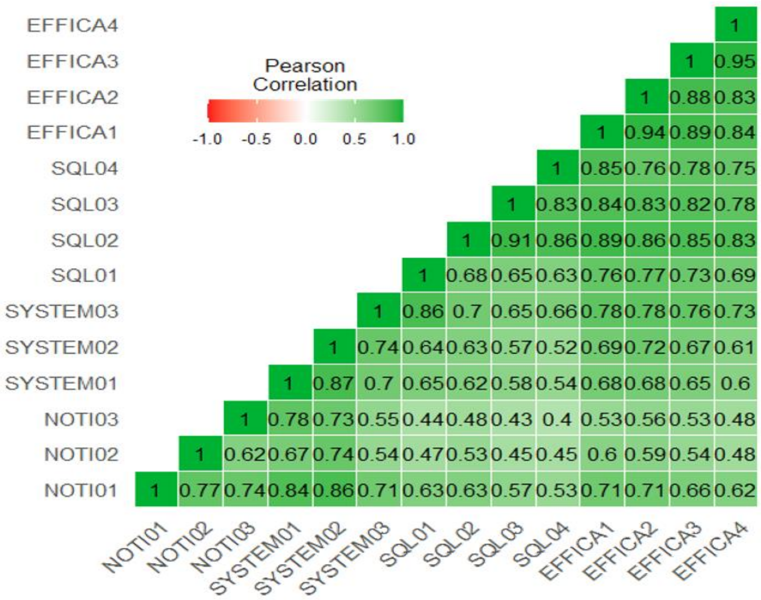

Figure 3.
Cronbach's alpha และ McDonald’s Omega of framework.

This image is a heatmap showing a correlation matrix with Pearson correlation coefficients. Each cell represents the strength of correlation between pairs of variables, with values ranging from -1.0 to 1.0. The color gradient indicates the degree of correlation, where green represents a strong positive correlation, red would represent a strong negative correlation (though there don’t appear to be any negative correlations here), and lighter shades represent weaker correlations.

Table 8.
Measurement model.

Latent	Observed	Estimate	SE	95% Confidence intervals		β	z	p
				Lower	Lower			
Endogenous1	NOTI01	1.000	0.0000	1.000	1.000	0.947	23.2	< .001
	NOTI02	0.953	0.0411	0.873	1.034	0.800	22.7	< .001
	NOTI03	0.874	0.0384	0.798	0.949	0.793	-	-
Endogenous2	SYSTEM01	1.000	0.0000	1.000	1.000	0.916	34.0	< .001
	SYSTEM02	1.163	0.0342	1.096	1.230	0.944	21.7	< .001
	SYSTEM03	0.851	0.0392	0.775	0.928	0.788	-	-
Endogenous3	SQL01	1.000	0.0000	1.000	1.000	0.726	20.0	< .001
	SQL02	1.218	0.0608	1.099	1.338	0.970	19.2	< .001
	SQL03	1.210	0.0629	1.087	1.334	0.933	18.3	< .001
	SQL04	0.956	0.0524	0.854	1.059	0.889	-	-
Endogenous4	EFFICA1	1.000	0.0000	1.000	1.000	0.966	47.2	< .001
	EFFICA2	1.042	0.0220	0.998	1.085	0.953	44.0	< .001
	EFFICA3	0.893	0.0203	0.853	0.933	0.942	36.0	< .001
	EFFICA4	0.920	0.0256	0.870	0.971	0.902	-	-

This table displays a measurement model with four latent variables (Endogenous1, Endogenous2, Endogenous3, and Endogenous4) and their observed indicators (e.g., NOTI01, SYSTEM01, SQL01, EFFICA1). Here's a breakdown of the key columns. Estimate: The estimated factor loading for each indicator on its respective latent variable. Values close to 1 indicate strong relationships between the latent and observed variables. SE (Standard Error): This shows the precision of the estimate; lower SE values suggest more precise estimates. 95% Confidence Intervals: These intervals (Lower and Upper bounds) show the range within which the true loading value is expected to lie with 95% confidence. β: Standardized loadings, which allow for comparisons across indicators and latent variables. Values closer to 1 indicate stronger relationships. z: The z-statistic for testing the significance of each loading and p: The p-value, which indicates whether the loading is statistically significant. All values here are less than .001, indicating high statistical significance for all observed variables.

Table 9.
Fit indices used to evaluate the performance of a user model compared to a baseline model in structural equation modeling (SEM).

