LOGI – Scientific Journal on Transport and Logistics
Vol. 14 No. 1 2023 DOI: 10.2478/logi-2023-0026
© 2023 R.V.P. Sunarso and B.S. Wibowo. This is an open access article licensed under the Creative Commons Attribution-NonCommercial-NoDerivs License (http://creativecommons.org/licenses/by-nc-nd/3.0/).

The Impact of Consolidating On-Demand Food Delivery on Sustainability: A Simulation Study

Radhitya V.P. Sunarso[1] and Budhi S. Wibowo[1*]

[1]*Universitas Gadjah Mada, Department of Mechanical and Industrial Engineering, Yogyakarta, Indonesia; Email: radhityavirya@mail.ugm.ac.id; budhi.sholehwibowo@ugm.ac.id*

***Corresponding Author:** Budhi Sholeh Wibowo

Received: 18 April 2023; Revised: 16 August 2023; Accepted:15 September 2023; Published: 1 November 2023

Abstract: On-demand food delivery services have transformed the food industry, offering customers a convenient way to order their favorite food from restaurants and have it delivered to their doorstep. However, the increased number of delivery vehicles has led to higher costs, traffic congestion, and carbon emissions. To tackle these negative impacts, consolidating the delivery process by combining multiple orders from different restaurants to various customers has been suggested. This study evaluates the sustainability impact of direct versus consolidated orders in the on-demand food delivery sector. To achieve the objective, we used an agent-based simulation model based on real delivery data from Yogyakarta, Indonesia. Our simulation results indicate that due to constraints in time windows and routing complexity, only a small portion of all orders can be consolidated. But where consolidation is feasible, it can benefit businesses and the environment by reducing costs for customers, increasing drivers' productivity, and reducing carbon emissions. The downside is that it may result in a longer customer waiting time. These findings provide valuable insights for businesses and policymakers seeking to promote sustainable practices in the on-demand food delivery sector.

Keywords: Consolidated delivery, on-demand food delivery, agent-based simulation, sustainability

1. Introduction

E-commerce has experienced rapid growth in recent years, driven by the increasing number of customers who prefer online shopping, resulting in the remarkable expansion of the e-commerce market. Along with this trend, on-demand food delivery (ODFD) services have become increasingly popular. It offers customers a convenient and easy way to have their meals delivered directly to their doorstep, making it a popular option for people seeking hassle-free food delivery.

While ODFD services offer several positive impacts, such as creating new job opportunities and fostering stronger consumer relationships, the increased number of delivery vehicles required to meet

the growing demand has resulted in negative consequences. First, the increased number of delivery vehicles on the road has caused traffic congestion, especially during peak hours, resulting in longer travel times and potential delivery delays. This, in turn, can lead to a higher carbon footprint as vehicles spend more time on the road [1]. Besides, the surge in delivery orders may cause drivers to experience an increased workload, resulting in fatigue that could adversely affect their physical and mental health [2]. The time constraint to meet delivery deadlines and the pressure to earn higher commissions could result in safety concerns for drivers and increase the likelihood of traffic accidents [3].

To address these negative effects, consolidation has emerged as a potential solution [4-6]. Consolidation combines multiple orders or shipments into one delivery, reducing shipping costs and shortening delivery times. By combining several shipments at once, consolidation can reduce shipping costs and shorten delivery times, thus maximizing vehicle capacity utilization [1]. However, consolidated delivery has not yet been widely adopted in ODFD services. Further research is needed to determine the potential benefits of consolidation for related stakeholders such as customers, drivers, service providers, and society.

This study aims to evaluate the impact of consolidated versus direct delivery in the ODFD sector. An agent-based simulation model is developed to examine the impacts of both delivery models on sustainability. Our study contributes by proposing the concept of consolidation as a potential solution to address the negative effects of ODFD services, highlighting its impact on sustainability and related stakeholders. The study can increase public awareness of the positive and negative impacts of the service and the need for solutions. Moreover, it could inspire further research into the topic, leading to more effective and sustainable practices.

The paper is organized as follows. First, relevant literature in the ODFD sector is reviewed. Next, the methodology used to develop and evaluate the simulation model is explained. The results are presented in Section 4, followed by a discussion and managerial insights in Section 5. Lastly, the study is concluded in Section 6.

