ABSTRACT

City logistics is one of the significant branches of supply chain management, dealing with the logistics and transportation activities in urban areas. The growth of urban population and the rise of e-commerce activities increase the complexity of the last-mile of parcel deliveries and its impacts to the environment and quality of life. As a result, city logistics, which focuses on the efficient and effective transportation of goods in urban areas while taking into account the negative effects on congestion, safety, and environment, is critical to ensuring continued quality of life in cities. There are key areas within cities that are largely affected by logistics activities, such as shopping areas and densely populated areas. These locations attract many freight vehicles attempting to fulfill deliveries, often with limited parking space. This results in long queues of delivery trucks waiting for parking spaces or illegal kerbside parking. Therefore, urban planners and decision-makers are motivated to initiate policies that can mitigate these impacts. Urban freight management policies like delivery time or truck size restrictions, and Urban Consolidation Centres (UCC) have been proposed as potential solutions.

The above-stated issues are the motivation behind this research work. First, this thesis focuses on the city logistics problem with respect to policy decisions regarding the use of light commercial vehicles through urban consolidation schemes in a way to minimise carbon emissions and, thus, total transportation costs. Different supporting policies such as purchase subsidies, zone entry fees, vehicle taxes, access regulation fees, and emission charges have been studied, while computational experiments have been executed on a real-life case study. Second, a two-tier city logistics system with urban consolidation centre (2E-CLS-UCC) is becoming an increasingly popular last-mile distribution strategy. It aims to improve the operational efficiency of the logistics industry, reduce carbon emissions, and also help to keep large vehicles out of densely populated city centres. The mathematical formulation for 2E-

CLS-UCC was developed considering three different vehicles: heavy commercial vehicles (HCV), light commercial vehicles (LCV), and electric vehicles (EV). Third, logistics collaboration has been studied to analyse the effects of resource sharing on the sustainability of logistics networks. A two-echelon location routing problem (2E-LRP) is developed to determine the distribution centres to be opened, customer and supplier allocation, and routes, while minimising the total cost and emissions caused by transport. Lastly, in big cities, it is common to find various inner-city regions with few parking places and narrow streets, which make it difficult for logistics companies to meet all customer demands. We consider heterogeneous vehicles (mini-truck and e-LCV) delivery services to customers from the UCC, and meet at joints for reloading of the EVs, and finally, all the vehicles return to the UCC after completing their delivery. A mathematical model has been developed to minimize the total cost and determine the number of sub-fleets (mini-truck and e-LCV).

The thesis adds value in the existing knowledge of city logistics through its various findings. Some key findings are (*i*) the purchase subsidy and zone entry fee play a significant role when promoting electric vehicles (EVs) in city logistics. (*ii*) economic and environmental benefits could be achieved by establishing urban consolidation centres (UCC) and deploying electric vehicles for the goods distribution. (iii) collaborative scenarios in urban freight transportation can lead to minimization of the total cost while reducing emissions as compared to non-collaborative scenarios. (iv)reorganising the city logistics network has potential to reduce pollution and improve operational efficiency. (v) The feeder vehicle routing problem (FVRP) model has the potential to improve the distribution of goods in densely populated urban areas with narrow streets.

Keywords: City logistics system, policy measure, electric vehicles(EV), heterogeneous vehicles, collaborative scenarios, urban consolidation centres(UCC), vehicle restriction, mixed-integer linear programming(MILP), vehicle routing problem.