Last-mile delivery model for E-commerce businesses using self storage

Final Year Project Plan

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1. Introduction

1.1. Background of eCommerce Logistic

Logistic management is critical in every aspect of the eCommerce business as it is the gist of the entire industry. The effectiveness of the logistic system directly affects the profit margin of the company and the customer experience of the entire purchase. Logistics has benefited substantially as the eCommerce sector obtains tremendous gains due to COVID-19 [1]. Nevertheless, the growth of the eCommerce logistic industry shows no sign of deceleration in the post-pandemic future. In 2022, Market Research Future (MRFR) published a thorough Research Report on the eCommerce logistics market, which estimated that the 2030 eCommerce Logistic market would be worth over USD 2.5 trillion [2]. Therefore, Companies are now driving new technology to their logistic system to manage delivery efficiently and satisfy customer needs.

1.2. Overview of “Last mile” delivery

When it comes to the highest cost of eCommerce logistics, "last mile" delivery topped the list of eCommerce business owners. Last-mile delivery is defined as the process of transferring goods from the last point of transit to the final destination. Effective last-mile delivery allows the correct amount of goods to be delivered to customers' hands within the prearranged deadline [3]. More than half of the total shipping costs are associated with last-mile delivery, equivalent to around 40% of the entire supply chain expense [4], making it the most crucial element throughout the delivery process.

1.3. Current solutions for “last mile” delivery Problem

1.3.1. Third-party logistics (3PL)

With the last-mile delivery market flourishing alongside the booming eCommerce industry, a different last-mile logistic solution arises. Currently, there are various third-party logistics (e.g. Easyship, Shipwire [5]), also named "3PL", to tackle the logistic issue, including the final delivery for eCommerce business. The 3PL outsources the transportation processes of eCommerce to other transportation service providers [6]. eCommerce is allowed to choose a suitable delivery service provider with an optimized delivery route, leading to quick packet delivery and substantial productivity gain and a lower cost [7].

1.3.2. Real-Time Delivery Tracking System

The real-time delivery tracking system is another antidote for the 'last mile delivery problem. A survey by Chillman [8] reveals that seven out of ten customer demands flexibility in the delivery process. Modern customers are only sometimes available to pick up their packets. The tracking system helps the eCommerce company update their customers on the delivery status with regular notifications. Customers can also communicate with the customer service on their package throughout the delivery process. Thus, couriers are aware of customer availability for receipt, fulfilling customer expectations on flexible delivery and creating a loyal customer base.
1.4. Challenges of existing “last mile” solution

The abovementioned approach alleviates the last-mile problem to a certain degree. However, there is a difference between a theoretical solution and real life situation. The route optimization needs to achieve a better performance in reality as in theory due to the highly dynamic real-time environment. Another restriction of these approaches is the limited number of customers they can tackle. Hence, they are not suitable for reality as a courier is required to deliver the package to a large scale of customers.

Several common last-mile-related issues prevail. Firstly, fail, or late delivery occurs even though the company has a tracking system and customer service team to help manage the delivery progress throughout the entire process. This is owing to the fact that the route provided by the software is not fully optimized. Some packages are not given to the customer within a fixed time window. Besides, the customer demand for same-day shipment is zooming. The occurrence of delivery delays cannot be minimized. There is a survey illustrates that 57% of consumers would not shop with the same retailer again after three late orders [9], which is unfavourable for providing customers enjoyable purchasing experience and building a solid customer base. Secondly, there is still room for improvement in logistic reduction. As some of the delivery is unsuccessful under these approaches, eCommerce companies are forced to pay extra cost for rescheduling the order, doubling the original logistic expense [10]. On top of that, other additional charges may be required as well.

1.5. Alternative approach for current last mile model

In view of the existing challenging, the project introduces another approach to the last mile delivery model. Instead of delivering directly from the depot to the customer's address, eCommerce can use self-storage facilities as "lockers" for customer pickup, similar to the parcel locker model already worth more than USD 700 million in 2021 [11]. This model reduced some of the factors that are hard for the current depot-to-customer model to handle. For example, the constraint of customer availability is diminished as the customer can now collect their packet from the pickup spot. Then, few locations must be reached compared to the existing strategy that requires visiting all customer addresses. Time and memory for computing an optimized route are lessened. More details will be explained further when designing precedence and constraint for the model in future deliverables.