2. Literature Review

Over the years, ODFD services have gained popularity, partly driven by the increasing use of mobile devices and the growth of the internet. As this industry continues to grow, it has garnered the attention from various disciplines to understand its impact on sustainability.

Schnieder et al. [7] conducted a focused investigation into the environmental impact of ODFD services on traffic flow and emissions in New York City. Their study revealed that direct deliveries produce three to four times higher emissions than consolidated delivery. Building on this premise, Allen et al. [8] delved into the prevalence of ODFD services in London and their consequences for

transportation and the environment. Their research highlighted that food deliveries made by cars and petrol mopeds emitted more greenhouse gases per item than bicycle deliveries. Wang & He [9] found that orders for meal delivery are greater in urban areas with low walking accessibility but high accessibility for cycling. These studies emphasize the urgent need for greener delivery practices in the ODFD industry.

Further, from a social standpoint, Aguilera et al. [10] analyzed the welfare of ODFD drivers in Paris, France. They discovered that most drivers depended solely on their income from delivery jobs, earning less than minimum wage and facing numerous hazards during their work. Wang et al. [11] explored how ODFD riders in the gig economy found meaning in their work from a mobility perspective. Their findings revealed that riders valued the freedom provided by flexible working hours, immediate cash transfers, and the ability to control their destiny. However, they also perceived ODFD as a transitional job. Additionally, Seghezzi et al. [12] investigated the business profitability performance of ODFD in Italy. They found that the composition of fixed and variable wages significantly affected the profitability of both drivers and platforms. This highlights the need to improve driver profitability and welfare in the ODFD industry.

Some researchers have proposed order grouping/batching or consolidation as a potential solution to improve the sustainability of ODFD service [13]. For instance, Liao et al. [1] observed a significant transport cost saving from implementing consolidation in ODFD. However, the performance of consolidated delivery deteriorates as demand increases. Simoni & Winkenbach [6] presented an order batching and assignment algorithm that utilizes a graph-based approach and clustering to consolidate orders into batches within ODFD platforms. Their results revealed that increasing the maximum batch size only offers marginal cost savings for batches of three orders or more, primarily due to time and capacity constraints. Hewitt et al. [14] proposed a consolidation model for delivering frozen meals to investigate its cost-saving potential and ability to serve a larger client base. Their study discovered that the cost savings achieved through consolidation diminish as the customer service level increases. However, Steever et al. [15] demonstrated that with effective scheduling, it is possible to deliver consolidated orders no later than the last item would have arrived in direct delivery. Another solution to address the operational issue in ODFD is by using bicycles [8] or drones [16] to deliver the meal or to solve the imbalance between demand and drivers' availability in certain regions [17].

However, it is worth noting that while consolidation has the potential to provide significant cost savings and to improve profitability for drivers, it also carries the risk of customer dissatisfaction due to longer waiting times. Safira et al. [18] observed that waiting time and delivery cost are the two most critical factors influencing people's preference for ODFD services in Jakarta. To address the waiting time issue, other studies [19-21] demonstrated that providing sustainability information, such

as emissions and environmental impact, could extend customers' willingness to wait for their delivery, thereby reducing the need for financial incentives.

One of the main shortcomings of previous studies is their narrow focus on one or two actors, which hinders their ability to capture the complexities arising in the ecosystem. Our study takes a different approach by using simulation to provide a comprehensive and multi-stakeholder perspective, including customers, drivers, policymakers, and service providers. This allows for a better analysis of the interactions among the various actors and how their actions impact the overall performance of the ecosystem.

Furthermore, our study takes a sustainability-focused approach, providing a more comprehensive understanding of the challenges and opportunities facing the sector. Our study considers sustainability aspects from all three pillars, not just economic considerations but also societal and environmental implications. This approach is essential for policymakers, service providers, and other stakeholders concerned with sustainable and equitable growth of the sector.

3. Methods

3.1 System Descriptions

We are interested in examining the dynamics of the ODFD ecosystem, which involves multiple stakeholders or agents. These agents include customers, drivers, and the service provider acting as the dispatcher. Customers are the ones who initiate the order process by deciding what food items to order, when to place the order, and where they want the order to be delivered. They are primarily concerned with getting their orders delivered as quickly as possible while paying the lowest possible cost.

