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ISTANBUL SABAHATTIN ZAIM UNIVERSITY

GRADUATE EDUCATION INSTITUTE

DEPARTMANT OF BUSINESS ADMINISTRATION

MASTER OF BUSINESS ADMINISTRATION

THE RETAIL STORES AND THEIR CHANGING ROLE IN OMNICHANNEL RETAILING

MASTER THESIS

Mazdak HOOSHYAR AZAR

Istanbul

August-2022

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Supervisor

Asst. Prof. Dr. Canser BILIR

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THESIS APPROVAL

To the Institute of Graduate Education

This study has been approved in partial fulfillment of the requirement for MASTER THESIS in The Retail Stores and Their Changing Role in Omnichannel Retailing.

Chair Person of Jury

Asst. Prof. Dr. Canser BILIR

Member of Jury

Prof. Dr. Selim ZAIM

Member of Jury

Assoc. Prof. Abit BALIN

Approval

I approve that the signatures above belong to the academic members specified here.

Director,

Institute of Graduate Education

Prof. Dr. Metin TOPRAK

DECLARATION OF SCIENTIFIC ETHICS AND ORIGINALITY

This is to certify that this MA thesis dissertation titled "**The Retail Stores and their changing role in Omnichannel Retailing**" is my own work and I have acted according to scientific ethics and academic rules while producing it. I have collected and used all information and data according to scientific ethics and guidelines on thesis writing of Sabahattin Zaim University. I have fully referenced, in both the text and bibliography, all direct and indirect quotations and all sources I have used in this work.

Signature

Mazdak HOOSHYAR AZAR

Istanbul, August 2022

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Mazdak HOOSHYAR AZAR

Istanbul, August 2022

ABSTRACT

THE RETAIL STORES AND THEIR CHANGING ROLE IN OMNICHANNEL RETAILING

Mazdak HOOSHYAR AZAR
Master, Business Administration
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In recent years, with accelerating online shopping, Omnichannel retailing has become popular and will be the future of retailing because pure offline retailers have been adding online channels to their traditional channels. In the new retailing paradigm that provides a seamless shopping experience by fully integrating retail channels, stores have a pivotal role because of their location advantage based on their proximity to customers. The research at hand, considering financial factors, investigates the different functions of Brick-And-Mortar stores (BMS) in an Omnichannel retail network to find the most proper distribution network structure. For this purpose, we determine the main factors on store efficiency in an Omnichannel environment. Afterward, we develop a model to evaluate the stores' profits under different roles (physical retail store, dark store, and showroom), which enable us to find the most profitable retail network configuration with retail stores' changing roles. Moreover, we examined the impact of some crucial factors on an Omnichannel retail network, such as product sales price, cost of production, the operational cost for in-store sales, home delivery costs, and the ratio of customers who order online with pick-up in-store, and lead-time sensitivity of online customers. Our result revealed the severe effects of lead time sensitivity, operating cost, and home delivery cost on retail network profitability or/and layout. Furthermore, results demonstrated that networks with hybrid retail structures (wherein stores play roles according to their most profitable function) face a lower profit reduction than uniform retail networks. Considering that the distribution network efficiency depends on its structure design (Prabhuram *et al.*, 2020), the presented approach in this study helps Omnichannel retailers enhance their efficiency by optimizing the structure of their distribution networks by increasing the flexibility of possible roles that stores play.

Keywords: Supply Chain Management, Omnichannel Retailing, Network Design, Buy Online Pickup in Store (BOPS), Distribution Network Optimizing

ÖZET

Perakende Mağazaları ve Çok Kanallı Perakendecilikte değişen rolleri

Mazdak HOOSHYAR AZAR
Yüksek Lisans, İşletme
Tez Danışmanı: Dr. Öğr. Üyesi Canser BILIR
Ağustos, 2022 - 121 sayfa

Son yıllarda, çevrimiçi alışverişin hızlanmasıyla birlikte, çok kanallı perakendecilik popüler hale geldi ve perakendeciliğin geleceği olacak çünkü saf çevrimdışı perakendeciler geleneksel kanallarına çevrimiçi kanallar ekliyorlar. Perakende kanallarının tamamen entegre edilerek sorunsuz bir alışveriş deneyimi sağlayan yeni perakende paradigmasında mağazalar, müşterilere yakınlıklarından kaynaklanan konum avantajlarından dolayı kilit bir role sahiptir. Eldeki araştırma, finansal faktörleri göz önünde bulundurarak, en uygun dağıtım ağı yapısını bulmak için çok kanallı perakende ağındaki Tuğla ve Harç mağazalarının (BMS) farklı işlevlerini araştırıyor. Bu amaçla, Çok Kanallı Perakendecilikte ortamında mağaza verimliliğine etki eden faktörleri belirliyoruz. Daha sonra, mağazaların karlarını farklı roller altında (fiziksel perakende mağaza, karanlık mağaza ve showroom) değerlendirmek için bir model geliştiriyoruz ve bu da en karlı perakende ağ konfigürasyonunu bulmamızı sağlıyor. Ayrıca, ürün satış fiyatı, üretim maliyeti, mağaza içi satışların operasyonel maliyeti, eve teslimat maliyetleri ve çevrimiçi sipariş veren müşterilerin oranı gibi bazı önemli faktörlerin etkisini inceledik. mağazadan teslim alma ve çevrimiçi müşterilerin teslim süresi hassasiyeti. Sonucumuz, bahsedilen faktörlerin perakende ağı karlılığı ve/veya yerleşimi üzerindeki ciddi etkilerini ortaya koydu. Ayrıca sonuçlar, hibrit perakende yapılarına sahip ağların (mağazaların en karlı işlevlerine göre rol oynadığı) tek tip perakende ağlarından daha düşük bir kâr düşüşüyle karşı karşıya olduğunu göstermiştir. Dağıtım ağı verimliliğinin yapı tasarımına bağlı olduğu göz önüne alındığında (Prabhuram ve diğerleri, 2020), bu çalışma tarafından sunulan yaklaşım, çok kanallı perakendecilerin dağıtım ağlarının yapısını optimize ederek verimliliklerini artırmalarına yardımcı olur.

Anahtar Kelimeler: Tedarik Zinciri Yönetimi, Çok Kanallı Perakendecilik, Ağ Tasarımı, Mağazadan Çevrimiçi Alım (BOPS), Dağıtım Ağı Optimizasyonu

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BMS	Brick-and-Mortar Stores
DLT	Delivery Lead Time
OSDH	Order at Store Delivery to Home
BOPS	Buy Online Pickup at Store
CSL	Customer Service Level
PRS	Physical Retail Store
SFWSB	Ship-From-Warehouse-With-store-Backhaul
B2B	Business-to-Business
B2C	Business-to-Customer
MIP	Mixed Integer Program
STS	Ship-To-Store
DC	Distribution Center
COGS	Cost of Goods Sold

CHAPTER I

INTRODUCTION

In recent years, the internet fundamentally transformed the retailing environment, where online shopping has grown in general and after spreading the Coronavirus in particular. As an integral component of a distribution network for many retailers, stores have been affected drastically. Consequently, retailers have invested in e-commerce as an auxiliary approach to regain their lost revenues. Thus, they have been transforming into Omnichannel retailing and have added online channels to their traditional channel (Wollenburg *et al.*, 2018).

Nowadays, retailers with a widespread network of brick-and-mortar stores (BMS) have started to store role definition in the supply chain regarding a novel retailing environment. Therefore, they have leveraged their existing stores to fulfill online orders (Difrancesco, van Schilt and Winkenbach, 2021). Due to possessing BMS network competitive advantages compared to online retailers, Omnichannel retailers with established distribution centers and stores can have better performance. In more cases, brick-and-mortar retailers have a location advantage due to being closer to the customers than online retailers, which have a central warehouse or/and a limited number of distribution centers (He, He, and Xu, 2020). However, exploiting these facilities will not be affordable if the physical stores operate in their traditional form. To this end, retailers integrating their store and DC inventories will be available to have more benefits from utilizing a decentralized store network (Ishfaq *et al.*, 2016). The subject of the thesis is to study the various roles of physical stores in Omnichannel retailing.

It is a reality that in recent decades the internet has played a fundamental role in retailing, which has evolved retailing shape. In this new retailing era, Omnichannel retailing is a popular retailing strategy. The reality is that supply chain efficiency depends on the proper design of the distribution network (Prabhuram *et al.*, 2020).

Currently, due to the development of e-commerce, to cope with the detrimental effects of online competitors on the market share of traditional retailers, they must prepare a comprehensive plan. As is expected, the traditional retailers with a widespread network of physical stores and distributer centers have started to offer the online-services besides their in-store service. Basically, in the absence of an obvious definition of the new application for BMS, most if not all the traditional retailer's efforts to maintain their market share will be in vain. Therefore, to specify the specific role of physical stores in the emerging retailing type, it will be necessary to concentrate on finding new functions for the BMS of Omnichannel retail supply chains. Motivated by this, in parallel with enhancing the online sales portion in the supply chain, determining the new roles of stores is the purpose of this thesis study.

With the advent of online shopping, retailers have been gravitating to e-commerce, either an alternative channel for physical stores or a supplementary approach besides their existing traditional store network. In all likelihood, it can be necessary for a realignment of the physical distribution if integrating both channels-include on-store retailing and e-commerce- is considered the fundamental retailing strategy - called Omnichannel as a newly coined term. As we can see, in line with the retailers' efforts to develop a consistent Omnichannel physical distribution process, the physical stores have been playing an outstanding role in the delivery process (Ishfaq *et al.*, 2016). In this respect, finding an approach to evaluate the role of each store in order fulfillment and delivery will be beneficial for emerging Omnichannel retailers. Motivated by this, the thesis study aims to develop a model to evaluate the role of physical stores in Omnichannel retailing.

The study at hand seeks to answer the question, how can Omnichannel retailers improve the efficiency and profitability of their distribution networks by leveraging the retail stores? However, to find the answer to that, the following key questions need to be addressed in the first step:

> RQ1: What are the main factors for evaluating the retail stores according to their new role in Omnichannel retailing? In light of making a model, we will be able to answer the question related to the optimum use of each store in order accomplishment and delivery.
>
> RQ2: How the role of the store can change in terms of the results of their evaluation?
>
> RQ3: How does the optimality of the roles of various roles of stores change against the changes in different parameters?

In chapter 2, we review the theoretical background of this study, including the Supply chain management definition and a comprehensive explanation of the supply chain components. Furthermore, the chapter describes the general description of traditional (in-store) and online retailing. In particular, we discuss the implication of Omnichannel retailing. Moreover, this chapter contains a synopsis description of the role of physical stores in Omnichannel businesses.

In the third chapter, we presented the research methodology and mathematical model for evaluating stores to answer research questions. To this end, we determine the influential factors and the probable function of brick-and-mortar stores (BMS) in the novel retailing environment.

Chapter four is the stage of utilizing research results achieved in decisions making. So, we will investigate how we can assess the function of each store based on explored models. Then, we illustrate the proper way to design an Omnichannel retail network. Lastly, we present the conclusions of the research with further research supposition.

CHAPTER II

THEORETICAL BACKGROUND

In this chapter, we express the theoretical background and related literature. We investigate concepts such as supply chain management, network design, retail types, omnichannel retailing, and related literature.

2.1 Supply chain management

In any supply network, supply chain management is a crucial factor. Thus, it is necessary to have an accurate conception of supply chain management.

