INTERNATIONAL JOURNAL
ON INFORMATICS VISUALIZATION

journal homepage : www.joiv.org/index.php/joiv

Enhanced Technology for Logistics Courier Delivery Using RFID Label to Minimize Processing Time

Nia Novitasari [a], Nashirudin Anwar [b]

[a] *Department of Logistics Engineering, Telkom University, Bandung,40257, Indonesia*
[b] *Sefatech.id, Bandung,40192, Indonesia*
Corresponding author: [*]novitasarinia@telkomuniversity.ac.id

***Abstract*— Courier services have become a sector that has experienced a growth spurt during the Covid-19 pandemic. The soaring growth of courier services is due to e-commerce in Indonesia. Increased people's digital activities show this during the pandemic, including online or online shopping. Data from the Indonesian Ministry of Finance shows that purchase transactions via e-commerce increased 18.1 percent to 98.3 million, with a total transaction value of 9.9 percent to Rp20.7 trillion. Fast and efficient delivery and pick-up of goods is the core operation of courier services. The biggest challenge for courier service providers is how to compete with other companies that offer the same type of service. Service users are increasingly demanding the security and reliability of delivery services so that they can meet the expectations of service users. The expectations of service users used as targets for company achievement are (1) reliability (on time, accuracy, integrity), (2) convenience (collecting units, delivery coverage, operating hours), (3) services, and (4) cost. Based on the activities in courier services, the potential for errors or inefficiencies in processing time is in the pre-delivery activities. In the pre-delivery activity is also the initial activity used to input the data base, collect goods, distribute goods and so on. This research proposes that RFID Label technology can overcome errors and increase process time efficiency in shipping goods on courier services, especially in pre-delivery and delivery activities.**

***Keywords*— Courier services; RFID label; intelligent technology; logistics; IoT.**

Manuscript received 15 Jan. 2022; revised 12 Mar. 2022; accepted 20 Apr. 2022. Date of publication 30 Sep. 2022.

I. INTRODUCTION

Courier services have become a sector that has experienced a growth spurt during the Covid-19 pandemic. The soaring growth of courier services is due to e-commerce in Indonesia. Increased people's digital activities show this during the pandemic, including online or online shopping. Data from the Indonesian Ministry of Finance shows that purchase transactions via e-commerce increased 18.1 percent to 98.3 million, with a total transaction value of 9.9 percent to Rp20.7 trillion [1]. Globally, it is estimated that the e-commerce market will continue to increase to USD 400 billion by 2024 [2]. Courier services are very ordered in delivering goods; courier services are very efficiently used to send goods to places where the public cannot reach them. The product sent can be in the form of documents, parcels, or other goods. Fast and efficient delivery and pick-up of goods is the core operation of any courier [3], [4].

The number of courier service providers in Indonesia, such as JNE, J&T Express, POS Indonesia, TIKI (Titipan Kilat), SiCepat, Wahana, Ninja Express, DHL Express, ID Express, SAP Express, and others makes competition quite tight for the courier services offered. Data shows that the top brand index in 2021 is J&T (33.4%), JNE (28%), TIKI (11.2%), Pos Indonesia (8.5%), and DHL (6%) [5]. The data shows that the biggest challenge for courier service providers is how to compete with other companies that offer the same type of service. Service users are increasingly demanding the security and reliability of delivery services so that they can meet the expectations of service users [6]. The expectations of service users used as targets for company achievement are (1) reliability (on time, accuracy, integrity), (2) convenience (collecting units, delivery coverage, operating hours), (3) services, and (4) cost [6], [7], [8]. The overall achievement of this company's target is influenced by the activities in courier services in each company. If analyzed, activities in courier services can be divided into three stages: (1) pre-delivery, delivery, and past delivery. The activity scheme is shown in Figure 1.

Fig. 1 Stages of Delivery Activities on Courier Services

Pre-delivery activities are the activities that start from receiving goods from consumers to activities in the sorting area. Delivery activity is the activity of distributing goods from the sorting area to the nearest warehouse/branch office or the location of receiving goods. In comparison, past delivery activities are carried out when the goods have been received or are at the intended location. Based on the existing activities, the potential for errors or inefficiencies in processing time is in the pre-delivery activities. Not only that, but the pre-delivery activity is also the initial activity used to input the database, collect goods, distribute goods, and so on. Based on this problem, it can be proposed that the research objective is the need for technology that can be used to overcome errors and improve the efficiency of processing time in shipping goods on courier services, especially in pre-delivery and delivery activities.

II. Materials and Method

A. Logistics

Logistics is part of supply chain management, which is an approach used to integrate suppliers, factories, warehouses, and retailers so that the goods produced can be distributed in the right quantity, time, and location to minimize overall costs and improve customer service. Logistics is defined as a discipline related to procurement, storage, and delivery of goods according to the type, quantity, time, and place desired by consumers from the point of origin to the point of destination. So it can be seen that the object of logistics is goods, with various activities in it in the form of procurement, storage, and delivery, with the mission to be achieved, namely the right goods, at the right time and in the right place [9], [10].