The service provider acts as the intermediary between the customers and the drivers, responsible for assigning orders to drivers and ensuring that the orders are delivered promptly and efficiently. The dispatcher's primary interests are to increase customer satisfaction and revenues. To achieve these goals, the dispatcher must manage the available resources, including the number of drivers and delivery vehicles, and ensure that the drivers are optimally allocated to meet the customers' demands.

Finally, the drivers are responsible for physically delivering customer orders. They are primarily concerned with maximizing their profits by taking on more orders with lower effort. This means drivers must carefully consider their delivery routes to minimize the time and fuel needed to complete their delivery trips.

The interactions among these agents in the ODFD system can significantly impact society. For example, the increased number of delivery vehicles on the road can lead to higher traffic congestion, longer travel times, and potentially increased carbon emissions. The interactions between the agents

can also have economic impacts, such as increased operating costs and decreased profits for the drivers and service providers.

3.2 Modeling Process

We employed an agent-based simulation method to model the behaviors and interactions of the various stakeholders in the system, including customers, drivers, and the service provider. The agent-based simulation method is a modeling technique used to simulate the behavior of individuals or entities within a system. It involves modeling each agent as an individual with a unique set of attributes, goals, and decision-making processes. The agents interact with each other and the environment to achieve their objectives, and the simulation records the outcomes of their actions.

The simulation was implemented using Eclipse SUMO (Simulation of Urban Mobility) software [22]. Eclipse SUMO is an open-source simulation package that provides tools for modeling and simulating transportation systems, including road networks, demand models, vehicle types, and traffic control interfaces (TraCI). The software uses a microscopic approach to simulate the behavior of individual vehicles and drivers within a traffic network. This approach enables us to model the impact of the delivery process on traffic flow and to analyze the potential effects of different delivery scenarios on delivery speed and carbon emissions.

Our simulation model consisted of two scenarios: (1) direct delivery and (2) consolidated delivery. In the direct delivery scenario, the dispatcher assigns each order to a vacant driver who quickly picks up the food from the restaurant and delivers it directly to the customer. In the consolidated delivery scenario, the dispatcher assigns multiple orders to a vacant driver, considering time constraints and location factors. The driver then collects food from various restaurants and delivers it to multiple customer locations.

Fig. 1 illustrates the operations of the two scenarios using an activity cycle diagram. Upon the predetermined arrival time, drivers will enter the system and commence order-taking once assigned to pick up. Orders will be incorporated into the system based on their arrival time and will undergo a "cooking" process, indicating the need for processing before being picked up by the driver. Once processed, the nearest driver will be assigned to move to the pick-up location, collect the order, carry out the delivery process, and arrive at the scheduled drop-off point. In the direct delivery scenario, drivers will repetitively pick up and deliver single orders directly to the drop-off point. Conversely, in the consolidated delivery scenario, drivers will collect multiple orders from multiple restaurants at once and execute delivery to the drop-off point of several customers.

In the SUMO software, we used the greedy-shared algorithm as the dispatching method to support the consolidation process. This algorithm works by first assigning the closest restaurant for each available driver. If the arrival time in the future is too far, the order is postponed. The driver then

tries to pick up another order while delivering the first order to its customer. When the drivers are idling, we employ the stop rule, meaning that the drivers will wait at the last delivery location until the next order arrives. In the simulation, we assume that the drivers will only take the food in the restaurant once they are ready to be picked up. To evaluate the outcomes from the two scenarios, we conducted a numerical experiment by varying the initial locations of the drivers with ten replications. We set the speed of vehicles to 25 km per hour.