2.1.1 The objective of a Supply chain

The objective of a supply chain is maximizing supply chain surplus. The surplus of the supply chain (value) is the differences in the product's value for the final customer and the costs that the supply chain impose on meeting customers' need.

Supply chain surplus= customer value – supply chain cost

Supply chain profitability is the difference between the revenue and all costs, including costs of production, information conveying, distribution, inventory, transport, and found transferring expenditures.

Profitability is an index to indicate the success of a supply chain. For this reason, companies try to increase their profits. Either by enhancing customer value or reducing the costs of the supply chain. However, the customer is the only source of revenue for any supply chain. Thus, for any supply chain, appropriately managing the generated cost is known as a success key, where reducing the cost of the supply chain provides more profits for a company than its counterparts (Chopra and Meindl, 2013, p.3).

Generally, for manufacturing companies, supply chain elements include material, money, and end-to-end information flow. Considering these elements, they can properly design the supply chains that enable them to compete with their rivals (Tiedemann, 2020).

2.1.2 The importance of supply chain decision

Design and management of supply chain flow (production, information, and funds) are closely associated with the success of a supply chain. As can be seen, many successful companies built their success on planning and operation of their supply chain, including Walmart, Amazon, and Seven-Eleven, for instance.

Conversely, weaknesses in supply chain design are the cause of the failure of many online businesses in recent decades, with Webvan as an example. Specifically, in recent years, with a rapidly changing market environment affected due to technological evolutions, companies have had to revise their supply chain design based on new circumstances, where customers' needs are changing. Dell Computer may be one of the remarkable examples of this supply chain transformation by focusing on online sales instead of traditional distributors (Chopra and Meindl, 2013, p.4).

2.1.3 Decision phases in a supply chain

Supply chain management success needs many decisions about products, funds, and information, where each decision should raise the surplus of the supply chain. In practice, all decisions in each Supply chain management can be categorized into three main phases: designing, planning, and operation.

These phases have a fundamental role in the success and profitability of the supply chain. As two salient examples, Wal-Mart and Seven-Eleven Japan's success depends on their effective supply chain decisions in design, planning, and operation (Chopra and Meindl, 2013, p.161).

2.1.3.1 Supply chain design

In the supply chain designing phase, companies make decisions for the next several years that determine the chain's configuration, resources allocations, and process for each stage. In essence, during this phase, companies make strategic decisions about in-house, outsourcing, location and capacities, warehouse facilities, transportation, and the type of information system. In this regard, companies should ensure that supply chain configuration supports their strategic goals completely.

For instance, PepsiCo Inc. 2009 decided to purchase its two largest bottlers as a strategic decision. Expecteinglly, the supply chain design phase is a long-term decision (several years), while altering them is expensive. Therefore, firms should consider the uncertainty in market conditions for the next few years (Chopra and Meindl, 2013, p.6).

2.1.3.2 Supply chain planning

The time frame in the planning phase is shorter than the designing phase (a quarter to a year). For this reason, the configuration of a supply chain is constant according to the strategic decisions. The planning phase's goal is to maximize the surplus of the supply chain. In doing so, the planning phase starts with forecasting prices, costs, and demand for the coming year.

Moreover, in the planning phase, companies should make decisions such as manufacturing subcontracts, inventory policies, timing, marketing size, price promotions, and determining which locations will supply which markets.

Additionally, in the planning phase, items such as uncertainty in competition, demand, and exchange rates are crucial that retailers cannot overlook. Generally, the planning phase results show how companies can define operating policies to govern their short-term operations.

2.1.3.3 Supply chain operation

Supply chain operation has a weekly or daily time horizon. Individual customer orders form decisions in this phase. Firms define planning policies and supply chain configuration at the operational level. Additionally, the supply chain operation goals centered around customer order handling as best as possible.

During this phase, companies consider allocating inventory, providing pick lists, allocating a proper shipping mode, delivery timetables, and placing orders for replenishment. In the operations decision phase, demand information uncertainty is minimum (having a short-term time horizon). During the operational phase, the objective is to reduce chain uncertainty besides optimizing performance (Chopra and Meindl, 2013).

2.1.4 Components and Elements of Supply Chain Management

In an efficient supply chain, some components and elements have fundamental roles.

2.1.4.1. Demand Management

Utilizing pricing and other promotion approaches, companies can influence demand. However, companies often make a promotion decision without considering its impact on the whole supply chain, where a close collaboration on pricing and form of promotion is a must to earn maximizing the supply chain surplus.

In many cases, aggregate planning that considers both demand and supply can increase the profitability of the supply chain. On the one hand, demand can increase due to a growth in the market by enhancing consumption of products from existing or/and new customers. On the other hand, companies can increase their customers by a stealing share policy. They encourage customers to substitute their products for a competitor's product (Chopra and Meindl, 2013, p.737). On the other hand, demand uncertainty can negatively affect other aspects of supply chain management, including products, inventory management, and transportation planning (Seyedan and Mafakheri, 2020).

2.1.4.2. Inventory Management

The mismatch between supply and demand causes inventory in the supply chain. More specifically, the necessary inventory level to meet future demand. Furthermore, inventory management plays a fundamental role in the supply chain to enhance the amount of product demand where available products satisfy customers' needs upon they want to purchase. Because of economies of scale, inventory has a significant role in reducing costs.

Inventory management affects responsiveness, incurred costs, and assets held in the supply chain. However, in the apparel industry, a high inventory level improves the responsibility of the supply chain, but it can reduce the profit margins. Despite improving inventory efficiency, a low inventory level may compromise product availability with increasing lost sales. As a result, inventory control needs to pay attention to by managers. Hence, they should try to keep inventory in the lower levels while the inventory amount must be enough to make a balance between costs and responsiveness.

In practice, parameters location, form, and inventory level affect responsiveness improvement and cost reduction. Inventory management is controversial, where a large amount of inventory that is close to customers gives more responsiveness to the supply chain at the expense of higher costs. Conversely, centralizing inventory lowers the costs, while the responsiveness starkly decreases.

Overall, the inventory management goal is to optimize the location, form, and quantity of inventory in the best possible manner to have the right level of responsiveness besides minimizing costs (Chopra and Meindl, 2013, p.47).

Generally, inventory management has a fundamental role in the inventory management based on companies' dependency on inventory for a balance between supply and demand (Rehman Khan and Yu, 2019).

2.1.4.3. Transportation Management

In a supply chain, transportation moves products from one stage to another impacts efficiency and responsiveness. Possessing fast transportation system can increase responsiveness while efficiency reduces. The type of transportation plays a significant role in any supply chain to allocate inventory and locations.

To have the right balance between efficiency and responsiveness of companies, adjusting location and inventory by transportation is crucial. A rapid transportation system allows companies with high-value products to reduce their inventory and facility costs. On the contrary, low-value selling firms having high-demand items prefer to carry a high inventory level close to their customers while utilizing low-cost transportation for replenishment.

For designing a transportation network, collecting an effective transportation mode and locations must be taken into account. In addition, the firms need to decide about direct-to-customer or intermediate consolidation transportation points. Moreover, they must define whether the demand points are supplied in a single run or multiple supplies.

Choosing a proper transportation mode can have a crucial impact on the supply chain network by determining how products move from one location to another. Attention needs to pay that each type has different characteristics such as shipping size, shipping costs, flexibility, and speed (Chopra and Meindl, 2013, p.49).

a) Inbound transportation

Inbound transportation is shipping products inside the firm's network. Shipping products from warehouse to stores, for instance. Inbound transportation cost is considered the cost of goods sold (COGS). Ideally, inbound costs should be measured per product's unit. However, in practice, this is challenging. Furthermore, it's necessary to calculate the average transportation cost per shipping. Greater incoming shipment size helps to improve economies of scale in inbound transportation.

b) Outbound transportation

Outbound transportation costs include general, selling, and administrative expenditures. Thus, outbound transportation costs can affect the total profit of the company. Ideally, outbound costs should be measured per product's unit, but it is considered as a percentage of product sales because separating this metric by the customer will be more beneficial.

2.1.4.4 Information

Nowadays, information has a fundamental role in supply chains' success, which helps improve the appropriately utilizing of assets in the supply chain. In consequence, responsiveness increases while costs decreases. Seven-Eleven Japan, employing data improves product availability while decreasing inventories. This example shows the importance of the information in providing higher responsiveness besides efficiency improvement. In addition, it can able the supply chain better meet customers while simultaneously decreasing costs. In the supply chain, coordination of decisions and visibility of transactions can be improved by appropriate investment in technology. Generally, the goal is to achieve maximum coordination, whereas the minimum amount of data is shared. When all stage of a supply chain collaborates to maximize supply chain profitability,

supply chain coordination occurs. In this sense, lack of coordination due to inappropriate information sharing can compromise the total surplus of the supply chain. Concerning information sharing, sales and operation plans are a critical part of information because they can affect both demand and supply (Chopra and Meindl, 2013, p.51).

2.1.4.5 Pricing Policies

Pricing plays a significant role in the supply chain when companies decide how much to charge their customers for services or offered products. On the customer side, pricing can affect the expectation of customers. Moreover, pricing policy allows firms to match supply and demand without a flexible supply chain. Also, the Short-term discount can be a lever to eliminate the supply chain surplus or to control the seasonal demand rate.

Care must be taken to ensure that the company possesses the right pricing policy because it’s a significant factor with crucial effects on the type and level of demand that the supply chain may have. Pricing is a competitive factor that has a determinant role in a firm success over its competitors. For example, as a wholesaler in the United States, Costco has a steady low pricing policy, where customers expect low prices but do not care availability of products (Chopra and Meindl, 2013, p.56).

As can be expected, steady prices cause a stable amount of demand. In short, Costco aims for high efficiency at the expense of lower responsiveness. On the contrary, some firms change product prices based on the response time desired by their customers. This way, companies can target a broader range of customers than firms with a fixed pricing policy. For instance, Amazon offers a menu to its customers that can choose different prices according to the shipping option. In doing so, Amazon can serve both groups of customers that value either low cost or high responsiveness.

Commonly, most firms offer quantity discounts and display economies of scale. But it is not the case for everyday-low pricing such as Costco, where they keep steady prices regardless of customer shopping quantity. Because of having two pricing strategies, firms have to set different supply chains to serve several demand profiles.

Generally, companies can have two pricing strategies. They offer products/services with either a fixed price or a menu of prices. In cases where customer value or managerial supply chain costs significantly change, possessing a price menu is more effective (Chopra and Meindl, 2013, p.57).

2.1.4.6 Forecasting

Demand forecasting is the bases of designing and planning all supply chains. In the supply chain, all push processes operate based on customer demand forecasting, while all processes operate in response to customer demands. In both forms, the first step for the supply chain managers should be forecasting demand.

In a supply chain, if each stage has its demand forecasting, these forecasts will be different, wherein a mismatch can be seen between supply and demand. In contrast, with a collaborative forecast that is formed by all stages of the supply chain working together, the anticipation will be more accurate.

Possessing accurate forecasting supply chains will be able to be more efficient and responsive simultaneously. As a practical instance, collaborating with bottlers, Coca-Cola benefits the collaborative forecasting, which is remarkably accurate. Having accurate forecasting strongly depends on the type of product. Usually, for mature products with a stable demand (e.g., milk), the forecasting is simple than raw material or finished products' forecasting. As the two difficult to forecast industries, both fashion goods and high-tech products have an extremely complicated demand forecasting.

