Last-mile delivery innovations – a systematic literature review

Background: The demand for last mile delivery is increasing as the urban population and e-commerce continues to grow [1]. These delivery vehicles add to traffic congestion [1], diminish available space in cities [2], and produce emissions [3]. The cost of last mile delivery is estimated to be 28% of the total transportation costs, making it the most expensive part of the entire supply chain [4]. To improve the sustainability and resilience while minimising the cost of deliveries, there is a growing need for alternative last mile delivery solutions [5]. Therefore, it is not surprising that huge amounts of research have been devoted to improving last mile delivery over the last decade.

Aim: The aim of the paper is to offer a point of reference for innovations in the last mile delivery research area. Both academic publications as well as grey literature are considered given that the focus is not on identifying the best quality publications nor evaluating the usefulness of innovations. The aim is to provide a repository of solutions for innovators, academics, and policymakers. Favourable benefits in one area does not necessarily mean that they will have the same effect in other urban environments, therefore the focus is not on providing an overall judgment of the innovation, but rather to illustrate their maturity level, as well as identify where they worked well and where they didn't.

Methodology: A systematic literature review will be conducted to identify innovations in last mile delivery to achieve net zero. Any type of study or grey literature will be included from theoretical proposals, simulations, small scale case studies or evaluations of real-world implementations.

Results: Various innovations in the last mile delivery area have been proposed, tested, or implemented. The use of parcel lockers is probably the most frequently suggested way to mitigate the externalities associated with last mile delivery [3]. They are often recommended as the ultimate solution for failed deliveries [6], to fix address finding issues [7], return deliveries [7], to consolidate deliveries [8], to reduce the number of drop-off points [8], to reduce the vehicle kilometre travelled [7], to lowering the delivery costs [9], to increase sustainability [10], as well as reduce emissions, noise and traffic congestions [11]. However, research has also shown that allowing people to drive their car to pick up parcels can completely reverse these benefits [3]. Also, the inhomogeneity of the parcel deliveries as well as seasonal demand changes makes achieving a high utilisation of parcel lockers a challenge. Modular lockers have been proposed as an option to adjust the lockers to the current demand [12]. Another innovation proposed are pedestrian porters and cycling couriers which are trialled as a case study in London, UK [13]. Autonomous delivery robots, especially sidewalk autonomous delivery robots (SADRs) are gaining popularity to meet the growing expectations of on-demand delivery [14]. However, they do come with their own unique set of challenges and pitfalls [14].

References

[1] X. Guo, Y. J. Lujan Jaramillo, J. Bloemhof-Ruwaard, and G. D. H. Claassen, "On integrating crowdsourced delivery in last-mile logistics: A simulation study to quantify its feasibility," *J Clean Prod*, vol. 241, no. 2019, p. 118365, 2019, doi: 10.1016/j.jclepro.2019.118365.

[2] H. Buldeo Rai, S. Verlinde, and C. Macharis, "Shipping outside the box. Environmental impact and stakeholder analysis of a crowd logistics platform in Belgium," *J Clean Prod*, vol. 202, pp. 806–816, 2018, doi: 10.1016/j.jclepro.2018.08.210.

[3] M. Schnieder, C. Hinde, and A. West, "Sensitivity analysis of emission models of parcel lockers vs. Home delivery based on hbefa," *Int J Environ Res Public Health*, vol. 18, no. 12, 2021, doi: 10.3390/ijerph18126325.

[4] S. M. Saad and R. Bahadori, "Sustainability evaluation of last mile food delivery: Pickup point using lockers versus home delivery," *International Food Operations and Processing Simulation Workshop, FoodOPS 2018*, pp. 37–42, 2018.

[5] S. Kapser and M. Abdelrahman, "Acceptance of autonomous delivery vehicles for last-mile delivery in Germany – Extending UTAUT2 with risk perceptions," *Transp Res Part C Emerg Technol*, vol. 111, pp. 210–225, 2020, doi: 10.1016/j.trc.2019.12.016.

[6] E. Morganti, S. Seidel, C. Blanquart, L. Dablanc, and B. Lenz, "The Impact of E-commerce on Final Deliveries: Alternative Parcel Delivery Services in France and Germany," *Transportation Research Procedia*, vol. 4, pp. 178–190, 2014, doi: 10.1016/j.trpro.2014.11.014.

[7] G. Zenezini, A. Lagorio, R. Pinto, A. De Marco, and R. Golini, "The Collection-And-Delivery Points Implementation Process from the Courier, Express and Parcel Operator's Perspective," *IFAC-PapersOnLine*, vol. 51, no. 11, pp. 594–599, 2018, doi: 10.1016/j.ifacol.2018.08.383.

[8] K. F. Yuen, X. Wang, L. T. W. Ng, and Y. D. Wong, "An investigation of customers' intention to use self-collection services for last-mile delivery," *Transp Policy (Oxf)*, vol. 66, pp. 1–8, 2018, doi: 10.1016/j.tranpol.2018.03.001.

[9] L. Jiang, H. Chang, S. Zhao, J. Dong, and W. Lu, "A Travelling Salesman Problem with Carbon Emission Reduction in the Last Mile Delivery," *IEEE Access*, vol. 7, pp. 61620–61627, 2019, doi: 10.1109/ACCESS.2019.2915634.

[10] M. Giuffrida, R. Mangiaracina, A. Perego, and A. Tumino, "Home delivery vs parcel lockers: An economic and environmental assessment," *Proceedings of the 21th Summer School Francesco Turco, Naples, Italy 13-15 Sep*, pp. 225–230, 2016.

[11] M. Moroz and Z. Polkowski, "The Last Mile Issue and Urban Logistics: Choosing Parcel Machines in the Context of the Ecological Attitudes of the Y Generation Consumers Purchasing Online," *Transportation Research Procedia*, vol. 16, pp. 378–393, 2016, doi: 10.1016/j.trpro.2016.11.036.

[12] M. Dell'Amico, W. Deloof, S. Hadjidimitriou, G. Vernet, and W. Schoenewolf, "CityLog - Sustainability and efficiency of city logistics: The M-BBX (Modular BentoBox System)," *2011 IEEE Forum on Integrated and Sustainable Transportation Systems, FISTS 2011*, pp. 132–135, 2011, doi: 10.1109/FISTS.2011.5973626.

[13] F. N. McLeod *et al.*, “Quantifying environmental and financial benefits of using porters and cycle couriers for last-mile parcel delivery,” *Transp Res D Transp Environ*, vol. 82, p. 102311, 2020, doi: 10.1016/j.trd.2020.102311.

[14] M. Schnieder, C. Hinde, and A. West, “Land Efficient Mobility: Evaluation of Autonomous Last Mile Delivery Concepts in London,” *Int J Environ Res Public Health*, vol. 19, 2022.