Assessing the potential of delivery consolidation to campus center

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Abstract. The purpose of this research is to investigate the characteristics of students who partake in online shopping and the potential of the consolidation method for delivering packages in Universitas, Indonesia (UI). The consolidation method for delivering packages is considered a solution for reducing freight volume and its negative impact on the environment. The study was based on the interview of 1824 UI students regarding their preferences on two package delivery services used in online shopping, namely direct (home) delivery and consolidation. The data was analyzed using the Analytical Hierarchical Process method and Expert Choice 11. The result shows that 56% of the students experienced problems in online shopping, with 46% experiencing a delayed delivery. Compared to the direct delivery, 51.3% of the students chose the consolidation method. In general, the most important aspect of choosing a delivery method when shopping online is time (24.7%), convenience (23.3%), accessibility (22.5%), cost (16.4%), and distance (13.2%). For those who choose direct delivery, time is the most important aspect; for those who choose consolidation, convenience in using the system and accessibility to the consolidation point are the most important. These should be taken into account in implementing the system in the UI campus so the campus can share benefits by reducing the negative impact of freight transport on the environment.

Keyword: Online Shopping, Consolidation Method, Direct Delivery, Freight Transport

1. Introduction

The frequency of online shopping in various parts of the world continues to increase both in urban and rural areas. In urban areas, the increasing demand for online shopping has led to increased logistical activities, especially last-mile delivery activities (Visser, Nemoto, & Browne, 2014). This is shown by the increasing number of freight vehicles in urban areas to deliver goods to customers’ homes for home delivery. The presence of freight vehicles in urban areas increases the use of non-renewable energy sources and pollutant emissions, traffic accidents, noise, and visual disturbances while driving (Simoni, Bujanovic, Boyles, & Kutanoglu, 2017).

Centralization of delivery, often called delivery consolidation, in the final destination of a delivery is considered a solution to the increased freight transport problem (Morganti, Dablanc, & Fortin, 2014) (Stainslaw, Kinga, & Justyna, 2016) (Simoni, Bujanovic, Boyles, & Kutanoglu, 2017). In optimizing this system, Edwards (2010) and Wiese (2015) stated that students are a driving force of freight transport. According to Statista (2016), increasing freight transport activities is caused by people aged 18–24 who carry out online shopping activities. This age group accounted for 42% of all customers in 2014 (Tom et al., 2017).

Considering this condition in which there is generally a large number of young people on a campus with the potential to be online shopping consumers, students on the campus can be used to optimize the delivery centralization (or consolidation system) of the shipments. The purpose of this study is to analyze the potential application of the consolidation method within the campus area, using Universitas Indonesia as the object of study. Section 2 will describe the literature review, section 3 will explain the research method, section 4 will be focused on the result and discussion, and section 5 will present the conclusions of the study.
2. Literature Review

The development of economic activity in urban areas has resulted in increased freight transport activities. This has an impact on the increasing of greenhouse gas emissions. According to the US EPA (2008), in the United States, freight vehicles produce a disproportionate amount of NOx and particulate matter — heavy vehicles represent roughly 9% of vehicle miles travelled but produce nearly 50% of the NOx and PM10 from transportation (Wygonik & Goodchild, 2018).

In order to reduce the negative impact of transport, there are several solutions to reduce the freight transport volume in urban areas, namely, the reception boxes system, delivery boxes, controlled access systems, collection points, and locker banks (Stainslaw, Kinga, & Justyna, 2016). These solutions include a system in which the goods (packages) are sent to an area that can be accessed by consumers who live, work, or participate in activities around the service point (Morganti, Dablanc, & Fortin, 2014; Stainslaw, Kinga, & Justyna, 2016; Simoni, Bujanovic, Boyles, & Kutanoglu, 2017). The other solution is the consolidation method. Consolidation, which is based on Crainic (2004), Browne (2005), and Daniels (2010), is the centralizing of deliveries by sorting and transferring deliveries to smaller vehicles—such as minivans, electronic vans, and cargo bikes—in warehouses and then sending these to a centralized delivery point (Simoni, Bujanovic, Boyles, & Kutanoglu, 2017). The transfer of these deliveries to smaller freight vehicles is aimed at reducing the use of non-renewable resources and greenhouse gas emissions that are caused by the movement of large trucks. By centralizing the deliveries, the size of fleets can be reduced, which can be beneficial in reducing congestion and road hazards as well as greenhouse gas emissions (Spijkerman, 2015). According to Edwards (2010) and Wiese (2015), student accommodation can be a driving force of this system. According to the Higher Education Statistics Agency in the UK (2015), students who lived in dormitories during the academic year made up 27.5% of a total of 1.4 million students in the UK (Tom et al., 2017).