In all stages of designing and planning a supply chain, considering forecast error is necessary because always forecasts are inaccurate and should measure the forecast error. Another reality in demand forecasting is that aggregate forecasting methods are more accurate than disaggregate forecasts. In addition, a vast majority of long-term forecastings are not-accurate enough, while short-terms are rather accurate.

In general, having adequate knowledge about the influence factors in demand forecasting is essential for all companies, such as past demand, lead time, marketing efforts, price discount planning, and actions (Chopra and Meindl, 2013, p.108).

2.2 The role of network design in a Supply Chain

The goal of designing a supply chain network is to satisfy customer needs regarding responsiveness and demand while maximizing profit.

In essence, with changes in market conditions, firms should redesign their networks. In other terms, firms determine the amount of their flexibility to meet the customer demands at a minimum cost, for example, too much capacity allocation for a poor demand area. In contrast, too little capacity allocation when product demands are not satisfied or/and demand fulfillment is at a high cost. Therefore, to maintain low cost and responsiveness, both DC locations change, and proper changes in demand allocation are necessary for firms.

In addition to the above reasons, the firm competitive strategies have a crucial impact on decisions to design a supply chain network. It can be seen as a salient competitive strategy for convenience store chains that have been designed to provide easy access to customers, wherein convenience store networks with many stores cover an area.

Conversely, the competitive strategy for discount stores focuses on low prices while their supply chain networks consist of large stores. It is acceptable that the area covered by these large discount stores is approximately wider than convenience stores, Costco and Sam's Club, for instance. Proximity to local customers helps the convenience stores to have lover transportation costs. However, in the network design context, it should not be neglected, that technology significantly influences the firm strategy.

Consequently, having a depth perception of competitors' characteristics such as location, size, and strategy is vital for supply chain network design. Firms with customers who value a short response time need to pay attention to locating their stores to be close to customers. In essence, these customers are not willing to travel a long distance (to get to stores). Hence, the discounters target customers with less time sensitivity.

For example, W.W. Grainger’s network includes 400 stores in the United States with same-day delivery, While McMaster-Carr targets customers who prefer to wait for next-day delivery. In this respect, McMaster-Carr can provide a next-day delivery service to a large number of customers whit only utilizing five centers throughout the United States. (Chopra and Meindl, 2013, p.153).

2.2.1 Factors that affect network design decision

Companies must consider several parameters in designing a distribution network because they significantly impact network efficiency. According to c main factors highly influence network design are expressed as follows:

2.2.2 Strategic factors

A network design decision can be affected by firm competitive strategy. In essence, if the firm focuses on cost leadership, its preference is the lowest cost location for facilities. However, lower location costs may impose higher transportation costs due to more distance from their customers because they are far from their target market.

On the other hand, if the firm focuses on responsiveness, its preference is the closest location to the customers. If located closer to the customer make firms able to react quickly, they will select a high-cost location of facilities. For example, Zara has become one of the most successful international apparel brands (Chopra and Meindl, 2013, p.153).

2.2.3 Technological factors

Generally, new technology significantly affects network design decisions. In practice, utilizing higher technology can reduce the total cost. Lower fixed costs allowed companies to employ local facilities to decrease transportation costs (Chopra and Meindl, 2013, p.153).

2.2.4 Macroeconomic factors

Beyond internal factors, macroeconomic factors such as exchange rates, shipping costs, tariffs, and taxes have an overlookable impact on firms network design decisions. With increasing global trade, the role of macroeconomic factors on the success or failure of distribution networks has increased. So, firms take into account macroeconomic factors when designing their network.

For example, fluctuation in the exchange rate has a crucial impact on the total profit of any business in the world. To cope with the negative effect of the fluctuating exchange rate, utilize some overcapacity in the network. In practice, this extra capacity makes networks able to be more flexible, where the flexibility allows them to alter product flows to obtain maximum profit.

Considering the reality in mind that shipping cost strongly depends on fuel price, fuel cost is another crucial factor that can drastically affect the profitability of any supply network. However, flexibility can help the supply chain deal with fluctuating circumstances, but when it comes to fuel prices, it seems challenging to cope with it. In this regard, long-term contracts can protect the firms from the detrimental effects of fluctuating fuel prices (Chopra and Meindl, 2013, p.153).

2.2.5 Response time and local presence factors

When customers value a short response time, firms must locate close to their customers. In these cases, most customers will not go to convenience stores if it is required to travel a long distance to get there. In this sense, a proper layout for a convenience store chain should include many stores in an area to quickly respond to the customers' needs.

On the contrary, supermarkets' customers who seek a larger quantity of goods travel a longer distance. Generally, the number of supermarkets is fewer than convenience stores (Chopra and Meindl, 2013, p.153).

2.2.6 Facilities and logistics factors

Within a supply chain capacity allocation, the number of facilities and their location significantly impact the total profit of the supply chain. For designing a supply chain network, companies necessarily consider the reality of logistic costs, where logistic costs comprise inventory, facility, and transportation.

Widely observed in practice improve the response time, firms have to increase their facilities. More specifically, the additional facility costs are justifiable when increasing revenue occurs because of improving the response (Chopra and Meindl, 2013, p.153).

2.3 Retail types

Growing online shopping in recent two decades has had a shaping impact on retailing, particularly after coronavirus. So, scholars started to investigate Omnichannel retailing. Studies show that Omnichannel retailing will be the future of retailing because pure offline retailers have been adding online channels to their traditional channels (Wollenburg *et al.*, 2018). However, during the coronavirus pandemic, e-commerce witnessed an accelerating increase and then decreased (Fig 2.1), yet we can see a steady upward trend in e-commerce retail sales in general (Smartinsight.com, 2021).

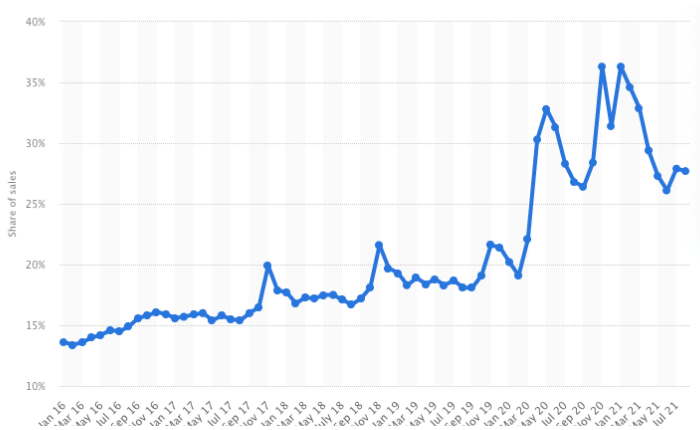

Fig 2.1: Share of e-commerce sales in the UK

(Smartinsight.com, 2021)

The different types of retailing that retailers can apply consist of:

2.3.1 Single channel retailing

In this retailing type, products are sold through only one channel.

2.3.1.1 Pure offline retailing

Pure offline retailers only serve in-store customers. Customers must travel to the stores for shopping, where they can touch or/and perches products (Fig 2.2).

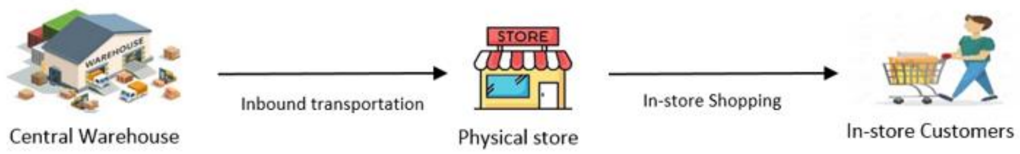

Fig 2.2: Pure offline retailing

2.3.1.2 Pure online retailing

Pure online retailers offer their products online, so the customers have no chance to touch products before the purchase (Fig 2.3).

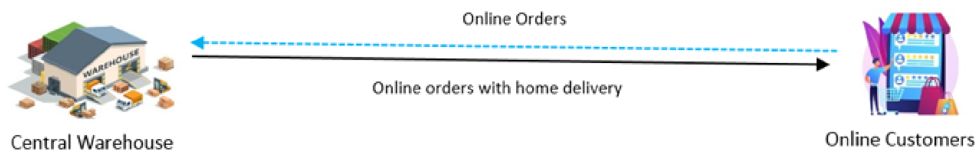

Fig 2.3: Pure online retailing

2.3.2 Multi-channel retailing

In the Multi-channel retailing type, retailers sell their products through two or more channels, where channels operate independently and separately. In reality, online orders are fulfilled from CDC (central warehouse) with home delivery, while stores only serve the in-store customers' demand (Fig 2.4).

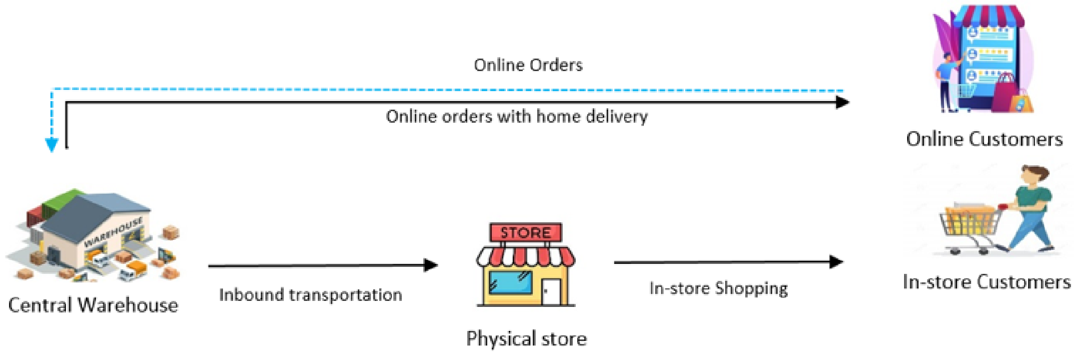

Fig 2.4: Multi-channel retailing

However, multi-channel retailers benefit from economies of scale for larger volumes of orders and reduce advertising costs due to synergy in advertising, where there is no inventory integration, correlated pricing policy, and coherent fulfillment decisions. For instance, Nordstrom serves online orders from its website from a central warehouse, which is separate from its retail network (Jasin, Sinha, and Uichanco, 2019).

Brick-and-Mortar stores (BMS) were an integral part of the traditional retailing form and had a fundamental role in the downstream supply chain. In the transition process to multi-channel retailing, firms seek opportunities to reduce costs and improve efficiency (Adivar, Hüseyinoğlu, and Christopher, 2019).

2.3.3 Cross-channel retailing

In the Multi-channel retailing type, retailers sell their products through two or more channels, where channels are integrated at the back end. Although there is somewhat collaboration between retail channels, customers perceive them separately yet. For example, when a customer places an online order, the retailer ship the order either from a dedicated inventory in the central warehouse or from the store's inventory. However, this circumstance can be a temporary stage for retailers, with utilizing the upper technological capabilities, they will benefit from a fully integrated system (Jasin, Sinha, and Uichanco, 2019).

2.3.4 Omnichannel retailing

However, this circumstance can be a temporary stage for retailers, with utilizing the upper technological capabilities, they will benefit from a fully integrated system (Jasin, Sinha and Uichanco, 2019).

2.4 Omnichannel retailing

In the Omnichannel retailing method, seamlessly follow of information, customer, and information all give customers a seamless shopping experience. For example, apparel customers may collect information online, visit the stores to size and touch the products, then purchase the product with home delivery, but exchange some items at a different store or return it at a kiosk. In practice, this seamless shopping experience can exist in the presence of a fully integrated inventory, fulfillment operations, and pricing (Jasin, Sinha and Uichanco, 2019).