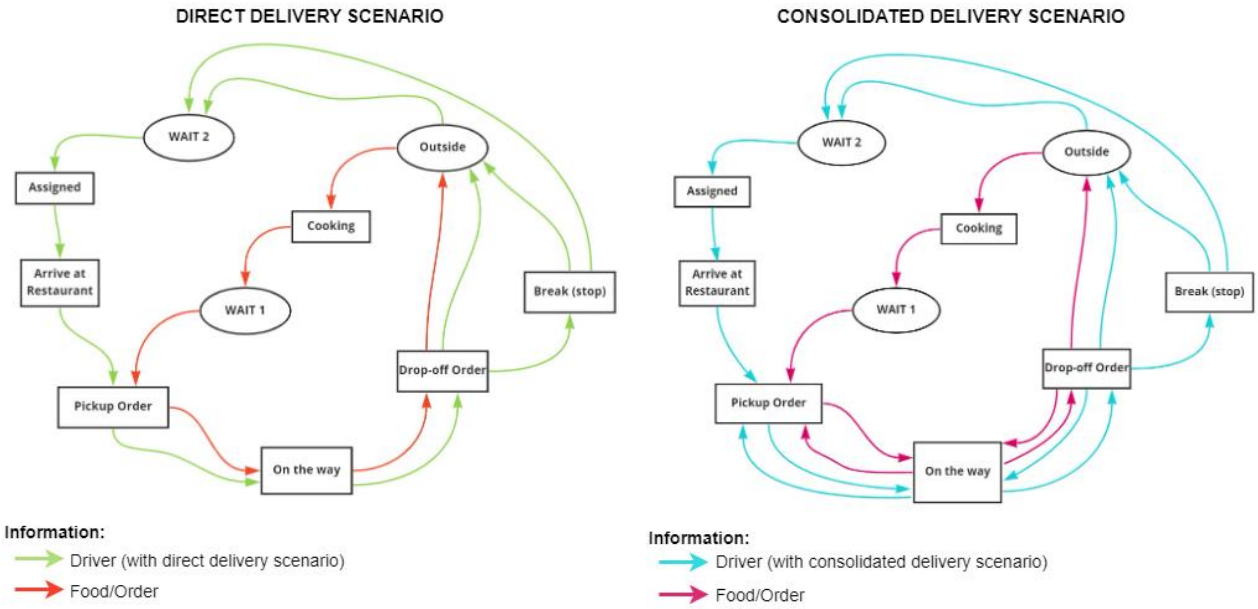

Fig. 1 Activity cycle diagram for direct delivery (left) and consolidated delivery (right). Source: authors

3.3 Key Performance Indicators

The key performance indicators (KPI) in this study are developed based on the interest of multiple stakeholders in the system, as summarized in Table 1. By doing so, we can evaluate the trade-off on stakeholder interest in each scenario. Some stakeholders may have a common interest, such as customer waiting time, trip duration, and costs.

Table 1 Key Performance Indicators. Source: authors

Stakeholder	Interest	KPI
Customer	Fast delivery	Avg. customer waiting time
	Low cost	Avg. delivery fee ($ 0.18 / km)
Driver	Higher profit	Avg. revenues per driver based on paid trip ($ 0.15 / km)
	Productivity	Avg. trip duration per order
Service Provider	Higher revenues	Total revenues (15% commission fee)
	Customer satisfaction	Avg. customer waiting time
Society	Healthy environment	Total carbon emission (0.11 kg/km)
	Less traffic	Avg. trip duration per order

4. Simulation Results

Data for the study were collected from an online survey. The respondents are users of ODFD services in the greater area of Yogyakarta city, Indonesia (see Fig. 2). In total, we received 110 data from 32 respondents from Yogyakarta. They provided historical records of on-demand food orders, including the number of items, restaurant address, order time, and delivery point. The data were then transformed into the coordinates of pick-up and drop-off points.