B. Logistics Service Activity for Courier Business

Courier services have increased significantly globally and domestically. This courier business is included in the Logistic Service Provider (LSP) [2]. A Courier business is a business of delivering goods or documents carried out by individuals or companies. The emphasis in this sense is based on the type of service provided, namely delivery services from one place (sender) to another (recipient). The main service of the courier business is delivery services (delivery), so the difference from this business lies in the speed of delivery [11], [12]. Courier business can cover areas within one city or country or regional or global services (various countries). Each courier's business scope is adjusted to the market network built by each courier company [13]. The courier business categories are (1) Multi-modal courier services that involve transportation and delivery services for domestic and foreign destinations, or parcels, which are carried by couriers and use one or more modes of transport. (2) Other courier services Goods delivery services such as using trucks or transfer services without warehousing [14]. This courier business offers quality service for consumers. The level of satisfaction is one of the benchmarks for achieving the targets set by the company.

C. Logistics Service quality (LSQ)

A specific measurement of the quality of service is also applied to courier services (logistics delivery) with the concept of Logistics Service Quality (LSQ). The LSQ value is based on the results of a continuous evaluation (series) of the interaction of the logistics process from the courier service provider. It can be in the form of an evaluation between time or between transactions from the courier service is satisfactory [15], [16]. Some aspects assessed on the LSQ are reliability of delivery deadlines, agility in delivery, delivery of correct quantity and correct product; no damage to goods, the flexibility of services provided, problem-solving, traceability, communication, trust, and knowledge [12]. This study discusses the achievement of quality targets to be achieved to minimize processing time or delivery time so that consumers can receive goods on schedule. So proposed a technology that can minimize the time.

D. Radio Frequency Identification (RFID)

Radio Frequency Identification (RFID) is a system for automating data retrieval using tag items. The tags can be in the form of cards, stickers, hanging items, and others. In the tag item, a transponder that emits radio waves is stored, which can be read by the RFID Reader Device. In general practice, RFID tags are used to store identification numbers from the database system, which are then used according to the needs and processes of the business flow. This makes it easy to retrieve information from tagged items wirelessly [17] (See. Figure 1)

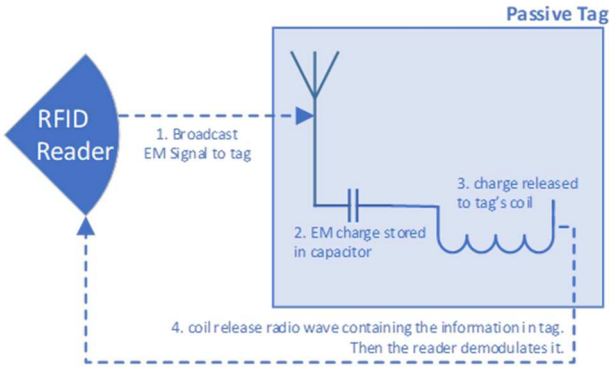

Fig. 2 Data transfer in low-frequency passive RFID tags [17]

The division of the RFID system based on the wave range is adjusted to the use and operating environment of the device. The division includes (1) Low Frequency (LF 125 KHz), (2) High Frequency (HF 13.56 MHz), (3) Ultra-High Frequency (UHF 860-960 MHz), (3) Microwave (2.45 GHz). Each of the above systems has its advantages and disadvantages depending on operational needs and tag reading distance. For tracking delivery, the UHF tag type is chosen, because the reading distance can be carried out up to a maximum distance of 10 meters and the tag reading process can be carried out in large quantities simultaneously. This provides cost benefits because the installation of devices is not too much, and the reading process is much faster.

RFID technology provides much convenience in sending, storing, or other processes in an enterprise. However, RFID technology is still under-utilized, considering the so much potential it has. RFID technology minimizes human

interaction, thereby reducing the risk of human error. The delivery monitoring process is updated automatically in the database [18], [19]. RFID technology's advantages include simplifying business processes, increasing data accuracy, and reducing labor costs. RFID is intended to replace the barcode system and visually represent the delivery item [20].

E. Adoption of RFID in a Logistics

The adaptation of RFID in logistics has been quite a lot; this is shown from several previous studies. This technology is very suitable for tracking and trashing an item. In logistics, RFID technology can be used in several aspects, including warehouse management, inventory management, goods transportation, manufacturing, and retail. The main function to be achieved by adopting this RFID technology is to achieve high performance and achievement in both logistics and supply chain management [21], [22], [23], [24]. As described in more detail, the application of RFID can have a fungus to minimize logistics costs, improve quality and safety, improve inventory accuracy, provide information, integrate information, capture data, and so on. [21], [25]. Some of the applications of RFID adoption are shown in the table below.