In an Omnichannel retailing framework, an integrated fulfillment process satisfies the demands, which come from several channels with a seamless experience, including physical retail stores, mail, call centers, applications, and websites (Prabhuram *et al.*, 2020).

According to Hajdas, Radomska, and Silva (2022), internal and external factors collectively impact channel integration evolution (Fig 2.5). They show retailers can fully integrate channels by increasing the Omnichannel potential of the industry besides the firms abilities to overcome internal obstacles:

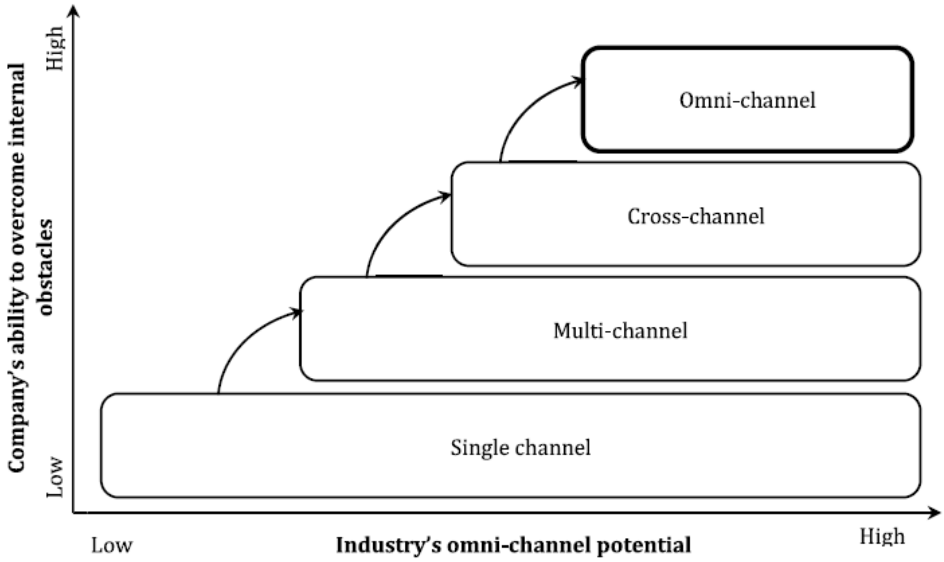

Fig 2.5: Channel integration options

(Hajdas, Radomska, and Silva 2022)

In new market circumstances, Omnichannel retailing can play a significant role in product supply because of its importance and remarkable advantages.

2.4.1 Importance of Omnichannel retailing

Customer expectations are escalating gradually in several aspects, such as cost, speed, and choice (UPS, 2017). Moreover, Cao and Li (2015) showed that retailers boost their sales growth by utilizing a channel integration strategy. In addition, by merging the inventory of online and offline channels, Omnichannel grocers can decrease stack out rate and back-ordering (Klibi, Babai, and Ducq, 2021).

2.4.2 Advantages of Omnichannel retailing

Omnichannel retailing has remarkable advantages compared to other types of retailing, including pure online, pure offline, and multi-channel retailing.

2.4.2.1 Switching between channels

During the customer shopping journey, they can switch between different channels (e.g., physical store, website, and application). Even customers can concurrently utilize several channels, where they are allowed to collect product information online inside a Brick-and-mortar store, for instance (Bijmolt *et al.*, 2021). Omnichannel customers have the chance to take advantage of both online and offline channels. (Brynjolfsson, Hu and Rahman, 2013). In other words, customers can choose the channels based on their priorities and situations.

2.4.2.2 Delivery lead time

Regarding delivery lead time, some trends include same-day or rush delivery services. However, care must be taken to the nature of lead-time, which depends on several variables such as the urban population of the region, local logistic facilities, and network architecture (Janjevic and Winkenbach, 2020). Surprisingly, 67% of customers who need their order by a deadline are willing to pay more for same-day delivery (mhlnews.com, 2016). But, it is not remote from reality that the delivery window might be longer in an urban area with less population. Conversely, in densely populated urban areas, delivery lead time can be shorter to a certain extent. Due to possessing an existing physical network, Omnichannel retailers have a location advantage, where they are closer to the customers comparing their pure online counterparts (He, He, and Xu, 2020).

2.4.2.3 Delivery cost

As a purely online retailer giant, Amazon Prime offers most items with a free 2-day shipping service (Stone, 2013). In recent years, several Omnichannel retailers have given free shipping within 1 or 2 hours. For instance, it ships its items in a 1-hours interval (Chen, 2018).

To cope with the challenges of a novel market environment, retailers must seek distribution models that obviate retailing multiple dimensions issues such as customer satisfaction, cost-effectiveness, and sustainability. Furthermore, they must pay attention to the elements of local market characteristics such as local demand features, customer priorities, and the environmental circumstances of the operation area (Janjevic and Winkenbach, 2020).

2.4.2.4 Inventory costs

To maximize efficiency, by merging in-store and online inventories, Omnichannel retailers can operate with lower inventory costs while fulfilling both online and offline orders from the individually allocated inventory have more expenses, including holding, managing, maintaining, and replenishment costs. Moreover, utilizing the same inventory level to fulfill both channels' orders will decrease the back-ordering rate overlay. That is to say, sharing inventories makes Omnichannel retailers offer their items with a higher level of CSL, where the inventory volume is remarkably lower than their previous mode or compared to their rivals which use separate inventories. Additionally, Omnichannel retailers can augment their revenue by utilizing a merged inventory level that allows them to have more sales with a lower inventory level (Klibi, Babai, and Ducq, 2021).

2.4.2.5 Increase in demand

The retailers will be able to satisfy customer demands widely by utilizing the Omnichannel distribution network compared to single-channel models (Modak, 2017). Omnichannel retailers, like online businesses, entice more customers by providing a wide product selection with lower prices, besides the possibility of rating and reviewing the products (Brynjolfsson, Hu, and Rahman, 2013).

2.4.2.6 Overstocks & shortages

Omnichannel retailers optimizing stocking decisions can control overstocks and shortages to manage uncertain demand in online and offline channels (Modak, 2017). If two sales channels use the same inventory level to satisfy their orders, they will have the lowest back-ordering. Using the shared inventory will able the retail stores to increase the CSL with a lower inventory holding volume (Klibi, Babai, and Ducq, 2021). Besides, by optimizing delivery lead time, Omnichannel retailers can reduce lost sale amounts and increase the delivery lead time (Modak, 2017).

2.5 Related Literature

Reviewing previous literature gives a deep insight into the effecting factors of Omnichannel retailing networks. And help us to determine different performances of a store in an Omnichannel retail environment. As is expected, most Omnichannel-related papers have been published by researchers from the USA and China, considering the prosperity of Omnichannel in the USA and China (Cai and Lo, 2020). Reviewing related literature reveals that we can assume three roles for each store in Omnichannel retail networks including BMS, dark store, and showroom. In recent years, the majority of retailers have developed Omnichannel strategies. For instance, 45% of Chinese companies have gravitated toward transforming operating as an Omnichannel (Song *et al.*, 2021).

2.5.1 Channels integration

In recent times, retailers have invested in e-commerce as an auxiliary approach to compensate for their lost market share. For this reason, they have been gravitating to Omnichannel retailing and have added online channels to their existing traditional channel (Wollenburg *et al.*, 2018). With the growth of online shopping in recent two decades, physical stores have been affected drastically. In line with this evolution, retailers have invested in e-commerce as an auxiliary approach to regain their lost revenues. In essence, they have been transforming into Omnichannel retailing and have added online channels to their traditional channel (Wollenburg *et al.*, 2018). But Coupey, Huré, and Piveteau (2016) found out shifting directly from multi-channel retailing to Omnichannel retailing will be difficult. As a result, they suggest, first organizations implement trial-and-error learning in channel design to have a successful Omnichannel retailing strategy.

In a new retailing era, Omnichannel retailing is a popular strategy, where the retail business models are transforming due to emerging technologies, digitalization, big data, and social media. However, multi-channel retailing provide products and services with both online and offline channels, but there is no synergy to increase total efficiency. That is why, in recent years, the Omnichannel retailing operation adopted and become super popular (Cai and Lo, 2020). In fact, with the penetration of e-commerce, many traditional retailers have added online channels to compete with their online counterparts. Concurrently, these have Omnichannel features that enable consideration channel switching behavior of customers. According to Gupta, Ting, and Tiwari (2019), for Omnichannel retailers that have already had a network of physical stores, improving their digital presence requires price optimization, inventory control, and solving online order fulfillment problems. In other words, Omnichannel retailers' objective is to obtain maximum profit by minimizing the lost sales. In reality and practice, to achieve their goals, retailers can either decrease no-purchase probability (by reducing delivery cost) or fulfill online orders at higher operational costs.

We can see in theory and practice that the Omnichannel approach is the best form of offering to the end customers, according to academics and professionals propose (even been reinforced by the recent universal pandemic). In this context, not only the Omnichannel method is proper for business-to-customer (B2C) relationships, but it can be beneficial for a business-to-business (B2B) relationship as well (Garcia, Martí, and Barriopedro, 2021)**.** As an emerging trend, Omnichannel retailing coordinates technology and processes. Saghiri *et al.* (2017) had interviews with experts in the grocery industry in the UK, where retailers such as Amazon, Tesco, and Ocado have been attempting Omnichannel. To this end, they introduced services including same-day delivery, locker box delivery, credit card services, click collect scheme, free in-store Wi-Fi, Internet of Things technology, iPhone apps, and loyalty cards. MIT Sloan (2022) illustrated that predictive analytics identify new indicators for the future behavior of customers, where these new indicators allow firms to create value for themselves and their customers alike.

Moreover, utilizing RFID, QR-cod, and NFC allows Omnichannel retailers to manage their inventory, particularly perishable food products. Because at any time, they can locate and identify food products. Additionally, it is possible to know how long products remain at a fixed location (Vanderroost *et al.*, 2017). Also, comparing the number of stores in a retailer's distribution network and retailer's sales, (Adivar, Hüseyinoğlu, and Christopher, 2019) shows that it would be a failure for the retailer if the sales decrease despite increasing the number of stores. According to their study, companies can successfully increase sales by transforming into Omnichannel retailing and reducing the number of stores (Macy's, JC Penney, and Belk, for instance).

Fikar and Braekers (2022) focused on food quality loos and highlighted that food products retailers (in the grocery distribution industry) can properly moderate last-mile delivery by integrating online and offline channels. Because orders picking up accrue by utilizing store-based delivery from stores. Moreover, they will be able to decide the pick-up location in terms of current inventory levels in stores. To enhance efficiency, e-grocery retailers should trade-off travel distances to minimize food quality losses. Hence, by optimizing delivery operations, they can reduce food waste. Furthermore, utilizing shared inventory allows e-grocers to benefit from managing perishable food products, where to decrease food waste, products with shorter shelf lives are shipped first (Fikar, 2018).

Studies show that channel integration can be beneficial for firms. For instance, Tagashira and Minami (2019) demonstrate that retailers can enhance cost efficiency by integrating their channels. Widely observed, the companies with a higher level of in-store service have more difficulty integrating their retail channels. Similarly, online retailers will have more challenges integrating online and offline channels. Also, according to (Li *et al.*, 2021), unlike pure online retailers, offline retailers can provide services to demonstrate, display, and fit the product. This way, they help customers to understand the products' suitability. Also, customers can compare and assess the products' Non-digital attributes through in-store demonstration service. In many cases, to collect information about products, customers use offline stores and switch to online stores to purchase, probably at lower prices.