3. Research Method

This study began with the cross-sectional observation of 1824 total respondents. Universitas Indonesia has approximately 40,000 students from 11 faculties. The Analytical Hierarchical Process (AHP) method was used to determine respondents’ choice on two options of online shopping delivery services, namely Direct (Home) Delivery and Consolidation to Campus. The decision is based on several criteria, namely delivery cost, time duration (from payment until the delivery package is in the hands of the consumer), convenience (the easiness of application of the system), accessibility to the service point, and the distance to the service point. Figure 1 shows the AHP structure. In AHP, Criteria and Alternatives are assessed through pairwise comparisons. All the criteria were assessed in terms of their importance through pairwise comparisons, and finally, a score was established to each criterion based on its level of significance. In addition, pairwise comparison was also made to two options of delivery services (Home Delivery and Consolidation), based on their criteria and level of importance. The data processing is carried out using Expert Choice 11.

The validity of the AHP analysis was indicated by the Consistency Index, which must be less than 0.1. In addition, Equation (1) was applied to determine the Consistency Index.

\[
CI = \frac{\lambda_{max} - n}{n - 1}
\]

\[CI = \text{Consistency Index} \]
\[\lambda_{max} = \text{Principal eigenvalue} \]
\[n = \text{Dimension of the matrix} \]

In addition to determining the weight of the two delivery service options, an analysis of potential locations for consolidation services was also carried out through questions put to respondents about their preference of location of service point and the reasons behind this choice.
4. Results and discussion

4.1 Criteria and Alternatives Weight

1447 of the 1824 respondents (79%) have participated in online shopping in the last two months, while the rest have not done that. The proportion of students who have participated in online shopping in the last two months for each faculty ranges from 71% to 90%. This illustration shows a significantly large proportion of students doing online shopping. From the figure, 64% of the total respondents are women, while 36% of the respondents are men. The types of goods purchased are mostly clothes (31%), beauty products (26%), electronics (16%), daily necessities (11%), sports equipment (4%), household appliances (3%), and miscellaneous (9%).

Among the entire set of respondents, 56% experienced problems in online shopping, with the most common problems being delivery delays (75%), exchanged items (17.86%), and goods not arriving at their destination (7.14%). One factor that influenced delivery delays is traffic congestion. Delivery delays can be detrimental to online shopping consumers and also the delivery operator—productivity of the delivery can decrease and in turn disrupt other deliveries.

The results of data processing using Expert Choice 11 are shown in Table 1 and Table 2.

| Criteria | Priority |
|----------|----------|
| Time     | 24.7     |
| Convenience | 23.3   |
| Accessibility | 22.5  |
| Cost     | 16.4     |
| Distance | 13.2     |

| Alternative          | Criteria | Priority |
|----------------------|----------|----------|
| Direct Delivery Weight | Time     | 14.6     |
| Direct Delivery       | Convenience | 10.9   |
|                       | Accessibility | 10.9  |
|                       | Cost       | 7.1      |
|                       | Distance   | 5.2      |
| Consolidated Delivery Weight | Convenience | 12.4   |
| Consolidated Delivery |           |          |

Figure 1. AHP Diagram of Delivery Method Choice
Table 1
| Factors   | Score |
|-----------|-------|
| Accessibility | 11.6  |
| Time       | 10.1  |
| Cost       | 9.3   |
| Distance   | 8     |

In Table 1, it is shown that, regardless of the type of delivery method, time is the most important factor that affects the decision to choose the delivery method. It is followed by convenience, accessibility, cost, and distance. In general, people always want to receive their packages soon.

As the type of delivery method is regarded, in Table 2, it can be seen that consolidated delivery has a slightly higher weight to be chosen (51.3%) compared to direct delivery (48.7%). This shows that the potential of using a consolidated delivery system on campus is sufficient enough to replace the direct delivery system. This consolidation system is expected to shorten the courier’s trip chain and the costs required for the delivery. A study on the urban consolidation center’s potential at the University of Southampton, UK, shows that in cities with multiple higher education institutions, where in excess of 8,000 students live in halls, over 13,000 courier trips could be generated annually, delivering over 4,000 m3 of packages. These could be consolidated onto fewer than 300 vehicles for an annual service cost of approximately £18 per student, reducing congestion and parking infringements, and improving air quality (Tom, Janet, Fraser, Jason, Gavin, & Gray, 2017). For Universitas Indonesia, which has over 40,000 students, 71%-90% participated in online shopping. It is a great chance for Universitas Indonesia to contribute to reducing the number of freight vehicles in the last mile of delivery.