TABLE I
RFID ADOPTION AND IMPLEMENTATION IN SUPPLY CHAIN AND LOGISTIC

Adopted RFID	Implementation
Warehouse and Inventory	RFID technology can be used for inventory by combining it with a warehouse database and inventory management system.
Transportation	1. RFID technology can automate workflows and processes while recording data about tracked assets across multiple sites and sequentially identify shipping bottlenecks to adjust delivery schedules in the supply chain quickly. 2. RFID technology can be used for Vehicle Tracking and identification.
Manufacturing	RFID technology in manufacturing can be used as an intermediary for the gap between the physical flow of materials and the associated information flow.
Retailing	RFID can be used as outlined: Merchandise planning, Sales planning, Price management, Promotion planning, etc.

In this study, the use of RFID in transportation is discussed. This RFID technology has been used from time to time, and this study discusses the optimal use of RFID for courier services.

F. Anti-Collision Algorithm

Anti-collision algorithm is intended to speed up the process of reading tags in large volumes. Popular algorithms used are tree-based and ALOHA-based anti-collision algorithms. However, the resulting throughput is still not optimal for the massive number of tag readings, e.g., 1000 tags at once. The solution is to use a hybrid method, so when reading the first 354 tags, using Dynamic Frame Slot Aloha (DFSA), and so on, the reading is done with the Query Tree Algorithm [26],.

G. Method

The workflow of this research begins with the collection of literature reviews and the implementation of RFID in logistics and supply chains. Based on some existing literature combined with case studies of courier services in Indonesia, resulting in a research purpose, namely research on the use of RFID in courier services by considering technology tools, one of which uses an RFID label that was affixed to replace the existing label on current delivery services. The proposed use of RFID labels is intended to facilitate the traceability and tracking process. In addition, it can minimize processing time because the RFID Scan RFID label can be read simultaneously to check its existence. No need to scan one by one using the Anti-Collision Algorithm. Figure 3 shows the details of the flow of this research.

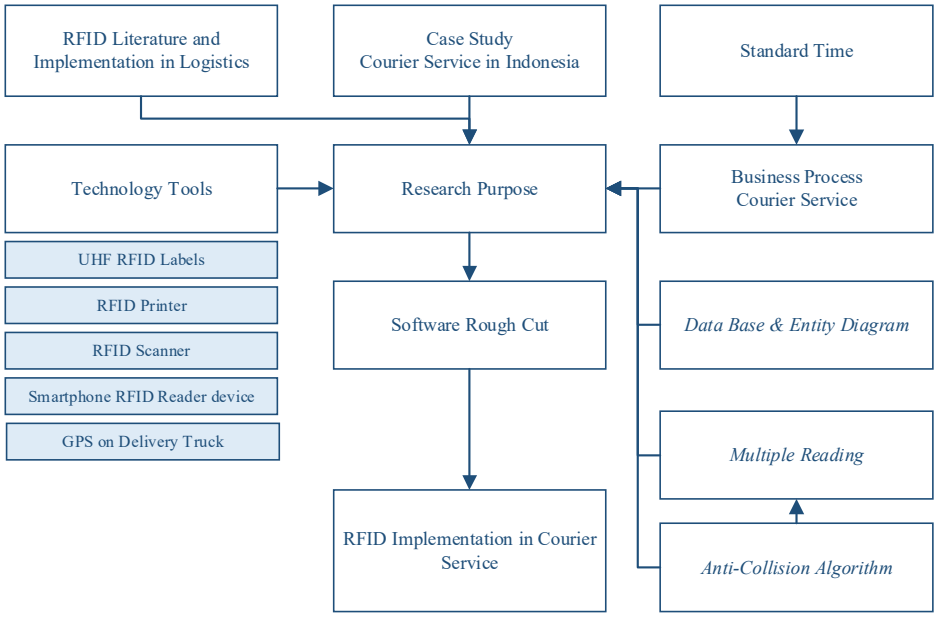

Fig. 3 Research Method

III. Results and Discussion

A. *Business Process Courier Service*

The business process in courier services is a mapping carried out to map existing activities in sending goods from the customer to the recipient of the goods through courier services. The activity consists of three tiers: customers, courier services, and recipients. The customer has a person as the sender of goods to the courier agent. This courier service is tasked with receiving goods from customers and continuing with the process of collecting, sorting, and distributing goods to the recipient's endpoint. At the same time, the recipient has a role in receiving goods from the courier service. The process of sending goods from customers through many processes, including the updating and sorting processes. These processes also affect the delivery time, tracking, and traceability of the goods sent. Status checks and updates are always carried out at every hub or branch office location. This is done to make it easier for customers to check the existence of the goods sent. The details of the activities can be seen in Figure 4. Figure 4 also shows that the activities in the business process are grouped into three stages pre-delivery, delivery, and fast delivery of goods. In this study, we analyze the pre-delivery and delivery processes. This is because the activity has a long processing time because the process of distributing goods goes through several stages to update the status. Scanning barcodes carry out data updates for each item at each hub or sorting location. So, the time spent is quite long. Therefore, this study tries to propose the use of RFID labels that can facilitate sorting and updating goods' locations by applying the concept of multiple readings. So that scans are not carried out one by one item, but scan readings can be done simultaneously.