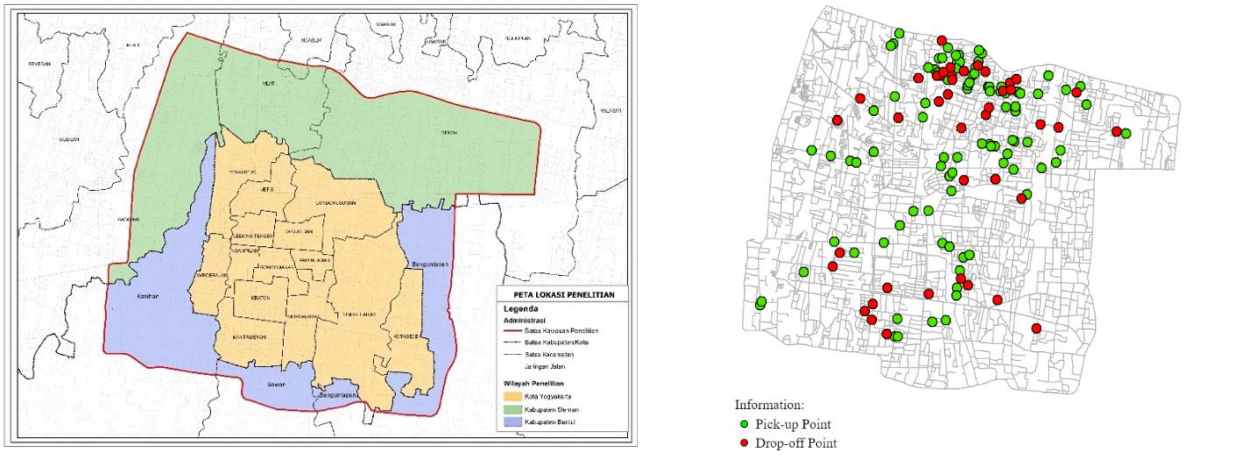

Fig. 2 Area of study (left) and its road network (right). Red bullets indicate customer locations and green bullets denote the restaurant locations. Source: authors

The simulation model evaluated the impact of consolidated versus direct delivery on the ODFD sector. Out of 110 orders, only 8 (about 7%) could be consolidated due to the substantial time gaps between orders and the dispersed locations of customers. When all orders were evaluated, there was no significant difference in performance between direct and consolidated delivery scenarios (see Table 2). This is because the effect of unconsolidated orders overshadowed the impact of consolidation. However, the true impact of consolidation was observed when focusing on the consolidated orders (see Table 3).

Table 2 Median performance from all orders (N=110 orders). Source: authors

Scenario	Customer Waiting Time (min./order)	Delivery Fee (USD/order)	Driver Revenues (USD/ driver)	Trip Duration (min/order)	Business Revenues (USD)	CO_2 Emission (kg)
Direct Delivery	33.06	0.91	8.52	12.24	199.46	33.12
Consolidated Delivery	33.16	0.93	8.50	12.48	199.32	31.65
Difference	0.10	0.02	-0.02	0.24	0.14	-0.05
Diff (%)	+2%	+2%	< -1%	+2%	<-1%	< -1%

The results in Table 3 reveal that while consolidated delivery resulted in a 26% increase in average customer waiting time (7.72 minutes), it also led to a 9% reduction in delivery costs for the customers. This is a significant finding as customers may be willing to tolerate the longer waiting time if they can benefit from a lower delivery fee. Furthermore, the consolidation process increased drivers' compensation by approximately 68% for consolidated orders and reduced the average trip duration by 9%, indicating the gains in productivity and efficiency associated with consolidated delivery.

Table 3 Median performance from consolidated orders (N=8 orders). Source: authors

Scenario	Customer Waiting Time (min./order)	Delivery Fee (USD/order)	Driver Revenues (USD/ driver)	Trip Duration (min/order)	Business Revenues (USD)	CO_2 Emission (kg)
Direct Delivery	35.04	0.97	0.95	13.06	10.92	1.81
Consolidated Delivery	42.76	0.88	1.61	11.84	7.69	1.28
Difference	7.72	0.03	0.65	1.22	3.22	-0.29
Diff (%)	+26%	-9%	+68%	-9%	-30%	-16%

Additionally, consolidation also contributed to an average 16% reduction in total carbon emissions, which is a crucial finding considering the growing environmental concerns. However, it is worth noting that the service provider's revenue was reduced by almost 30% due to the more efficient routing of consolidated delivery, as illustrated in Fig. 3. This presents a trade-off that service providers must carefully consider when implementing a consolidated delivery strategy. While it may lead to lower revenue in the short term, it can result in long-term benefits such as reduced environmental impact and improved driver retention.