This project aims to investigate this alternative approach to solve the last-mile problem. I will implement different algorithms proposed from various publications and compare the results to find the most optimized solution. Details will be discussed in the project objections sections.
2. Project objections

This project aims at different research objectives regarding the solution to the last-mile delivery problem under the self-storage locker model, which allows the customer to collect parcels from nearby self-storage facilities. In fact, the idea of this topic mainly comes from the paper *The Vehicle Routing Problem: State-of-the-Art Classification and Review* by Tan and Yeh from National Tsing Hua University [12].

2.1. Research Objectives

The primary research objective is to investigate optimized solutions for the last mile problem, which is treated as the Capacitated Vehicle Routing Problem with Time Windows (CVRPTW) in this project. The project will investigate various methods proposed by other publications. Those methods will be examined and compared with regards to such as the number of routes and total time required. After that, this project will conclude the investigation, and I will present the findings in detail. Finally, if the abovementioned objectives are fulfilled and sufficient time and resources are allowed, these will be a non-compulsory objective, which is designing a brand-new solution specified for the current last-mile delivery problem. These are some of the examples of the publications that will be used for examination and comparison: method proposed by Borcinova [13], Feld, Roch, Gabor et al. [14], Sarttra, Rajsiri, Uy et al. [15], Cuevas, Caballero, Flores et al. [16], Liu, Tao, Zhao et al. [17], Tanel, Kinay, Karakul et al. [18].

2.2. Deliverables

There are various deliverables for this final year projects. Firstly, his project will produce a project plan and a web page in the inception phase. Then, during the elaboration phase, a thorough interim report will be submitted. Finally, this project will present the final report, preliminary implementation and final tested implementation in the construction phase. These will fit all the requirements of the COMP4801 Final Year Project. If these are additional guideline and requirements from either the course and the supervisor, additional deliverables will be supported.
3. Project Methodology

3.1. Research

CVRPTW methods used for the experiment and comparison will be primarily sourced from relevant research papers and articles. Google Scholar is the main search engine this project utilised for exploring related research paper. If some of the publications are not available through google scholar. This project will access other publication through HKUL E-resources. For researching background information on the project, this project use google search to search related articles, news and surveys.

3.2. Language and Environment

This project use python as the primary computer language for writing the code and testing. The language version adopted is Python 3.10 7. For the development and testing stage, this project uses Google Colaboratory, an online notebook platform powered by google, to host Jupyter Notebooks for writing the concept and experimenting with algorithms published in various publications. The experiment and coding instructions and assumptions will also be written in the notebook, as a guideline to allow users to better understand before running the code.

Eventually, all the notebooks will be placed in a separate folder specific for the FYP in google drive. The access of the folder will then be shared to other users for testing the code in the notebook. The users will also be able to download the folder as well.

3.3. Data Preparation

For the data preparation stage, the project will use VRP-related datasets, such as figShare, VRP-REP, and JAMPR.

3.4. Reporting

After comparing different reporting tools available, this project design to use Trinka for presenting technical writing and generate necessary deliverables required from the FYP course.

3.5. Web Page

The project web page will be a WordPress website, with Astra being the main theme. Plugins, such as Elementor, will be used for editing the website content. Project information and various documentation will be founded on the web page. Users can find links to methodologies and result on the web page as well.
4. Scheduling

This project is divided into 3 phases.

The first phase is the inception phase, taking part from early August to early October. First, Initial research on the topic will be done to identify the scope of the project and its architecture. Then setup will be finished, including the FYP account, web page and development. After that, the project plan and initial web page will be completed as well.

The second phase is the elaboration phase, which starts from mid-October to late January. More in-depth evaluation and study will be carried out in this phase. I will continue the research studies regarding the topic. Then, I will start implementing code and constructing detailed documentation. After that, I will organize all the findings and prepare for the 1st presentation. The phase will end with an interim report.

The third phase is the construction phase, which starts from late January to late April. I will emphasize the implementation of the project and optimization in this phase. More comparatively testing on the algorithm proposed by various publications will be carried out. The results will then be summarized, and a conclusion will be drawn. The last item of this phase will be preparing the final presentation and report. After the third phase, I will prepare for the project exhibition in late April.

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5. References