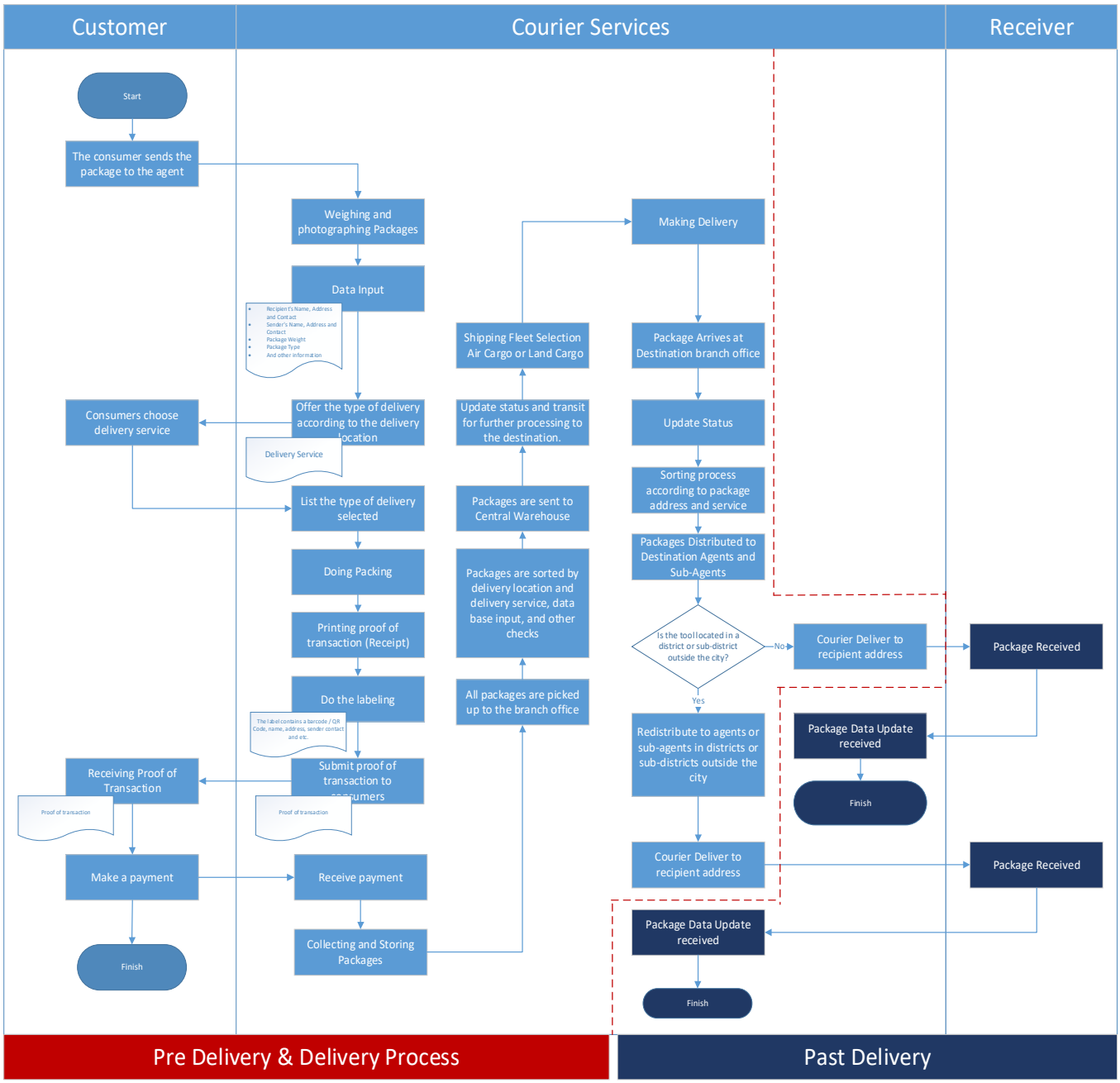

Fig. 4 The Example of Business Process Courier Service in Indonesia

B. System Specification and Synthesis

1) Tools: The following are the tools used for the experiment: (1) UHF RFID Labels, (2) RFID Printer, (3) RFID Scanner, (4) Smartphone RFID Reader device, (5) GPS on Delivery Truck.

2) Delivery Process: The delivery process starts when the user inputs the delivery package and the clerk performs the recording. RFID printer is a device for automating the process of encoding/writing data to RFID tags while also printing labels from packages. The RFID tag is then affixed to the face of the package. It is better if the tag is affixed in the middle to minimize interference between packages.

