Abstract

Due to the outbreak of COVID-19, customer behaviour around the world looks completely different today than it did even one year ago. For example, retail sales via e-commerce channels in both the United States and European Union recorded rapid growth (i.e., 15% and 30% respectively) in 2020, while the gross value of retail sales was in decline (OECD, 2020). The same trend could also be observed in Hong Kong. Total retail sales in Hong Kong recorded 11 consecutive months of decline in 2020 (Census and Statistics Department, HKSAR, 2020); by contrast, the value of individual customer purchases via e-commerce platforms doubled in 2020 (Hong Kong Television Network Limited, 2020b). The changes in customer behaviour and the burgeoning of e-commerce purchasing indicated shrinking sales at physical stores and the emergence of the 'next normal': B2C e-commerce business. Amidst these changes, the value chain of the retail industry may be reconfigured and Logistics Service Providers (LSPs) are urged to transform their routine operations (i.e., orders placed by wholesalers or retailers) into a sound e-fulfilment process (i.e., orders placed by individual customers via e-commerce) with effective strategies.

Recently, research studies on e-commerce industry have focused on improving operational effectiveness and efficiency, warehouse layout optimization, and last-mile delivery (Ranieri et al., 2018; Farooq et al., 2019). Considering the needs of next-day or even same-day deliveries as an e-fulfilment process, ensuring a fast and efficient retrieval of Stock Keeping Units (SKUs) from shelves, has become crucial for today's LSPs. To meet the trends of the 'next' e-fulfilment 'normal', LSPs need to be transformed with additional capabilities for handling discrete and fluctuating e-order demands. However, most LSPs in Hong Kong, especially small and medium (SME) -type LSPs, use rented warehouses to provide their services. They are unable to afford the large investments that would be entailed in adopting an automated storage and retrieval system and a sophisticated order picking system in rented warehouses; this limits their competencies and capabilities in handling e-orders. Therefore, research and development on effective e-fulfilment decision strategies regarding inventory replenishment and operational optimization is needed for enhancing and streamlining e-fulfilment operations.

This project aims to design and develop a Federated Learning-based e-fulfilment decision model for overcoming the new challenges presented to the logistics industry by today's B2C e-commerce business in the wake of the COVID-19 pandemic. This system integrates collaborative machine learning and operational decision modelling to facilitate the transformation from traditional warehouses to e-fulfilment centres. From the perspective of LSPs, the proposed model allows them to generate the optimal pick face replenishment strategy and fully utilize resources for handling the fluctuating demands of e-orders without needing to re-construct the whole premises and infrastructure. Considering the limited datasets obtained by SME-type LSPs, this project also contributes to establish an industry-wide solution for estimating quantity per SKU to be held in the pick face area. Through streamlined put-away and order picking in e-fulfilment operations, customer e-orders can be effectively fulfilled by the logistics warehouses, enhancing their online shopping experience. With the aid of the proposed decision model, the capabilities of the e-fulfilment process are enabled for LSPs, resulting in better competitiveness and service coverage when the 'next normal' emerges in the B2C e-commerce market.