On the other hand, integrating channels for retailers can be challenging for limitations such as assortment, operations space, and inventory, whereas brick-and-mortars engage in online order fulfillment (Hense and Hübner, 2021). Furthermore, they showed that if costs are equal across channels, substitution in-channel will be more profitable for the retailer than cross-channel substitution. In addition, Siawsolit and Gaukler (2019) demonstrated that advanced demand information is a valuable parameter for maintaining freshness, total profit, inventory level, outdating, and service performance. They illustrated that advance orders help reduce outdating occurrences, keep the freshness of products at the time of purchase, increase fill rate and availability levels, and augment long-run profit.

Furthermore, the authors (Mkansi and Nsakanda, 2021) demonstrate that this prominent advantage is a barrier for new entrances to this market, regarding being very difficult to switch.

2.5.2 Effective factors

Reviewing previous studies illustrate that with accelerating competition in the retail market, firms should pay more attention to factors that significantly impact on decisions of customers. The profitability of a retail supply chain is one of the main factors that indicate its success (Walters, 2006).

The results of Magalhães (2021) display that these factors include the delivery-service price, fill rate of orders, lead time, quality of products shipped, and spoiled/damaged products rate (e.g., perishable, fresh, and frozen food products require control of the temperature). Hence, failure to satisfy each of them strongly compromises their market share.

For Omnichannel retailers, all lead time, price, and stocking are assumed as decision variables because increasing each can severely diminish the brand acceptance and faithfulness of customers. Furthermore, delivery lead time can drastically affect the selling price and the firm's profit.

The results of a study by (Ishfaq *et al.*, 2016) imply that the order fulfillment method type used by an Omnichannel retailer depends on factors such as distribution network size, the online sales background of companies, level of online sales, and the number of salespersons of the store. With the mere existence of an online channel besides the physical store network, it seems necessary to possess a scheme of channel synergy. Generally, the retail networks include facilities that can operate as collection points, such as depots, distribution centers, parcel stations, kiosks, and stores.

Regarding the impact of collection points on customers' choice, figuring out the maximum distance customers are willing to arrive at them will be crucial. To achieve these objectives in the network design problem, Lorente, Gabor, and Ponce-Cueto, (2020) have proposed a mixed-integer program (MIP).

In practice, retailers face several internal and external obstacles. Internal obstacles comprise operational and strategic barriers, while external obstacles include product-related, customer-related, and competitive drivers (Thaichon, Phau, and Weaven, 2022).

Thanks to a flexible delivery option, online channels can give a discount to customers, a consequence of reducing the cost of distribution (Alım and Beullens, 2020). Moreover, they demonstrate that transportation and emissions reduction due to a great potential of flexible delivery. Also, (Wu and Wu, 2015) show when firms choose the actual delivery time because of price discounts, they can create a capacity buffer or the urgent demand.

We can see that delivery lead time and price have a pivotal role in parches decisions of customers. In this regard, Momen and Torabi (2021) showed that higher sales prices and shorter delivery lead time (DLT) would be achievable by utilizing a proper distribution method, where price and delivery time fundamentally impact customer preference for channel choosing. Their findings also reveal that Omnichannel retailers reduce the price in general. Although, offering OSDH (Order at Store Delivery to Home) service increases selling prices influenced by delivery cost. On the other hand, their analysis demonstrates that BOPS and OSDH services offered by Omnichannel retailers can augment their selling price. However, OSDH and BOPS both have contrary contributions to increasing benefits, considering the shipping fee and customer convenience. According to Momen and Torabi (2021), an Omnichannel strategy adoption enhances total profit besides improving customer experience.

A study by Guerrero-Lorente, Gabor, and Ponce-Cueto (2020) demonstrates the importance of factors that influence customer preferences, considering that the impact of these factors is not the same in different areas. According to their investigation, home delivery is a proper approach in high distribution time and low demand areas, wherein having facilities at a suitable distance from customers will be too costly.

Moreover, Jin, Li, and Cheng (2018) show that in recent years, adopting buy online pick-up at store (BOPS) service has been vastly expanded by retailers. They figure out that the ratio of unit inventory cost to customer arrival rate who prefer BOPS is the fundamental factor in determining the BOPS service size. In this regard, they have provided a practical guideline to specify the affordability of each type of product.

In practice, customer purchase behavior is drastically affected by increasing the lead-time that induces retailers to charge higher prices, which can compromise retailer profit (Guo *et al.*, 2020). Another study by Pereira and Frazzon (2021) illustrated that fulfillment lead time, backorders, and operational cost are key performance indicators for these days' changing competitive retail market, where mitigating them is necessary.

A study by Akturk, Ketzenberg, and Heim (2018) reveals that customers (for high-value products) switch to physical stores when retailers implement a ship-to-store (STS) policy. But on the contrary, for low-value purchases, customers remained with the STS services. In essence, employing a ship-to-store service may have different and antithetical effects on sales and returns of retailers in terms of various channels. Also, Liu *et al.*, (2020) showed that factors such as service perception degree, price competition degree, and service cooperation degree significantly influence choosing a channel to interact with customers by retailers and manufacturers.

However, in some stores, the financial factors are inferior compared to the non-financial functions of physical stores. It could be the case in flagship stores due to non-financial factors, such as brand experience, equity, brand attachment, loyalty, and high competition (Nierobisch *et al.*, 2017).

Generally, Mou, Robb, and DeHoratius (2018) Generally, Mou, Robb, and DeHoratius (2018) suggest that Omnichannel retailers pay more attention to several below contexts:

(1) To optimize their performance, retailers can evolve some stores into miniature distribution centers to fulfill online orders with home delivery or/and click-and-collect services.

(2) Omnichannel retailers should adopt new technologies to facilitate store operation.

(3) Retailers should pay attention to the management of retail stores' workforce because of overlooking the role of store associates in their success.

Additionally, improving measurement systems helps to meter the success of strategic policies, and more accurate measures lead to better alignment between performance and strategic objectives (MIT Sloan, 2022).

2.5.3 BMS

Taking into account the fact that the retailers with a widespread network of BMS have started to redefine the role of physical stores in the supply chain regarding a novel retailing environment, and they have leveraged their existing stores to fulfillment of online orders (Difrancesco, van Schilt and Winkenbach, 2021).

A comprehensive study by Mkansi and Nsakanda (2021) investigated on United Kingdom grocery market to determine whether leveraging the existing network can be a sustainable competitive advantage. They highlighted that food products' perishable nature has different handling requirements than non-perishable products. To address this issue, leveraging physical stores network, Omnichannel grocery retailers can offer both perishable and non-perishable to their geographically dispersed customers having a high level of faster and on-time delivery expectations.

According to previous studies, fresh food Omnichannel retailing has been popular in recent years, where Omnichannel operation can increase customers' surplus besides improving the total profit of retailers (Song *et al.*, 2021). Omnichannel food retailers operate in three cases: online shopping with home delivery, online shopping pick-up in-store, and in-store shopping. In addition, they demonstrated that utilizing pick-up locations will be more beneficial when the in-store loss rate is high.

We found out that BMS was an integral part of the traditional form of retailing and had a fundamental role in the downstream supply chain. Further, in the transition to Omnichannel retailing, Brick-and-Mortar stores (BMS) can be critical success components by developing education and awareness of the customer. Retailers are seeking opportunities to reduce costs and improve efficiency in the transition to multichannel. In this respect, Omnichannel retailers can operate by sustainable consumption and production with fewer physical stores, less distribution, and less inventory than traditional retailers. Indeed, the four main dimensions that have a fundamental role in Omnichannel retail supply chain success include efficiency, responsiveness, sustainability, and flexibility (Adivar, Hüseyinoğlu, and Christopher, 2019).

Although the retailers have gravitated into e-commerce in recent years, the physical stores will play a key role in preparing a unique sense of customer shopping experience. As a result of this trend, Omnichannel will be the new normal in the coming years. In this respect, retailers will concentrate on point-of-contact instead of channels. Further, thanks to smartphones, Omnichannel retailers can provide a seamless customer experience that the physical stores can have an outstanding role.

The mere existence of a traditional physical store network for Omnichannel retailers is not enough for a substantial upheaval. But they must revise their networks to create an in-store personalized shopping experience. To this end, retailers must equip their stores with digital technology. Additionally, in the absence of an effective and comprehensive information system, most in-store customers are currently anonymous (von Briel, 2018).

As a significant factor, He, He, and Xu (2020) demonstrated that the BMS retailers possess a location advantage due to being closer to the customers than online retailers with a central warehouse or/and a limited number of distribution centers. However, exploiting these facilities will not be affordable if the physical stores operate in their traditional form. That is to say, the proximity between collection points (physical stores) and end consumer locations make it possible to access them by either public transportation or walking (Halldórsson and Wehner, 2020). Particularly for customers who prefer saving money or/and time because of having authority in managing the last part of the last mile (Halldórsson and Wehner, 2020).

To this end, because of integrating stores and DC inventories, Omnichannel retailers can earn more profit from utilizing their vast network of stores (Ishfaq *et al.*, 2016). In the progress time retailers try to develop a consistent Omnichannel physical distribution process, the physical stores have had more portion in accomplishing orders and home delivery (Ishfaq *et al.*, 2016).

According to the (Wollenburg *et al.*, 2018) finding, existing logistics structures to fulfill their online orders operate as leverage by traditional retailers. Based on the results of this study, the grocery retailers depend on customers, products, market, and their different systems for warehousing, picking, and delivery. For Omnichannel retailer firms, in-store return service as an option is required to set logistic variables. Thus, under this reality, returns management is considered a strategic area (Marchet *et al.*, 2018). Besides the importance of the sales and delivery process for Omnichannel retailers, return policies and return management strategies have a decisive role in Omnichannel network configuration.

To provide a seamless customer experience, utilizing integrated return channels is one of the most significant factors. Studies show that the rate of products returned for pure online channels is more than in traditional stores. Giving this chance to the customer with online buying and return in-store not only will be satisfactory for hybrid channels' customers but also on the company side, it can enhance response for return of channels, particularly for geographic locations with a mature Omnichannel retailing (Bernon, Cullen, and Gorst, 2016).

Generally, Retailers with a widespread network of BMS' have started to redefine the role of BMS in the supply chain regarding a novel retailing environment. In doing so, they have leveraged their existing stores to fulfill online orders (Difrancesco, van Schilt, and Winkenbach, 2021).

According to the results of (Mkansi and Nsakanda, 2021), especially in grocery retailing, utilizing existing stores network as home delivery centers of online orders, able retailers to achieve tangible and intangible sustainable competitive advantages over their competitors. For instance, because the position of stores is closer to customers, it can help retailers alleviate the price of delivery charges besides reducing delivery-window time (faster) or/and having on-time delivery. Therefore, the stores have a strategic role as necessary cost reduction assets for Omnichannel retailers. Concerning intangible benefits, shortening the distance for delivery due to proximity to residential areas allows Omnichannel to offer a quick delivery service compared to their pure-online rivals, which develops the brand identity.

With increasing the role of physical stores in Omnichannel retailing, retailers can obtain more benefits by utilizing any spare capacity of the inbound vehicle, which replenishes store inventories. In fact, by transferring online orders at a lower cost, the fulfillment cost of online orders decreases (Paul, Agatz, and Savelsbergh, 2019).

In sectors with delivery charge limitations, existing BMS is as leverage for online orders the fulfillment as a sustainable competitive advantage, specifically for e-grocery retailers in a large geographically dispersed population with faster and on-time expectations (Mkansi and Nsakanda, 2021).