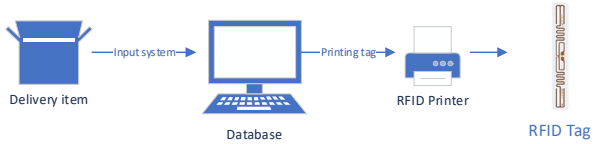

Fig. 5 Delivery process (1)

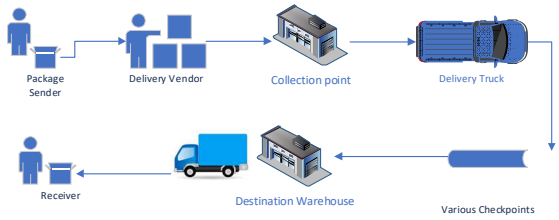

Fig. 6 Delivery Process (2)

A fast and accurate package identification process is required at each delivery stage. There are several techniques commonly used. The most used is the barcode system or QR Code. The weakness of the barcode system is the distance to read the code, which must be close and can only read one item per reading. In addition, if the barcode is crossed out, dirty, or deleted, the code is difficult to read. The advantages of the barcode system are low cost and ease to use. The use of RFID as a substitute for a barcode system is intended to speed up the identification process at the shipping stage and reduce the risk of reading errors.

3) Multiple Reading: For use at shipping outlets or package drop points, a Reader box solution can be used; in a large box, we install an RFID scanner to identify packages simultaneously when they want to send them to the next phase. Reading RFID tags with a wall reader is used by taking advantage of the advantages of the UHF RFID system, which can read from 3-10 meters so that the reading process can be carried out in a 3x3 meter room, so the packets can be placed and left in place within a few seconds until the entire package read successfully. This method is used in large shipping warehouses or at checkpoints with large capacities. Wall Reader can read when the packet passes through the reader's sensor, but tag collision must occur when reading large volumes. So that the reading process is carried out when the object is idle, and the process can be continued when all tags are successfully read.