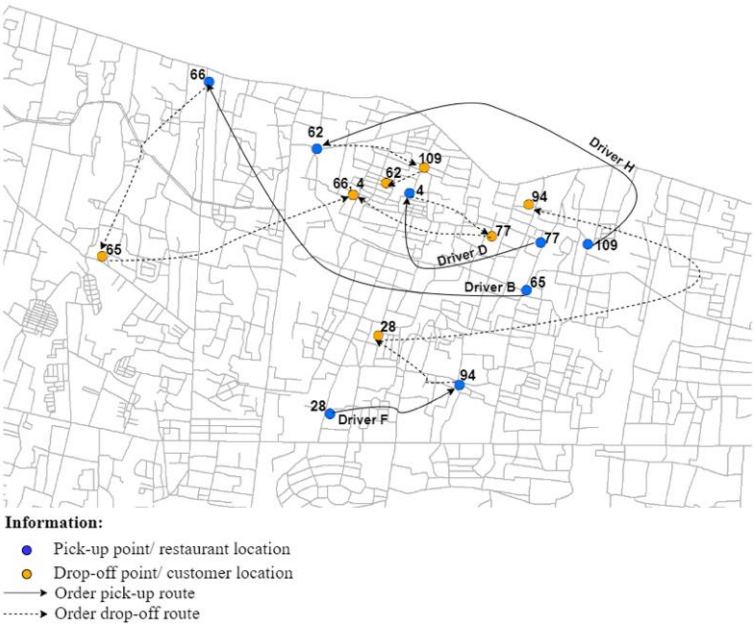

Fig. 3. Consolidated orders and delivery flows. Source: authors

5. Discussion

The findings of this study have significant implications for ODFD services. Our results indicate that implementing the consolidated scenario can substantially improve environmental and economic sustainability. This result is in line with previous studies on trip consolidation highlighting the potential reduction in cost and carbon emission [1,14]. However, due to the variability in ordering time and restaurant preferences, only a small portion of orders can be consolidated. It hinders the actual benefit of order consolidation in the ODFD system.

To improve the number of consolidated orders, service providers can invest in more efficient scheduling algorithms to ensure delivery times are reasonable [6,15]. By optimizing the assignment and routing deliveries, service providers could better match geographically close orders, thus increasing the likelihood of consolidation. Further, it is important to acknowledge that the consolidated scenario may result in some negative impacts. These can affect different stakeholders in various ways, and it is essential to consider their perspectives when making decisions.

For service providers, consolidated delivery can result in fewer revenues due to fewer total paid trips (-30%). However, service providers can benefit economically from consolidation. In fact, our study found that implementing the consolidated scenario resulted in higher productivity (less trip duration per driver), which can be attributed to the lower number of vehicles on the road. With fewer vehicles needed to fulfill the same number of orders, drivers can make more efficient use of their time and complete more orders, resulting in higher revenues for the service providers. Thus, the potential revenue gain from consolidation hinges on the service provider's ability to leverage the additional capacity of drivers to capture greater demand. Besides, the lower carbon emissions from consolidated delivery (-16%) can build a positive brand image and attract more environmentally conscious customers [19].

For drivers, the consolidated delivery can increase their productivity, and generate more income for the same amount of work (+68%). Consolidated meal delivery allows drivers to deliver multiple orders to different customers in a single trip, saving time and fuel costs. While earnings per delivery may decrease (-9%), drivers can earn more if they can deliver multiple orders in a single trip. These benefits could attract more drivers to the ODFD industry, potentially increasing competition and improving customer service.

For customers, the longer waiting times (+26%) resulting from implementing the consolidated scenario could hurt customer satisfaction and loyalty. To mitigate the negative impact on customer satisfaction, ODFD services can consider offering rewards for customers willing to wait longer for their orders to be consolidated. Our study suggests that the delivery fees can be reduced by 9%. This reduction can serve as compensation for the inconvenience. The compensation could be in the form

of discounts or non-financial incentives such as sustainability information [19,20], or acknowledgment through social media [21].

From a broader perspective, our study shows that implementing the consolidated scenario can benefit society by reducing air pollution and traffic congestion. Unlike previous studies in [7,8], which primarily emphasized discouraging the use of cars and petrol mopeds for food delivery, our research introduces an alternative approach that can achieve a remarkable 16% reduction in emissions through consolidation. By combining these alternatives, governments and policymakers can pave the way for a greener and more sustainable future by enacting thoughtful regulations and incentives. Encouraging the adoption of such sustainable delivery practices can lead to a healthier and more environmentally conscious society, ultimately benefiting every individual in the long run.