Some pure-online businesses, such as Amazon and Alibaba, recently to increase their physical footprint, have opened physical stores (Wolf, 2018).

All orders are fulfilled from physical stores to reduce inventory shortages. For example (Klibi, Babai, and Ducq, 2021) highlighted that using shared inventory will create the highest inventory efficiency for fixed inventory holding volumes. If two sales channels use the same inventory level to satisfy their orders, they will have the lowest back-ordering. The authors demonstrated that using the shared inventory will able the retail stores to increase the CSL with a lower inventory holding volume. Moreover, their findings revealed that joint demand is beneficial to forecast.

2.5.4 Dark store

Compared to hypermarkets, due to the lower cost of opening, dark stores can be established in large numbers and generally are in the urban area located near motorway junctions (Seidel, 2021). The study shows that a local dark store as a pickup point with a lead time of up to two hours can make a quick response possible compared to a central warehouse. By utilizing ship-from-warehouse-with-store-backhaul (SFWSB), stores can return goods that are going to expired or out of fashion to support online sales. Because there is no in-store customer in this scenario, the dark stores' stock is a portion of the total inventory to support backorders in any other part of the network (Millstein, Bilir, and Campbell, 2021).

Reviewing previous studies indicate that beyond the conventional function of the product offering place, utilizing as a pickup point, the BMS or dark store can be the missing link to help retailers in last-mile logistic fulfillment to save energy (Halldórsson and Wehner, 2020).

2.5.5 Showroom

Not long ago, the unique place in allowing customers to touch and feel the goods were BMS. On the other hand, online businesses entice more customers by providing a wide product selection with lower prices, besides the possibilities for rating and reviewing the products. But in recent years, having a seamless Omnichannel retailing experience, it seems impossible to distinguish between physical and online channels, where wallless showrooms go to be emerging (Brynjolfsson, Hu and Rahman, 2013).

In line with a combination of extended store networks and online-channel stores, they will maintain their existing functions besides operating as a pickup location or showroom. For this purpose, retailers should redesign their networks, transportation modes, the form of inventory, the location of stores, and information systems. The firms with a hybrid network should use the appropriate channel in terms of their customers' needs and the characteristics of products to develop their Omnichannel capabilities (Chopra, 2018).

A study focused on employing new technologies in the retailing industry that provide network facilities such as Wi-Fi in-store (showroom) can help the customers (Verhoef, Kannan and Inman, 2015). Also, according to (Statista, 2016), over 68% of internet users in the United States have utilized showrooming.

Further studies focus on the importance of showrooms. For instance, Mandal, Basu, and Saha (2021) demonstrate that the online demand will increase due to having the store/showroom as a competitive advantage over other pure online rivals, where customers have the opportunity to touch and feel the goods in the store/showroom before purchasing. In the Showrooms, the customers who do not know about online ordering can complete their online/onboard orders with the guidance of sales associates (Xu, Shao and He, 2021).

In many cases, customers buy from one channel while searching and collecting the information for the product in another (Verhoef, Neslin and Vroomen, 2007). Furthermore, analyzing the online customer behavior by (Johnson and Ramirez, 2020) indicates that showrooming can increase online shopping reducing the online shopping risk. On the other hand, showrooming avoids customer regret for purchases (Arora and Sahney, 2018).

According to (Herrero-Crespo *et al.*, 2021), the physical stores need to equip new technologies and required infrastructure so that the customers access the product information such as size, price, quality of merchandise, and available colors. As an example, tables and screens can be helpful in stores. Not only to help the customers but also to enhance the firm's advantages. Moreover, they demonstrated that with the help of smartphones, the customers inform themselves online before going to the store and even when visiting the showroom (which makes them Webroomers).

Overall, mobile technology enables online shoppers to utilize mobile devices within the showrooms (Yurova *et al.*, 2017). In this sense, mobile technology makes online shopping possible through the mobile device within the showroom store (which is called "mobile showrooming") (Grewal *et al.*, 2018).

CHAPTER III

RESEARCH METHODOLOGY

This research investigates optimizing distribution networks in an Omnichannel retailing environment while focusing on the different roles of retail stores. To this end, By merging the models of Guo *et al.* (2020) and Xu, Shao, and He (2021), we develop a method to explore the most profitable function for retail stores constituting a distribution network. Subsequently, the Omnichannel retailer will achieve optimum total profit by redesigning the network. Eventually, we investigate the effect of changes in each factor on the total profitability and layout of the retail network (Fig 3.1).

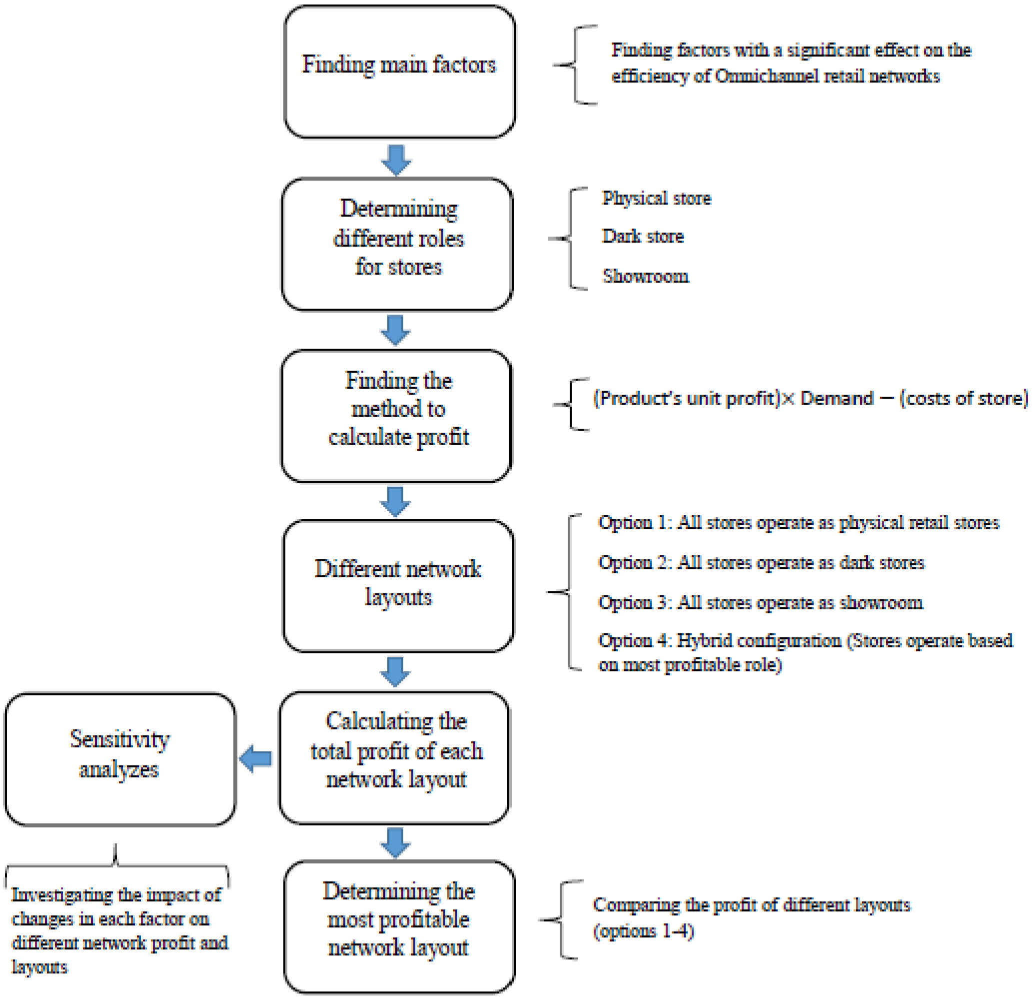

Fig 3.1: The overall structure of the

In practice, perfectly implementing the Omnichannel approach may be challenging, but utilizing a theoretical framework helps channel integration by recognizing how internal and external factors collectively impact channel integration evolution (Hajdas, Radomska, and Silva, 2022).

3.1 Determining the influential factors

In the first stage, by reviewing related articles, we determine the factors that strongly impact the Omnichannel retail network. In other terms, we aim to specify the factors that have remarkable effects on both customer decisions and the firm efficiency, where neglecting each may significantly compromise the total profit of the supply network (Magalhães, 2021).

3.1.1 Product sales price

Sales price plays a salient role in customer decision-making processes. In this regard, retailers changing the sales price can influence the no-purchase item rate (Gupta, Ting and Tiwari, 2019). Furthermore, firms often offer their products at different prices for online and offline sales (Guo *et al.*, 2020).

3.1.1.1 Unit in-store sales price

When customers face a big difference between online and online selling prices, they may examine the product at the BMS and then purchase the item from an online channel (due to the lower price). In many cases, this gap between channel prices leads customers to showrooming behavior that drastically diminishes the physical store revenue (Jing, 2018).

3.1.1.2 Unit online sales price

The online channel sales price is a significant factor that can drastically impact customer purchase behavior, besides its undeniable role in firms channel configuration strategy (Guo *et al.*, 2020).

3.1.2 Delivery cost

Omnichannel retailers can escalate online demands by reducing posted costs, even at relatively higher prices. That is to say that they can affect the online orders level by changing in delivery price that the customers pay (Gupta, Ting and Tiwari, 2019).

3.1.3 Lead time (Lead time-sensitivity of online customers)

Delivery lead time (DLT) is one of the main factors with severe effects on the profitability of any retail network (Momen and Torabi, 2021). Furthermore, Lead time has a remarkable efficiency indicator for Omnichannel retail networks, where reducing delivery time is necessary to elevate their efficiency (Pereira and Frazzon, 2021). Nevertheless, the lead-time sensitivity is different from region to region and product to product.

Changing the lead-time sensitivity of the customer in the areas in which stores operate will drastically affect the Omnichannel retail network structure (Pereira and Frazzon, 2021). As is expected, the delivery window might be longer in an urban area with less population. In contrast, in densely populated urban areas, delivery lead time can be shorter to a certain extent (He, He, and Xu, 2020).

3.1.4 Population in stores' zone

Having more people in the area of stores means that the store will have more customers. As a result, stores can obtain higher profit due to more sales, where a big part of costs are constant.

3.1.5 Additional profit from in-stores customers

Due to the existing physical store network, traditional retailers can augment their offline sales by bringing customers to the BMS who choose the BOPS option. Studies show that 45% of BOPS customers have additional in-store purchases besides online orders (UPS, 2015).

3.1.6 Pick-up at store

The ratio of customers who prefer BOPS service plays a significant role in changing the profit of Omnichannel retailers. For instance, the giant retailer in the United States, Wal-Mart, offers a buy-online-pick-up-in-store (BOPS) service and encourages picking up their orders at stores. Sometimes, retailers apply ship-from-store and ship-to-store strategies to cope with product shortages in their supply network. In this regard, customers can check the items online before purchasing to avoid order stock-out (Xu, Shao and He, 2021).

3.1.7 Customer attributes

Besides the retail network features, the cognition of customer characteristics are crucial to designing an optimal distribution network in an Omnichannel retailing environment.

3.1.7.1 Customer service level sensitivity

In the new retailing paradigm, service levels are growing due to high competition, where customers become sensitive about services more than ever. In practice, customers of Omnichannel retailers have been more sensitive to the service level they receive. For instance, when an Omnichannel retailer offers a BOPS service, online shoppers who have to pay travel costs to reach the store may be sensitive about the distance between their location and physical stores (Jin, Li and Cheng, 2018).