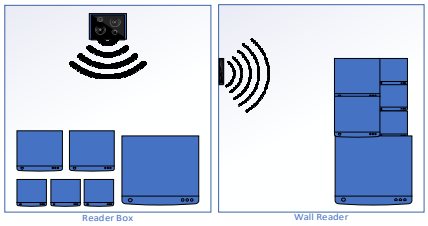

Fig. 7 Multiple Reading

4) Software Rough Cut

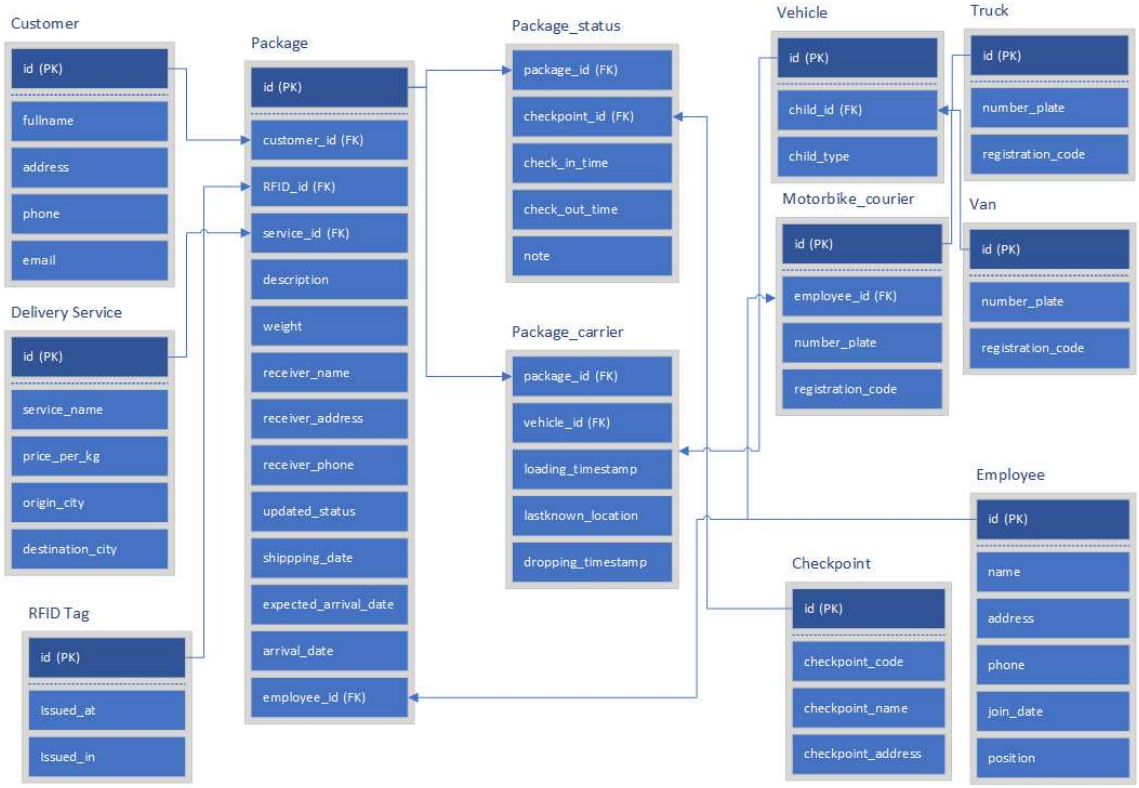

Fig. 8 Software Rough Cut

5) Database and Entity-Relationship (ER) Diagram: The database used includes sender information data, recipient information, and supporting data such as package descriptions, delivery dates, and delivery statuses that are automatically generated at each stage of delivery. This database that is obtained from the packets sent must have a special id recorded in the RFID tag. Entity-Relationship (ER) Diagram is needed to understand the relationship between entities. In the picture, there are 12 entities and their relationships. Vehicle entities can morph into 3 entities, large transport vehicles (trucks), medium vehicles (vans), and field couriers (motorbikes). The employee entity in the design functions to incoming input packages to the drop point and is the field courier who makes deliveries from the destination city hub to the recipient's address. There is also package_status and package_carrier tables that handle package status updates. These tables are many-to-many relationship tables that provide an overview of the status of where the packets are. In sending each package at the checkpoint, the rfid tag is read, which then automatically updates to the package_status table. The same thing also happens when the package is loaded into the carrier vehicle, the package is read by the rfid tag when loading, and the package_carrier status is updated. In the package_carrier table, there is also a lastknown_location attribute which contains the last GPS data retrieved.

6) Vehicle and Courier GPS: Almost all delivery trucks for shipping have GPS installed for the tracking process and on the container ship mode. However, the same thing does not happen in Indonesia's train mode. For the purposes of user experience from consumers, the integration of information on the location of the sending vehicle also is presented. So that users can find out in more detail where the package is located. The system utilizes the GPS system installed on the delivery courier's smartphone. The courier's smartphone installs an application that periodically provides location information when he is on duty. Pause location updates are not performed in a high frequency. Tracking or updating can be done within 1-2 hours for large vehicles and 10-15 minutes for field couriers. The whole process above is to provide a better experience for customers. When the customer or recipient of the package wants to track the airway bill, the data displayed is not only the status in text form about where the package is located but also provides a visual representation and detailed delivery route.

C. System Overview

The system is centralized in a main cloud server. The cloud server handle all the logic operations. Selected cloud for server to minimize server down and easier to manage load balance.

1) System overview: To reduce costs, the process of writing RFID tags is done centrally, and the tags are then distributed to each collection point. The cost of installing an RFID Printer is quite expensive, and if every drop-point must have an RFID Printer installed, the cost is too expensive. The distribution process can be through drop-point pick-up vehicles when they want to pick up packages to be sent to collection points. Drop point outlets notify the warehouse or central if the RFID tag stock is running low, to be sent later.

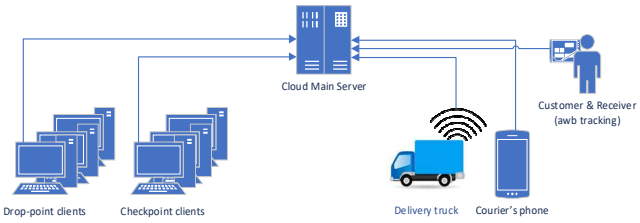

Fig. 9 System Overview

2) Pre-requisite: To reduce costs, the process of writing RFID tags is done centrally, and the tags are then distributed to each collection point. The cost of installing an RFID Printer is quite expensive, and if every drop-point must have an RFID Printer installed, the cost is too expensive. The distribution process can be through drop-point pick-up vehicles when they want to pick up packages to be sent to collection points. Drop point outlets provide notifications to the warehouse or central if the RFID tag stock is running low, being sent later.

3) Drop-point client: At the drop point, a client device is required to input packets into the database. The device must be connected to the main server via the internet. The main task of this device is to input data for new packets to be sent. The role of the employee here is not only to input the sender's and the recipient's data but also to synchronize the packet with the attached RFID tag. The synchronization process is carried out with an RFID reader installed on a computer device, e.g., package A is affixed with an RFID tag id X1, then the tag, before being affixed, is read by the id, then synchronized with the main system. The employee then prints a label on the RFID tag; no airway bill from the package. To end the process, the employee attaches the RFID-printed airway bill to the center of the package.

