Integration of location and inventory decisions: state of the art

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Companies face increasing costs because of unexpected circumstances such as the COVID-19 pandemic or the war between Ukraine and Russia. In addition, end customers' needs are changing regarding delivery. Most end-customers expect express delivery from companies such as delivery within 24 hours in e-commerce or healthcare. Consequently, the supply chain performance of companies is under pressure, and companies are continuously looking for efficiency improvements. These improvements can source from different supply chain functions such as inventory, distribution, routing, location, production, and procurement [4]. Over the past years, the focus has been on improvements (e.g., cost minimization) from the perspective of one supply chain function. Although, this may result in a sub-optimal improvement as cost minimization of one supply chain function often leads to higher costs in other supply chain functions. As a result, the integration of supply chain functions has been recognized as an opportunity to improve the supply chain performance of companies [4].

Two crucial supply chain functions affecting the service level companies can offer to end customers are location and inventory. The distance between the end customer and the location where a facility (e.g., distribution center) is established determines the service level to end customers. In addition, the inventory level of the established facility impacts the service level to end customers. Therefore, a trade-off exists between the desired service level and companies' costs.

Based on [1] and [3], much research has already been done regarding the location decision, which is known as the facility location problem (FLP). Nevertheless, the integration of the location and the inventory decision, corresponding to a location-inventory problem (LIP), has received less attention in the literature. In FLPs, the number and the locations of facilities and the allocation of end customers to those facilities are determined. In LIPs, the decisions to take simultaneously are the number and the locations of facilities, the allocation of end customers to those facilities, and the optimization of the inventory service level of each established facility. Integrated decision-making, including LIP, generates more complexity. Still, it may lead to improvements in the supply chain compared to isolated decision-making (i.e., when the location and/or the inventory decision are made in isolation).

The critical driver of integrating the location and the inventory decision is to achieve inventory pooling benefits. These benefits can be realized by consolidating multiple inventory locations into a single location or a few locations. As a result, improvements can be expressed as reduced inventory costs, decreased operational costs, and efficient transportation [2]. These improvements may increase the supply chain performance of companies to deliver the expected service to end customers while dealing with tight budgets.

This study's main contribution concerns reviewing existing literature on LIP over the past decade and identifying interesting research opportunities. The insights related to our review will be combined to investigate a LIP in a healthcare context. About 30% of hospital costs are associated with logistics activities which makes logistics costs the highest cost after personnel costs. Since hospitals are labor-intensive organizations, optimizing the hospital supply chain is a relevant aspect. By analyzing the LIP in the healthcare context, the hospital supply chain may improve while ensuring a high quality of care.

Our literature review shows that few studies about LIP have been observed. Moreover, the majority consider simplified assumptions when investigating LIP. To represent real-world situations, realistic features such as multi-product, multi-sourcing of facilities, multi-echelon, and stochastic lead time, should be included in future research studies [4,1]. Furthermore, the application of LIP in most studies is investigated based on artificial data. Using real data can be a future research direction for a realistic supply chain representation. A final finding is that the type of solution method most studies use (meta)heuristic due to the complicated integration.

A mathematical formulation including more realistic features will be proposed in the future for the general LIP. Next, this model will be extended with typical healthcare features such as service level constraints, perishability, and emergency deliveries so that it can be applied in a healthcare context.

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