3.1.7.2 Customer acceptance level of the online channel

In the regions where customers' acceptance of online channels is high, employing a dual-channel strategy is more profitable for a centralized supply chain. Conversely, in decentralized cases, the customers' acceptance of the online channel factor will benefit firms if they have a relatively high service cost. As a result, the customers' acceptance level of online channels can be a significant factor that directly and indirectly affects the total profit of a retail network (Guo *et al.*, 2020).

3.1.7.3 The proportion of customers prefer purchase online channel

The percentage of customers who prefer to order online is an influencing parameter that strongly affects the profit of an Omnichannel retailer. That's to say, the profitability of different Omnichannel networks depends on the proportion of customers who prefer to purchase from online channels than traditional in-store customers (Millstein, Bilir and Campbell, 2021).

3.1.7.4 Pre-sales service level

In practice, pre-sales service is one of the crucial factors that impact the purchase decisions of customers, where manufacturers face the new circumstance that customers are more than ever sensitive to pre-sales service. However, pre-sales service level sensitivity always does not positively affect the profit of the dual-channel retailers, yet it can positively affect the retail price (Guo *et al.*, 2020).

3.1.8 Inventory costs

Inventory management is a challenging context for firms when they try to decrease inventory costs by maintaining the productivity of the distribution network. To respond to this challenge, managers implementing proper replenishment policies enable them to reduce the inventory levels while the fill rate is constant (Duong, Wood and Wang, 2020). In practice, inventory cost is a crucial factor that impacts the purchasing quantity when the retailer implements a BOPS service (Jin, Li and Cheng, 2018).

3.1.9 Store operations costs

In practice, for each store, equipping the stores is one of the main factors which constitute the total cost. Beyond the equipping costs, operational cost is a significant part of store cost, while operation cost can be different from store to store.

3.2 Assumptions and notations

To find the most proper function for each store, we define possible scenarios which a brick-and-mortar store can adopt. Moreover, we describe our Constraints and presupposes.

3.2.1 Different roles of the retail stores

The retail networks and needs in the future have had a remarkable impact on the growth of Omnichannel retailing in recent years. Therefore, being strategic about designing their supply network is a must for retailers that include their inventory form, transportation modes, location, and the role of information. In traditional retailing, retailers only stock products in each physical store and pay only for inbound transportation aggregative while customers manage the last-mile delivery. In essence, not only a well-structured Omnichannel supply network is cost-effective, but it can be more responsive to customer needs than its counterparts. In cases where inventory cost is relatively high, stores can operate as showrooms to give information about the products before purchasing. However, the showrooms as information channels can act with lower inventory levels, operations costs, and transportation expenses. Additionally, when the transportation costs are probably high, the stores can be considered pickup locations for online orders due to having a location advantage when closer to the customers while reducing outbound transportation costs (Chopra, 2018).

Generally, regarding related literature, in an Omnichannel retail network, retail stores can have different functions according to the internal and external situations categorized into three scenarios (Fig 3.2).

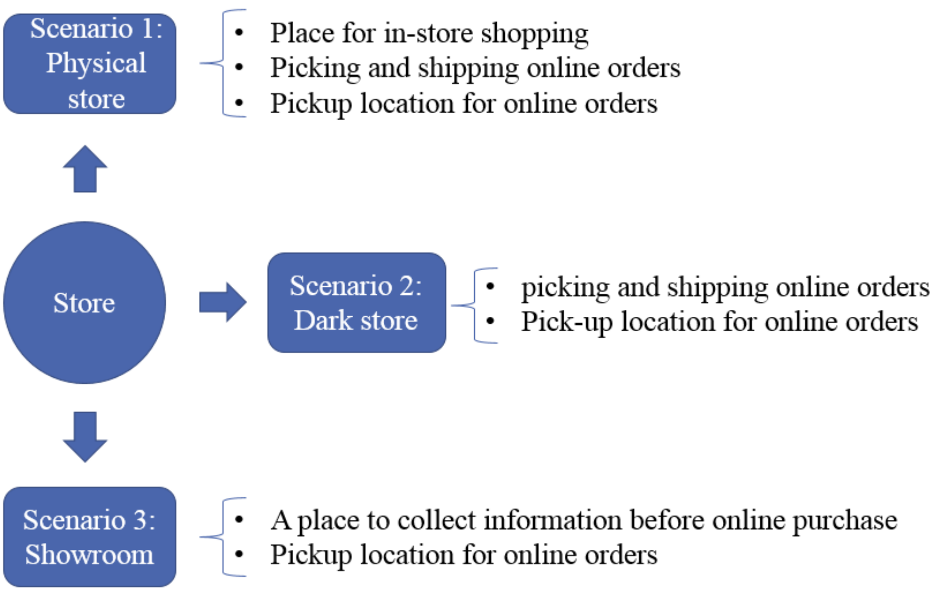

Fig 3.2: Possible scenarios for retail store

3.2.1.1 Scenario1 (Integration of Online and in-stores inventories, shipping from stores, and pickup point)

In this scenario, the physical store operates as a place for in-store shopping, a center for shipping online orders, and a pickup location for online orders. In other words, the physical store network operates to fulfill the customers' Online/Offline orders and interact with them (Fig 3.3).

Leveraging the existing physical store network enables Omnichannel retailers to achieve competitive advantages over their pure-online competitors by offering on-time, faster, and cheaper delivery for online orders. In reality, Omnichannel retailers possessing a network including retail stores can augment their service level (e.g., quick delivery service) while decreasing the delivery, inventory, and operational costs. On the other side, offering the same scale services to customers from pure online retailers will be possible at the expense of higher sales prices (Mkansi and Nsakanda, 2021).

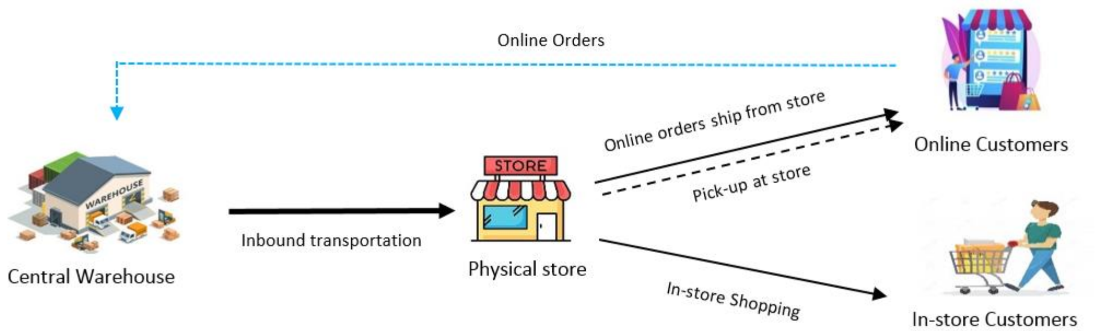

Fig 3.3: Store role in scenario1 (Physical retail store)

For customers who prefer purchasing in-store or buy-online-pickup-in-store (BOPS) service, proximity between their location and physical store is a remarkable advantage, particularly when they can reach the stores by walking or public transportation. This way, not only do customers save money due to the elimination of home delivery costs, but they can also manage the last part of the last mile (Halldórsson and Wehner, 2020).

If two sales channels use the same inventory level to satisfy their orders, they will have the lowest back-ordering. Using the shared inventory will able the retail stores to increase the CSL with a lower inventory holding volume. To obtain the highest inventory efficiency, stores play a pivotal role in Omnichannel retailing. Because utilizing an integrated inventory for online and in-store orders allows them to reduce inventory shortages while holding a fixed inventory volume for both channels (Klibi, Babai, and Ducq, 2021).

3.2.1.2 Scenario2 (Dark store)

In this scenario, the store only fulfills online orders while operating as a center for shipping to home and a pickup location for online orders, where the products are only accessible to pickers (Fig 3.4). In an Omnichannel retailing environment, local dark stores operate as pickup points with a lead time of up to two hours can make a quick response possible compared to a central warehouse while their operation and inventory costs are drastically low (Seidel, 2021).

Fig 3.4 Store role in scenario 2 (Dark store)

Currently, in the United Kingdom, 30% of all retail sales are fulfilled through online channels, where online shopping diminishes the need for customers to go to physical stores. So, in recent decades, Brick-and-Mortar stores (BMS) have lost their popularity for both customers and retailers. On the customer side, they prefer to change their shopping behavior to more convenient and time-saving approaches. On the retailer side, dark stores reduce the need for cashiers, in-store inventory, customer service, lighting, shopping space, and sales associates compared to BMS. Because, despite the physical retail stores that are public spaces for purchasing and social gatherings, dark stores are not open to the public (Fig 3.5) and are only allowed for merchandise pickers (X5 RETAIL GROUP, 2019). As a result, gravitating into dark store retailing, traditional Brick-and-Mortar retailers can reduce costs while avoiding narrowing their profit margin. Over time, the popularity of BMS retail stores is diminishing (Bitterman and Hess, 2021).

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Fig 3.5: In the dark store, pickers select merchandise,

Source: X5 Retail Group (2019)

Enhancing online shopping causes the extension of local warehouses for collecting, sorting, picking, packing, and sending the products purchased online. Nowadays, dark stores are more common in developed countries such as the United States and European countries, which possess high mobile technologies and electronic commerce (Nobre and Vita, 2021).

Concentrating on speed and convenience (instead of discounting), retailers (e.g., Zepto) have created a niche of customers. However, it could be possible by possessing a well-established network of dark stores (Mukhopadhyay, 2022).

3.2.1.3 Scenario3 (Showroom)

In this scenario, customers can collect product information in-store (showroom) before making an online purchase, while there is no inventory for in-store sales (Fig 3.6). Moreover, the physical store operates as a center for shipping to home and a pickup location for online orders. In many cases, customers buy from one channel while searching and collecting the information for the product in another (Verhoef, Neslin and Vroomen, 2007). Moreover, showrooming avoids customers' regret for purchases (Arora and Sahney, 2018), and it can also increase online shopping and reduce the online shopping risk (Johnson and Ramirez, 2020).

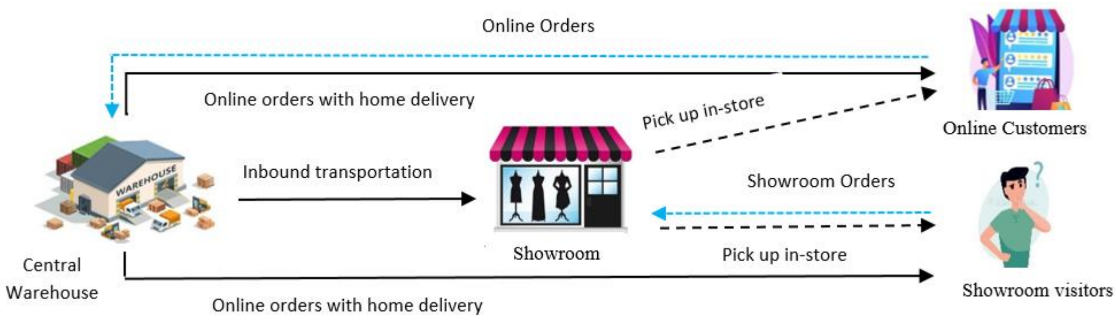

Fig 3.6 Store role in scenario 3 (showroom)

The traditional physical stores should equip new technologies and required infrastructure so that customers will access the products' information such as size, price, quality of merchandise, and available colors. In doing so, in stores, tables and screens help customers and enhance the firm’s advantages. Moreover, smartphones help customers collect product information online, before going to the store, and even when visiting the showroom (Herrero-Crespo *et al.*, 2021). By using smartphones inside the store, customers spend more time inside the store to have a more depth search (Grewal *et al.*, 2018). In this sense, mobile technology allows customers to purchase online by mobile device within the showrooms (Yurova *et al.*, 2017).

