

CHAPTER 1 – INTRODUCTION

This chapter describes the (rationale, benefits, and objectives of the research.) a general idea of why this research was conducted and what are the benefits and objectives of this research.

1.1 Background

Smart lockers are temporary storage areas to store various items with IoT (Internet of Things) technology implementation (Prasetyo and Andrianto 2021). Instead of using conventional keys to open the door, smart locker systems are integrated with the service provider system to give user access in the form of a code digitally (Faugere and Montreuil 2016). The digital code itself could present in a lot of forms such as RFID (radio frequency identification) (Hananto et al. 2019) (Hermawan et al. 2023), OTP (one-time password) (PopBox 2023b), Bluetooth (Amazon 2023), MFA (multi-factor authentication) (Hermawan et al. 2023), QR Code (Paxel 2023b), and even biometrics (Chavan et al. 2018). Smart lockers are commonly placed in public spaces such as resident areas, shopping malls, apartments, public transport stations, sports centres, etc. (Paxel 2023a; PopBox 2023a).

Smart locker systems are not new things but the implementation is rising in previous years due to the easiness they offer such as:

1. No physical key needed to be maintained. Using traditional keys might result in various problems around the keys. It is prone to missing and being duplicated by irresponsible parties (Nagarajan and Arthi 2017).
2. The handover processes do not require the sender and recipient to meet at the exactly same time. It also reduces the need for human workers to be the middleware of such handover process conditions (Trần, Thi Huong, and Ngoc Thiet 2020). The receiver will be highly benefited by having more flexibility to receive or claim the packages.

3. Users could easily know the availability of the locker (Sa-Ngiampak et al. 2019). With the implementation of an IoT system in smart lockers, the state of each locker could be monitored and visualized for both users and service providers.
4. Reduce the inefficiency of last-mile delivery with high drop points with low drop volume in each point (Luís et al. 2022). Instead of dropping the package individually at each customer's door, a smart locker in a resident area could help the courier drop all packages at a time in the smart locker.

Align with the rise of smart lockers usage, the number of e-commerce users also increased due to covid-19 pandemic. It is a blessing in disguise when another sector of the business tends to face a hard time. Even the government regulations with the concept of O2O (offline to online) also support the growth of e-commerce(Ricky, Ardyanti, and Govinda 2022). Since then, more people are staying at home with the new working and study-from-home system implemented. Due to those factors, more and more people doing everything online including purchasing groceries, snacks, and even window shopping (Chandra et al. 2022).

PT. XYZ as one of the Indonesian e-commerce and warehousing service providers also affected by the rise of the e-commerce market during and after the pandemic in Indonesia. The rise of the market also affects the variation of the goods purchased online. One of the most ordered goods is groceries due to the easiness and time saving (Warganegara and Hendijani 2022). In the majority, PT. XYZ customers order groceries for morning delivery with instant (delivery under 2 hours) or same day (delivery on the same day or under 8 hours) online delivery courier services due to some grocery items needing special treatment. Respectively, the number of orders in the morning spikes, causing queueing issues in the handover process.