In summary, our study implies that ODFD service providers must balance different stakeholders' interests and pursue strategies that support sustainability and economic performance. One key implication of the study is that environmental and potential economic gain should be given greater importance when evaluating delivery scenarios rather than simply focusing on customer waiting times.

6. Conclusions, Limitations and Future Research

This study investigates the performance and sustainability implications of implementing order consolidation in ODFD services. The rapid growth of the ODFD industry has led to increased concerns about environmental sustainability, economic viability, and societal impact.

To address these concerns, our study used agent-based modeling and performance evaluation to compare the effects of two scenarios: direct versus consolidated food delivery. The simulation model is based on real-world data from users of ODFD platforms in a mid-sized city in Indonesia. The evaluation considers several performance indicators, including customer waiting time, trip duration, paid trips, and carbon emissions.

The results show consolidated food delivery has several benefits compared to direct delivery. Firstly, it can significantly reduce the number of delivery vehicles on the road, thus reducing carbon emissions and traffic congestion. Secondly, it can reduce the trip duration and increase the drivers' productivity, leading to increased economic sustainability for drivers and service providers. However, the study also found that the consolidated scenario can result in longer customer waiting times which could cause inconvenience for customers and potentially decrease their satisfaction.

The study has several limitations that need to be acknowledged. Firstly, the simulation model is based on data from a single mid-size city, which may limit its generalizability to other contexts. Secondly, the study does not consider the effect of traffic conditions and queues in restaurants, which could impact the results. Lastly, the study is limited by the assumptions and simplifications made in

the simulation model, which may not accurately reflect the complexities of real-world delivery operations.

Furthermore, there are also some potential avenues for future research. The benefits of the consolidated scenario may vary depending on the specific context of ODFD services. Future research could conduct context-specific analyses to understand the effectiveness of consolidation in different regions with varying traffic levels and customer densities. This could help to tailor delivery strategies to optimize sustainability and economic performance in each region. We also found that consolidation may result in a disproportion between cost reduction and waiting time extension. Further research could examine if consolidation is profitable in the long run. Besides, since customer waiting time is a significant factor that could impact customer satisfaction and loyalty, future research could examine how offering incentives to customers (such as discounts or rewards) might influence their preference and willingness to wait longer for more sustainable deliveries.

References

[1] Liao, W., Zhang, L. & Wei, Z. (2020). Multi-objective green meal delivery routing problem based on a two-stage solution strategy. Journal of Cleaner Production 258, 120627. DOI: 10.1016/j.jclepro.2020.120627.

[2] Lou, Z., Jie, W. & Zhang, S. (2020). Multi-Objective Optimization for Order Assignment in Food Delivery Industry with Human Factor Considerations. Sustainability 12(19), 7955. DOI: 10.3390/su12197955.

[3] Li, C., Mirosa, M. & Bremer, P. (2020). Review of online food delivery platforms and their impacts on sustainability. Sustainability (Switzerland) 12(14), 1–17. DOI: 10.3390/su12145528.

[4] Zhang, Y., Sun, L., Hu, X. & Zhao, C. (2019). Order consolidation for the last-mile split delivery in online retailing. Transportation Research Part E: Logistics and Transportation Review 122(November 2018), 309–327. DOI: 10.1016/j.tre.2018.12.011.

[5] Justiani, S. & Wibowo, B.S. (2022). The Economic and Environmental Benefits of Collaborative Pick-Up in Urban Delivery Systems. LOGI – Scientific Journal on Transport and Logistics 13(1), 245–256. DOI: 10.2478/logi-2022-0022.

[6] Simoni, M.D. & Winkenbach, M. (2023). Crowdsourced on-demand food delivery: An order batching and assignment algorithm. Transportation Research Part C 149(January), 104055. DOI: 10.1016/j.trc.2023.104055.

[7] Schnieder, M., Hinde, C. & West, A. (2022). Emission Estimation of On-Demand Meal Delivery Services Using a Macroscopic Simulation. International Journal of Environmental Research and Public Health 19(18). DOI: 10.3390/ijerph191811667.