4) Checkpoint client: At the checkpoint, provided a computer device as a client that is connected to the RFID wall scanner. The computer client at this checkpoint can also be a stand-alone system, so delivery operations are not disrupted when there is no internet connection to communicate with the main server. The reading process is carried out in bulk. The reading classifies packet information regarding the next route. To then be separated based on the destination city. The reading process can also be carried out on the conveyor belt. When passing through the reader device, the package information can be displayed on the attached screen so that it can be quickly separated based on the destination city. Status updates are carried out at checkpoints, including statuses regarding the physical condition and presence of packages.

5) Delivery Vehicle: On large delivery vehicles such as trucks and vans, GPS is installed, periodically updating its position in the main system. The system then translates this position into the data map. For packages to be sent by motorbike couriers, what is used is the embedded GPS in the courier's smartphone, which has a client application installed that is connected to the main system.

6) Airway Bill Tracking: When the customer or the package recipient wants to track the airway bill, a web client is also provided that is connected to the main system. The customer enters the no airway bill and then displays the package status. The status

After identifying the business processes in the activity of shipping goods, they were then analyzing the System Specification and Synthesis, which is used to design a system that is used to implement RFID labels and multiple readings. The results of the calculation of processing time on pre-delivery and past delivery are obtained, shown in Table 2. Table 2 consists of processing time in the existing state and processing time in the state after applying the proposed system and tools. This existing calculation is obtained through time study. Calculations were performed using 1 batch of data. 1 average batch consists of 150 items. In one day, can make deliveries of about 8 to 20 batches if the situation is pick season. Based on the management of this data, it shows that there is a gap between the existing conditions and the proposed conditions. The GAP can be seen in each batch's average GAP improvement table.

TABLE II
CALCULATION ON THE TIME OF PRE-DELIVERY AND DELIVERY

Activity Group	Activity	Batch Processing Time (second)						Average Improvement GAP	
		Existing System			Proposing System				
		Average	Min	Max	Average	Min	Max	Minute	%
Pre-Delivery	Collection	1322	912	1494	430	366	460	892	67%
	Location Grouping	1017	722	1109	374	329	404	643	63%
	Transport Loading	1075	742	1215	292	251	301	783	73%
Delivery	Departure Sorting Center	1837	1304	2057	545	458	578	1292	70%
	Central Warehouse	2403	1754	2715	643	566	669	1760	73%
	Transport Loading	1003	732	1103	288	251	311	715	71%
	Transit Warehouse	2881	2017	3227	433	377	450	2448	85%
	Transport Loading	945	690	1068	199	165	215	746	79%
	Local Warehouse	2141	1520	2398	398	346	410	1743	81%
	Transport Loading	783	579	869	203	179	215	580	74%

IV. CONCLUSION

This study aims to minimize process time on courier services by applying the Anti-Collision Algorithm with RFID Label technology that can be multiple readings. Anti-collision algorithm is intended to speed up the process of reading tags in large volumes. So that the checking, tracking, and tracing processes are not carried out on items one by one but can be carried out simultaneously according to the possible distance specifications. This process can save an average GAP processing time of 74% on pre-delivery and delivery activities. This happens because the delivery of goods has a fairly long process to check, sort, and distribute each hub.

REFERENCES

[1] C. Indonesia, “Bisnis Logistik dan Jasa Kurir Melejit di Tengah Corona,” *CNN Indonesia*, 2020. .

[2] J. Jintana, A. Sopadang, and S. Ramingwong, "Idea selection of new service for courier business: The opportunity of data analytics," *Int. J. Eng. Bus. Manag.*, vol. 13, pp. 1–20, 2021, doi: 10.1177/18479790211042191.

[3] A. A. Musyafah, H. W. Khasna, and B. E. Turisno, “Perlindungan Konsumen Jasa Pengiriman Barang Dalam Hal Terjadi Keterlambatan Pengiriman Barang,” *Law Reform*, vol. 14, no. 2, p. 151, 2018, doi: 10.14710/lr.v14i2.20863.

[4] N. Izzah, D. Rifai, and L. Yao, "Relationship-courier partner logistics and e-commerce enterprises in Malaysia: A review," *Indian J. Sci. Technol.*, vol. 9, no. 9, pp. 1–10, 2016, doi: 10.17485/ijst/2016/v9i9/88721.

[5] T. B. Award, "Top Brand Index Courier Service 2021," *Top Brand Award*, 2021. .

[6] J. Astuti and E. Fatma, “Evaluasi Pemilihan Penyedia Jasa Kurir Berdasarkan Metode Analytical Hierarchy Process (Ahp),” *J. Manaj. Ind. Dan Logistik*, vol. 1, no. 1, p. 28, 2017, doi: 10.30988/jmil.v1i1.5.

[7] M. A. Muhammad, N. S. Yusoff, N. Tharra, F. Ahmad, and M. Melan, "Logistics Service Quality of Courier Providers Among Student in Uum," pp. 275–286, 2017.

[8] A. V. Vidyapeetham, "Assessment and Improvement of processes using customer-centric tools in the context of Courier Service."