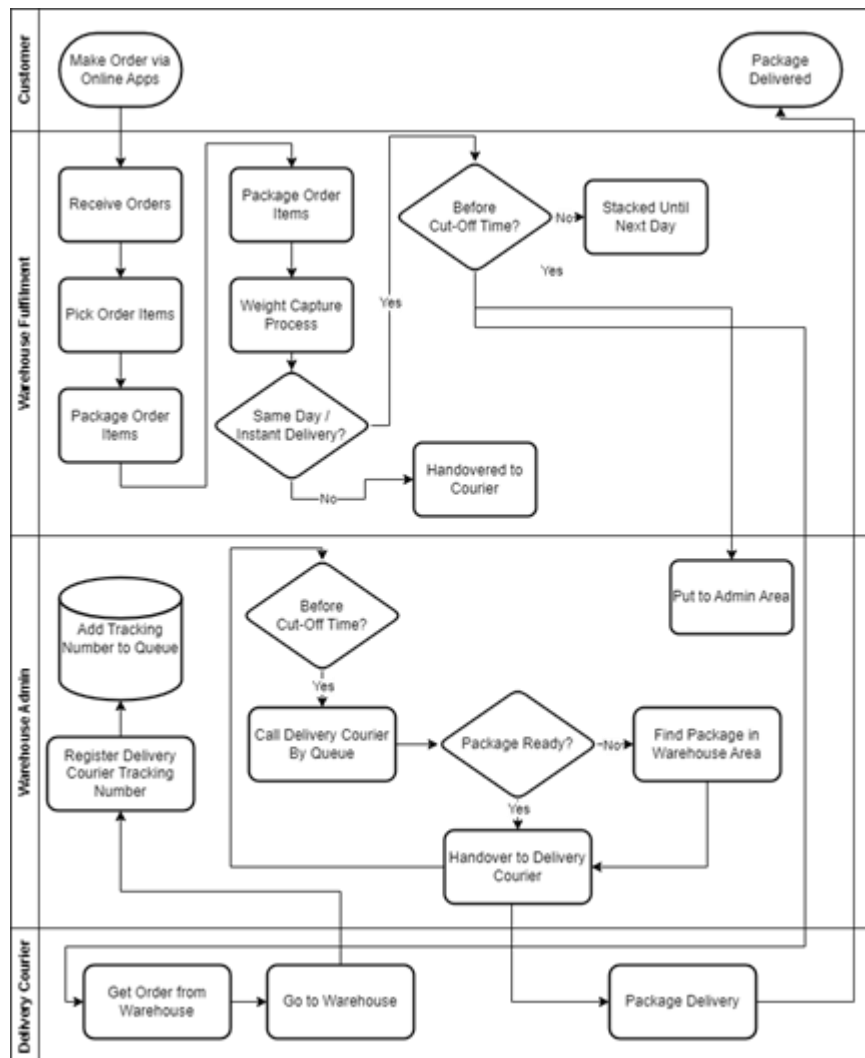


Figure 1.1 PT. XYZ Internal Warehouse Online Delivery Courier Order Fulfilment Flow

The Figure 1.1 above shows the PT. XYZ internal warehouse online delivery courier order fulfilment flow. The process is initiated by the customer making an order via PT. XYZ online apps. The order is then received by the warehouse fulfilment team to be packed. The packed packages then will be forwarded accordingly to the respective delivery courier. For the online delivery courier, same-day or instant service orders could only be done before the cut-off time of the day. All packages ordered after the cut-off time will be sent the following morning. All packages that are ready to be handed over to the courier will be stacked in the admin area for the handover process.

After the package is packed and within the delivery time, PT. XYZ's internal warehouse system makes an order to the online delivery courier service providers. When the couriers arrive in the warehouses, they will register their order tracking number to PT. XYZ internal system to be queued. The admins will call the courier's name one by one to hand over the package based on the queue. If the package is ready near the admin area, the package will be hand covered directly. Meanwhile, if it is not ready yet in the area, the admin with several dedicated warehouse workers will find the package in the warehouse area.



Figure 1.2 Queueing in PT. XYZ Warehouse Handover Area in the Morning

The Figure 1.2 above shows the queueing occurs in PT. XYZ warehouse handover area in the morning. The situation being shown above commonly occurs since the opening time of the warehouse (8:00 in the morning) and lasts for around 3 hours until 11:00 in the afternoon. Even though the package is packed and ready to be hand covered, the large piles of packages and admins counters make it sometimes harder to find the desired package resulting the queue. PT. XYZ could not control the number of orders at a specific time and the arrival time of the couriers. This problem causes a long queue for the handover process and negatively impacts all parties related to the order. The customer waiting time rises, the courier delivery period reduces, and PT. XYZ warehouses' order fulfilment speed performance drops due to forfeitable reasons.