Moreover, in order to make this happen, it is important to take into account the factors that influence the respondents in choosing a delivery service. Time is the primary determiner for those who choose direct delivery. This is reasonable, as direct delivery services are often perceived as the fastest. Meanwhile, convenience is the primary factor behind choosing the consolidation system. The respondents are less concerned with time than with the accessibility of the service point. The ease of use and access to the consolidation system as well as the location of the point of consolidation become crucial issues that should be considered for the success of the system. Also, if the consolidation system can offer a speed of delivery that competes with the direct delivery system, the use of the consolidation system will be maximized. Cost and distance are the two lowest priority factors, which signifies, firstly, that these aspects are accepted by students so improvements in this area are not the main focus and, secondly, that online retailers and delivery service providers should focus on the three highest priority factors in order to make students comfortable with online shopping.

4.2 Location of Consolidation Service Point
Respondents were asked their preference in the location of a consolidation point on campus and the reasons behind this choice. Each respondent could choose two locations. Table 3 shows that the main reasons for choosing the first location. The most common reason was proximity to their faculty of study (45%), followed by place most commonly visited (36%), and lastly, whether the place is located on their way home (19%).

| Reason in Choosing Location          | Total  |
|-------------------------------------|--------|
| Close to the faculty where they study | 930 (45%)  |
| Commonly visited location            | 740 (36%)  |
| Located on the way home              | 393 (19%)  |
Table 4 shows the distribution of reasons for choosing the second location. It can be seen that the difference between the commonly visited location (41%) and the location on the way home (39%) are the reasons for respondents to choose the second location.

| Reason in Choosing Location | Total     |
|-----------------------------|-----------|
| Commonly visited location   | 757 (41%) |
| Located on the way home     | 738 (39%) |
| Close to the faculty where they study | 381 (20%) |

Table 5 shows conclusions from locations chosen by students in each faculty. The locations chosen as the first choice are the Universitas Indonesia Station, the Faculty of Social Political Sciences, and the Central Library. This first choice is still closely related to the location where the respondents study because the most common reason for choosing this location was that it was close to students’ faculty. The second choice is dominated by the Central Library. This second location does not relate to the faculties where the students study because the most common reasons for choosing the second location are commonly visited locations and the locations being situated on their way home. If the number of service points is limited by these considerations, then common places such as libraries or stations can be considered as options. Since the two stations that were chosen by the respondents are public facilities that are used by the people who reside outside of the campus, then locating the service points at the station can reduce the number of direct delivery not only to the students but also to people outside of the campus.

| Faculty                                | Preferred Location 1 | Preferred Location 2 |
|----------------------------------------|----------------------|----------------------|
| Faculty of Dentistry                   | Pondok Cina Station  | UI mosque            |
| Faculty of Medicine                    | Pondok Cina Station  | Central Library      |
| Faculty of Mathematics and Science     | Central Library      | Pondok Cina Station  |
| Faculty of Engineering                 | Faculty of Economics and Business | Student Centre |
| Faculty of Law                         | Central Library      | Universitas Indonesia Station |
| Faculty of Economics and Business      | Faculty of Engineering | Universitas Indonesia Station |
| Faculty of Humanity                    | Central Library      | Universitas Indonesia Station |
| Faculty of Psychology                  | Faculty of Social and Political Science | Central Library |
| Faculty of Social and Political Science| Universitas Indonesia Station | Central Library |
| Faculty of Public Health               | Universitas Indonesia Station | Central Library |
| Faculty of Computer Science            | Faculty of Social and Political Science | Faculty of Administrative Science |
| Faculty of Pharmacy                    | Faculty of Mathematics and Science | Pondok Cina Station |
| Vocational                             | Universitas Indonesia Station | Central Library |
5. Conclusion
This research examines the potential of the delivery consolidation method of online shopping in Universitas Indonesia. The potential of applying the consolidation method in the UI campus is 51.3%, higher than the direct delivery (home delivery) system (48.7%). This choice is based on the consideration of its convenience (with a score of 12.4%), accessibility to service points (11.6%), time duration of delivery (from payment until consumer receives the item) (10.1%), cost (9.3 %), and distance (8%). In applying the consolidation method, these aspects need to be considered so the consolidation system can compete with the direct delivery system.

In implementing consolidation methods at Universitas Indonesia, in addition to each faculty, other locations that can be considered as service points are common places such as the Central Library, Pondok China Station, and Universitas Indonesia Station. Common places are generally chosen because they are often visited and also because the location is on many students’ routes home. Located service points in common places (which may also be public facilities) are also expected to increase the number of consumers, and it ultimately can reduce last-mile delivery trips.

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