[9] S. Chopra, P. Meindl, and D. V. Kalra, *Supply Chain Management Strategy, Planning, and Operation*, vol. 6, no. 0. 2016.

[10] D. Leon, I. Farahana, and B. Kamsin, “Logistics System By Using Rfid Technology,” vol. 17, no. 7, pp. 8659–8667, 2020.

[11] A. Gulc, "Determinants of courier service quality in e-commerce from customers' perspective," *Qual. Innov. Prosper.*, vol. 24, no. 2, pp. 137–152, 2020, doi: 10.12776/QIP.V24I2.1438.

[12] A. Gulc, "Multi-stakeholder perspective of courier service quality in B2C e-commerce," *PLoS One*, vol. 16, no. 5 May, pp. 1–18, 2021, doi: 10.1371/journal.pone.0251728.

[13] Agu, MN, N. Ci, and O. Bo, "Enhancing Courier Service with the Development of an Interactive Mobile App in Android Platform," *IOSR J. Mob. Comput. Appl.*, vol. 2, no. 2, pp. 2394–42, 2015, doi: 10.9790/0050-0225661.

[14] B. Emmanuel Prince and K. A. Bakon, "A Study on The Need to Implement a Courier Service Application on Android Smartphones," *Int. J. Inf. Syst. Eng.*, vol. 4, no. 2, pp. 28–42, 2016, doi: 10.24924/ijise/2016.11/v4.iss2/28.42.

[15] R. H. & Y. Ericko, “Pengaruh Logistic Service Quality Terhadap Kepuasan Dan Loyalitas Konsumen Kentucky Fried Chicken Di Surabaya.,” *Br. Food J.*, vol. 101, no. 5–6, pp. 493–496, 2015.

[16] G. Arabelen and H. T. Kaya, "Assessment of logistics service quality dimensions: a qualitative approach," *J. Shipp. Trade*, vol. 6, no. 1, pp. 1–13, 2021, doi: 10.1186/s41072-021-00095-1.

[17] V. Todorovic, M. Neag, and M. Lazarevic, "On the usage of RFID tags for tracking and monitoring of shipped perishable goods," *Procedia Eng.*, vol. 69, no. December, pp. 1345–1349, 2014, doi: 10.1016/j.proeng.2014.03.127.

[18] S. Khan, A. M., and M. S., "Impact of Information Technology on Internal Supply Chain Management Implementation of RFID Tags," *Eur. J. Bus. Manag. Res.*, vol. 5, no. 2, pp. 1–9, 2020, doi: 10.24018/ejbmr.2020.5.2.247.

[19] S. Muzhir and M. Al-Ani, "Packages Tracking Using RFID Technology," *Int. J. Bus. ICT*, vol. 1, no. 3–4, 2015, [Online]. Available: https://www.researchgate.net/publication/289505094_Packages_Tracking_Using_RFID_Technology.

[20] M. Ahmad, M. Akmal, A. Karim, M. Hafiz, and A. Bin Zaidi, "RFID Application in Courier Services," *Int. J. Perceptive Cogn. Comput.*, vol. 7, no. 1, pp. 108–112, 2021.

[21] J. Chanchaichujit, S. Balasubramanian, and N. S. M. Charmaine, "A systematic literature review on the benefit-drivers of RFID implementation in supply chains and its impact on organizational competitive advantage," *Cogent Bus. Manag.*, vol. 7, no. 1, 2020, doi: 10.1080/23311975.2020.1818408.

[22] X. Zhang, Q. Dong, and F. Hu, "Applications of RFID in logistics and supply chains: An overview," *ICLEM 2012 Logist. Sustain. Econ. Dev.*

- *Technol. Manag. Effic. - Proc. 2012 Int. Conf. Logist. Eng. Manag.*, no. January, pp. 1399–1404, 2012, doi: 10.1061/9780784412602.0213.
[23] V. Desingh and P. Panchuk, "An Overview of RFID Technology Applications and Diffusion in Supply Chain Management," *Int. J. Pure Appl. Math.*, vol. 119, no. 10, pp. 1291–1305, 2018.
[24] D. A. Kurniawan, "Analisis Penerapan Rfid Untuk Menurunkan Biaya Logistik," *J. Transp. Multimoda*, vol. 13, no. 1, pp. 11–20, 2017, doi: 10.25104/mtm.v13i1.192.
[25] P. Kgobe and P. A. Ozor, "Integration of radio frequency identification technology in supply chain management: A critical review," *Oper. Supply Chain Manag.*, vol. 14, no. 4, pp. 289–300, 2021, doi: 10.31387/oscm0460303.
[26] W. H. Zhou, N. De Jiang, and C. C. Yan, "Research on Anti-Collision Algorithm of RFID Tags in Logistics System," *Procedia Comput. Sci.*, vol. 154, pp. 460–467, 2018, doi: 10.1016/j.procs.2019.06.065.