Looking at the benefits of smart lockers, smart locker system implementation could be utilized to solve PT. XYZ problem. However, the standard smart locker system might

not be suitable to be directly implemented in the warehouse area for the handover process due to some reasons:

1. Currently available smart lockers such as OTP, MFA, and biometrics are only able to serve one customer at a time. It is mainly caused by the smart locker system could only doing one on one interaction with the user. It is not suitable for warehouse applications where there are a lot of users who want to pick up packages at a time. They all could have the same deadlines to fulfil the orders. Having a queue to pick up the orders could result in a big problem for all parties due to the order delivery over time.
2. RFID-based smart lockers could serve multiple users. However, it is not suitable due to the need of the user to hold the RFID card or tag in advance. It is not a good option in warehouse applications due to the dynamic courier assignment (most of the couriers come from external parties apart from the warehouses) each day.

Given the benefits and problems above, smart locker systems implementation could benefice PT. XYZ by organizing the package is ready to pick an area with the ability to serve multiple users at a time. However, they need some modifications to maximize the benefits. This research aims to develop a smart locker system that is suitable for warehouse handover applications. The smart lockers system itself will have one camera on each door with the capability to scan the QR code from the users' web page so that the system could serve a lot of users at a time without requiring them to have any service provider physical assets. Even though the system is developed based on PT. XYZ cases, the outcoming smart locker system of this research is suitable for any e-commerce warehouse handover process applications due to the similarity of the workflow of the e-commerce warehouse handover process.

1.2 Research Problem

Online courier delivery handover process in PT. XYZ warehouse consumes most of the delivery time that cause into the unfulfilled delivery deadline. Queueing is done by delivery courier in PT. XYZ warehouse area occurs often, especially during the rush hour in the morning. The time spent by the online delivery couriers waiting for the

handover process wastes the delivery time. All pending shipments after the cut-off time on the previous day are stacked up to the morning shipment. The package piles in combination with the uncontrolled package pick-up sequence are responsible for the long handover cycle time. This phenomenon causes significant losses for all parties starting from the customers, delivery courier, and PT. XYZ is the seller and warehousing service provider.

1.3 Research Objectives

The objective of this research is to solve the long online delivery courier waiting time to queue for handover process by developing a smart locker system that could serve multiple users simultaneously with less manpower and removing the need for the users to queue physically with better package handling system. The implementation of the smart locker system is expected to be able to solve the long online courier delivery waiting time in PT. XYZ warehouses resulting in shorter delivery time.

1.4 Significances of Study

The study result would be in the form of an implementable smart locker system specialized for e-commerce warehouse applications. The system could maximize the benefits of smart locker systems implementation in e-commerce warehouse applications that could serve multiple users at a time without requiring the user to have service providers' physical access in advance with widely available parts and affordable price.

1.5 Research Questions

- Questions 1: Where is the bottleneck that cause the long queue in PT. XYZ warehouse handover area?
- Questions 2: What is the queueing behaviour occurring in PT. XYZ warehouses handover area?
- Questions 3: How could the system reduce the online delivery courier waiting time?
How robust and reliable the system?

1.6 Hypothesis

- Hypothesis 1: The main bottleneck of the process is finding the current user's package that consumes a lot of time due to the bad package organization and uncontrollable behaviour of online delivery couriers' arrival time to the warehouse.
- Hypothesis 2: The queueing mainly occurs in the morning where all of the orders from the day before stacked and need to be hand overed immediately once the warehouse open in the morning.
- Hypothesis 3: The smart locker system reduces the online delivery courier by removing the needs of the online delivery courier physically queue, asynchronously serves all possible users at a time, and better package organization. The system is robust with over than 95% accuracy and repeatability since the QR-Code itself could tolerate up to 30% error.

1.7 Thesis Structure

The book documenting this thesis project will consist of several chapters with a brief description of the fellows.

Chapter 1 – Introduction

This chapter gives brief background, objectives, problems, scope, limitations, significance of study, and structure of this thesis.

Chapter 2 – Literature Review

This chapter contains information on all components and theories needed to develop the navigation module, as well as a short review of previous studies.

Chapter 3 – Research Methodology

This chapter discusses the methods and steps taken to achieve the objective of the project.

Chapter 4 – Results and Discussions

This chapter contains all data and results acquired while working on this project as well as further analysis, quantitatively and qualitatively, of the data and results.

Chapter 5 – Conclusions and Recommendations

This chapter provides conclusions of this project as well as recommendations for further development of the system.