User model versus baseline model:	**Model**
Comparative fit index (CFI)	0.699
Tucker-Lewis index (TLI)	0.685
Bentler-Bonett non-normed fit index (NNFI)	0.685
Relative Noncentrality index (RNI)	0.699
Bentler-Bonett normed fit index (NFI)	0.672
Bollen's relative fit index (RFI)	0.657
Bollen's incremental fit index (IFI)	0.700
Parsimony normed fit index (PNFI)	0.642

The table in the image presents fit indices used to evaluate the performance of a user model compared to a baseline model in structural equation modeling (SEM). Here is an explanation of the key indices and their values. Comparative Fit Index (CFI): Measures the fit of the user model compared to the baseline model. A value of 0.699 suggests that the model fits the data moderately but may not meet the conventional threshold for good fit (≥ 0.90). Tucker-Lewis Index (TLI): Similar to the CFI, it evaluates model fit while penalizing complexity. A score of 0.685 also indicates a less-than-optimal fit. Bentler-Bonett Non-normed Fit Index (NNFI): This index adjusts for model complexity. With a value of 0.685, it implies that the model could be further improved to achieve better fit. Relative Noncentrally Index (RNI): Measures the relative improvement over the null model. The value of 0.699 suggests a moderate level of fit. Bentler-Bonett Normed Fit Index (NFI): Assesses model fit by comparing the chi-square of the user model to the baseline. The value of 0.672 indicates suboptimal fit. Bollen's Relative Fit Index (RFI): Focuses on relative improvements in model fit. A score of 0.657 reflects a relatively low fit. Bollen's Incremental Fit Index (IFI): Evaluates the incremental improvement over a null model. A value of 0.700 is slightly better but still falls short of the ideal threshold. Parsimony Normed Fit Index (PNFI): Incorporates model parsimony (simplicity). A value of 0.642 is relatively low, suggesting that the model is not efficiently balanced between fit and simplicity.

Overall, the indices show that the user model provides some improvement over the baseline model, but the fit values are generally below the standard thresholds for good fit (typically ≥ 0.90). The model may require adjustments to improve its overall performance.

Table 10.
Parameters estimates.

				95% Confidence intervals				
Dep	**Pred**	**Estimate**	**SE**	**Lower**	**Upper**	**β**	**z**	**p**
CS	iOT	0.666	0.0496	0.568	0.7628	0.959	13.42	<0 .001
iOT	System	0.853	0.0931	0.67	1.0353	0.963	9.16	< 0.001
iOT	Notification	-0.285	0.1253	-0.53	-0.0393	-0.208	-2.27	0.023

The statistical model analysis findings are displayed in the table, which includes estimated values (Estimate), standard errors (SE), 95% Confidence Intervals, standard coefficients (β), z-values, and p-values for the specified variables. The initial row (CS → iOT) indicates an estimate of 0.666, signifying that iOT exerts a positive impact on Customer Satisfaction (CS) at an approximate level of 0.666 units. $p < 0.001$: The effect is statistically significant at the 99% confidence level. The 95% confidence interval of [0.568, 0.7628] substantiates the assurance that the estimate lies within this range. Second row (iOT → System) Estimate: 0.853, indicating that System exerts a positive influence on iOT at an approximate level of 0.853. $p < .001$: the effect is statistically significant. 95% confidence interval: [0.670, 1.0353]. Third row (iOT to Notification) Assessment: -0.285 signifies a marginally adverse impact of Notification on iOT. $p = 0.023$: The effect is statistically significant at the 95% confidence level. 95% confidence interval: [-0.530, -0.0393].

The iOT variable evidently exerts a substantial positive influence on CS and System, whereas its effect on Notification is marginally negative. The substantial p-value (< .05) signifies that these associations are not coincidental.

6. Conclusion and Discussion

The study on "Development of an Application System for Cross-Provincial Rail Parcel Deposit" seeks to create and assess the usability of a system intended for practical application in cross-provincial rail parcel transportation. The research examines the utilization of technology to enhance operational efficiency, minimize errors associated with conventional operations, and improve user convenience. The system's development revealed that the application efficiently satisfies user requirements. The primary capabilities encompass user registration, parcel booking, real-time tracking of parcel status, and notifications upon parcel arrival, thereby simplifying the process and enhancing operational transparency. The assessment of the user sample group (parcel senders and recipients) demonstrates that the system can enhance satisfaction with the service, particularly regarding convenience, speed, and assurance of parcel safety. The implementation of the application system for cross-provincial rail parcel deposit effectively enhanced the convenience and efficiency of the service. Nonetheless, advancing the comprehensiveness of functions and fostering confidence in the system remain critical challenges that must be addressed to enable the system to accommodate a broader spectrum of needs in the future.

7. Recommendation

Based on the research regarding the development of the interprovincial rail parcel delivery application system, recommendations for future enhancements include improving functionality, incorporating an online payment system, and integrating payment options within the application, such as QR codes, e-wallets, or credit card payments, which will streamline the routing and time selection processes. Incorporate options for route selection and the establishment of suitable periods for parcel dispatch and receipt to enhance operational flexibility. The real-time notification system broadens the range of alerts, including updates on delayed or malfunctioning parcels, as well as advance notifications prior to parcel arrival at its destination.

Enhancing system accessibility, creating a multilingual framework, and incorporating support for several languages, including English, Chinese, and local dialects, to accommodate diverse user demographics. Creating an intuitive interface by applying design principles that prioritize simplicity and usability (User-centered Design) to ensure accessibility for users of all ages.

Establishing user trust through parcel security protocols, incorporating parcel insurance features, and implementing rigorous identity verification systems for both senders and recipients. Additionally, enhancing complaint management and after-sales service, and introducing communication channels such as chatbots or 24-hour hotlines to address issues and improve customer satisfaction.

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