[8] Allen, J., Piecyk, M., Cherrett, T., Juhari, M.N., McLeod, F., Piotrowska, M., Bates, O., Bektas, T., Cheliotis, K., Friday, A. & Wise, S. (2021). Understanding the transport and CO2 impacts of on-demand meal deliveries: A London case study. Cities 108(February 2019), 102973. DOI: 10.1016/j.cities.2020.102973.

[9] Wang, Z. & He, S.Y. (2021). Impacts of food accessibility and built environment on on-demand food delivery usage. Transportation Research Part D: Transport and Environment, 100. DOI: 10.1016/j.trd.2021.103017.
[10] Aguilera, A., Dablanc, L. & Rallet, A. (2022). Digital Work and Urban Delivery: Profile, Activity and Mobility Practices of On-Demand Food Delivery Couriers in Paris (France). Information 13(9), 433. DOI: 10.3390/info13090433.
[11] Wang, Y., Wang, H. & Xu, H. (2021). Understanding the experience and meaning of app-based food delivery from a mobility perspective. International Journal of Hospitality Management 99. DOI: 10.1016/j.ijhm.2021.103070.
[12] Seghezzi, A. & Mangiaracina, R. (2021). On-demand food delivery: investigating the economic performances. International Journal of Retail and Distribution Management 49(4), 531–549. DOI: 10.1108/IJRDM-02-2020-0043.
[13] Seghezzi, A., Winkenbach, M. & Mangiaracina R. (2021). On-demand food delivery: a systematic literature review. The International Journal of Logistics Management 32(4), 1334–1355. DOI: 10.1108/IJLM-03-2020-0150.
[14] Hewitt, M., Nowak, M. & Gala, L. (2015). Consolidating home meal delivery with limited operational disruption. European Journal of Operational Research 243(1), 281–291. DOI: 10.1016/j.ejor.2014.10.045.
[15] Steever, Z., Karwan, M. & Murray, C. (2019). Dynamic courier routing for a food delivery service. Computers & Operations Research 107, 173–188. DOI: 10.1016/j.cor.2019.03.008.
[16] Liu, Y. (2019). An optimization-driven dynamic vehicle routing algorithm for on-demand meal delivery using drones. Computers & Operations Research 111, 1–20. DOI: 10.1016/j.cor.2019.05.024.
[17] Xue, G., Wang, Z. & Wang, G. (2021). Optimization of Rider Scheduling for a Food Delivery Service in O2O Business. Journal of Advanced Transportation, 2021. DOI: 10.1155/2021/5515909.
[18] Safira, M. & Chikaraishi, M. (2022). The impact of online food delivery service on eating-out behavior: a case of Multi-Service Transport Platforms (MSTPs) in Indonesia. Transportation 10, 1–5. DOI: 10.1007/s11116-022-10307-7.
[19] Stöckigt, G., Schiebener, J. & Brand, M. (2018). Providing sustainability information in shopping situations contributes to sustainable decision making: An empirical study with choice-based conjoint analyses. Journal of Retailing and Consumer Services 43, 188–199. DOI: 10.1016/j.jretconser.2018.03.018.
[20] Ignat, B. & Chankov, S. (2020). Do e-commerce customers change their preferred last-mile delivery based on its sustainability impact? The International Journal of Logistics Management 31(3), 521–548. DOI: 10.1108/IJLM-11-2019-0305.
[21] Buldeo Rai, H., Broekaert, C., Verlinde, S. & Macharis, C. (2021). Sharing is caring: How non-financial incentives drive sustainable e-commerce delivery. Transportation Research Part D: Transport and Environment 93. DOI: 10.1016/j.trd.2021.102794.
[22] Lopez, P.A., Wiessner, E., Behrisch, M., Bieker-Walz, L., Erdmann, J., Flotterod, Y.-P., Hilbrich, R., Lucken, L., Rummel, J. & Wagner, P. (2018). Microscopic Traffic Simulation using SUMO. 2018 21st International Conference on Intelligent Transportation Systems (ITSC), 2575–2582. DOI: 10.1109/ITSC.2018.8569938.