3.2.2 Constraints and presupposes

In this study, we focus on single product retailers. Moreover, in all scenarios, the parcels are delivered from stores. And inbound/outbound shipping costs are paid by the retailer. However, scenario1 and scenario2 have less lead time due to having the inventory to fulfill the online demands.

In this method, stores with a negative profit will be closed.

$$X_{ps}, X_{ds}, X_s \geq 0 \tag{1}$$

Additionally, there is no backorder and future orders. Having enough products to sell, there is no stock-out during the sales process.

$$(Q_r\ , Q_d\ , Q_T) \geq 0 \tag{2}$$

In all scenarios and regions, the in-store sales price is more than the online sales price.

$$P_p \geq\ P_o \quad \rightarrow \quad P_d = \frac{P_o}{P_{ps}} \leq 1 \tag{3}$$

According to Guo *et al.* (2020), $1 - \lambda\text{s}$ must be less than 1 and more than $P_d +\ \varphi\text{t} + 1 -\ \theta$.

$$(P_d + \varphi t + 1 - \theta) \leq (1 - \lambda s) < 1 \quad (4)$$

In this study, we assumed that the inventory cost of the physical store is 3% of revenue, where stores fulfill both online and in-store demands.

$$\mathrm{CC_{ps}}=0.03 \times D_{ps} \times P_p \quad (5)$$

Furthermore, we assumed that the inventory cost of the physical store is 2% of revenue, whereas dark stores satisfied only online demands.

$$\mathrm{CC_{ds}}=0.02 \times D_{ds} \times P_p \quad (6)$$

Characteristics of customers in all regions are considered the same such as lead time, lead time sensitivity, and the portion of online customers. Note that lead time for a showroom is assumed longer than for stores, which have inventory to fulfill online orders.

3.2.3 Notations of modeling

$\boldsymbol{P_p}$: Unit selling price
$\boldsymbol{P_o}$: Unit online selling price ($P_p \geq P_o$)
$\boldsymbol{P_d}$: Unit selling price ratio for online orders $P_d = \frac{P_o}{P_{ps}}$ Pd ϵ [0, 1]
ϕ: Unit Additional profit of in-stores customers
$\boldsymbol{C_{hd}}$: Unit home delivery cost
$\boldsymbol{C_{ps}}$: Unit Pick-up in-stores service costs
$\boldsymbol{C_p}$: Ratio of unit production cost
$\boldsymbol{C_r}$: Unit retail operational cost for in-store sales (inbound transportation cost, holding cost, replenishment, etc.)
$\boldsymbol{C_{er}}$: Equipment cost of in store sales (sales associate, decoration)
$\boldsymbol{C_{eo}}$: Equipment and operation cost to fulfill online orders
$\boldsymbol{C_{es}}$: Equipment cost to operate as a showroom
B: Proportion of customers who order online with pick-up in-store (willing to utilize BOPS)
θ: Customer acceptance level of the online channel
φ: Lead time sensitivity of online customers $\varphi > 0$
λ : Service level sensitivity parameter **λ** ϵ [0, 1]
$\boldsymbol{\rho}$: The number of people living in the zone of store
t : Lead time ratio t ϵ [0, 1]
S: Pre-sales service level of the retailer
$\boldsymbol{W_{ps}}$: The fixed costs of the store in scenario1 (rent, maintenance, bills, etc.)
$\boldsymbol{W_{ds}}$: The fixed costs of the store in scenario2 (rent, maintenance, bills, etc.)
$\boldsymbol{W_s}$: The fixed costs of the store in scenario3 (rent, maintenance, bills, etc.)
Variables:
$\boldsymbol{Q_r}$: Effective demand of in-store customers
$\boldsymbol{Q_d}$: Effective demand of online customers
$\boldsymbol{Q_T}$: Total quantity of demand in the zone of store
$\boldsymbol{D}ps$**:** Total demand in scenario1 (regional demand)
$\boldsymbol{D}ds$**:** Total demand in scenario2 (regional demand)
$\boldsymbol{D}s$**:** Total demand in scenario3 (regional demand)
$\boldsymbol{CC_{ps}}$: Inventory carrying cost in scenario1
$\boldsymbol{CC_{ds}}$: Inventory carrying cost in scenario2
a: Proportion of customers who order online
$\boldsymbol{X}_{ps}$: Profit of the store in scenario1
$\boldsymbol{X}_{ds}$: Profit of the store in scenario2
$\boldsymbol{X}_s$: Profit of the store in scenario3
Objective function:
Z: Total Profit of retailer (sum of most profitable scenarios)

3.3 Modeling

In this section, we introduce the model that aims to find the optimized condition in an Omnichannel retail network. Our model has been developed following (Guo *et al.*, 2020) and (Xu, Shao and He, 2021) to find the optimum configuration of the retail network to maximize the overall profit.

3.3.1 Profitability of scenario1 (physical retail store)

To calculate the profit for each store that operates as a BMS, we should determine the local demand in the first step. Afterward, we calculate the product unit profit. Then, we should compute all costs of the store. Eventually, we will calculate profit for a BMS, considering the circumstance of the region in which the store operates.

3.3.1.1 Demand in scenario1 (physical retail store)

We determine the expected demand in two sections in-store sales and online orders (shipping from the store and pick-up at the store).

In this regard, the following (Guo *et al.*, 2020) Q_r and Q_d denote the effective demand in the traditional channel and online channels, respectively:

$$Q_r = \frac{1-\theta-P_r + \lambda s+ P_d + \varphi t}{1-\theta} \tag{7}$$

$$Q_d = \frac{\theta P_r - \lambda\theta s - P_d - \varphi t}{\theta(1-\theta)} \tag{8}$$

$$Q_T = Q_r + Q_d \tag{9}$$

Therefore, the total quantity of demand in the zone of the store:

$$D_{ps} = \rho \times Q_T \tag{10}$$

3.3.1.2 Profit of scenario1 (physical retail store)

According to (Xu, Shao and He, 2021), with some modification, the total benefit of the retail store in the scenario1:

$$X_{ps} = \underbrace{[1-(1-B)\,aC_{hd} - BaC_{ps} + Ba\phi + (1-P_d)\,a-(1-a)Cr - C_p]}_{\text{Unit profit of the product}}\ P_p\ D_{ps} - \underbrace{[W_{ps} + CC_{ps} + C_{er} + C_{eo}}_{\text{Costs of the store}} \quad (11)$$

3.3.2 Profitability of scenario2 (dark store)

To calculate the profit for each store that operates as a dark store, we should determine the local demand in the first step. Afterward, we calculate the product unit profit. Then, we should compute all costs of the store. Eventually, we will calculate profit for a considering the circumstance of the region in which the store operates. In this scenario, there are no in-stores sales and related expenditures.

3.3.2.1 Demand in scenario2 (dark store)

In this scenario, following (Guo *et al.*, 2020), Q_r and Q_d denote the effective demand of in-store customers and online channels, respectively. (Q_T= 0+Q_d)

The total demand for a dark store is equal to online demand (Q_T=Q_d) for both online shopping with home delivery and online shopping with pick-up at store service.

$$Q_T = Q_d = 1 - \frac{P_d + \varphi t}{\theta} \quad (12)$$

Therefore, the total quantity of demand in the zone of store:

$$D_{ds} = \rho \times Q_T \quad (13)$$

3.3.2.2 Profit of scenario2 (dark store)

Following (Xu, Shao and He, 2021), their model for calculating the benefit of stores, with some modification, is used to assess the benefit of the dark store as:

$$X_{ds} = \underbrace{[P_d - (1-B)C_{hd} - B\,C_{ps} - C_p]}_{\text{Unit profit of the product}}\,P_p D_{ds} - \underbrace{[W_{ds} + CC_{ds} + C_{eo}]}_{\text{Costs of the store}} \tag{14}$$

3.3.3 Profitability of scenario3 (showroom)

To calculate the profit for each store that operates as a showroom, we should determine the local demand in the first step. Afterward, we calculate the product unit profit. Then, we should compute all costs of the store. Eventually, we will calculate the showroom's profit will considering the circumstance of the region in which the store operates. In this scenario, there are no in-stores sales and inventory to fulfill the online orders (Yurova *et al.*, 2017).

3.3.3.1 Demand in scenario3 (showroom)

In this scenario, with some modification of (Guo *et al.*, 2020) model, the total effective demand for a showroom is assumed to be the same as online customers' demand adding the parameters. We can consider the service level sensitivity and pre-sales service level in calculating effective online customer demand:

$$Q_T = Q_d = 1 - \frac{P_d + \varphi t - \lambda s}{\theta} \tag{15}$$

Therefore, the total quantity of demand in the zone of the store:

$$D_s = \rho \times Q_T \tag{16}$$

3.3.3.2 Profit of scenario3 (showroom)

Following (Xu, Shao, and He, 2021), their model for calculating the benefit of stores, with some modification, is used to assess the benefit of the showroom as:

$$X_s = \underbrace{[P_d - (1-B)C_{hd} - B\,C_{ps} + B\phi - C_p]}_{\text{Unit profit of the product}} P_p D_s - \underbrace{[W_s + C_{es}]}_{\text{Costs of the store}} \tag{17}$$

3.3.4 Total profit of the retail network

When a distribution network includes (n) number of stores, the total Profit of Optimized Hybrid Method (Z):

$$\mathbf{Z} = \sum_{i=1}^{n} Max[X_{ps}, X_{ds}, X_s] \tag{18}$$

CHAPTER IV

NUMERICAL ILLUSTRATION AND RESULTING

In this chapter, we use the model to find the most profitable retail network layout and investigate the impact of changes in factors on total profitability and network layout.

We implement the model to find the optimal network configuration for a retailer. To this aim, we considered a retailer with a distribution network, including 10 in ten cities in Turkey (n=10). The stores can operate only in one scenario (of the three scenarios): physical stores, dark stores, and showrooms.

Fig 4.1: Location of stores

4.1 Required data

At this stage, we assume all conditions and parameters are constant. We try to find the most beneficial layout for the retail network according to the existing circumstances as follows:

- The firm is considered a single product company that sells the product for \$15 ($P_p = 15$).
- The unit product cost assumed 50% of the product's offline selling price ($C_p = 0.5$).

- The unit selling price ratio for online orders is 80% of the product's offline selling price ($P_o = 0.8$).
- The unit retail operational cost for in-store sales, including inbound transportation, holding, and replenishment, assumed 10% of the product's offline selling price ($C_r = 0.1$).
- Unit additional profit of in-stores customers is 10% of the product's offline selling price (ϕ=0.1).
- Unit home delivery cost for retailer assumed 10% of the product's offline selling price ($C_{hd} = 0.1$).
- Unit Pick-up in-store service costs for retailers assumed 5% of the product's offline selling price ($C_{ps} = 0.05$).
- Equipment annual cost of in-store sales such as sales associates, cashiers, customer service, lighting, and decoration assumed $2000 for all stores ($C_{er} = 2000$).
- Equipment and operation annual costs to fulfill online orders assumed $1300 for each store ($C_{eo} = 1300$).
- Equipment annual cost to operate as a showroom assumed $500 for each store ($C_{eo} = 500$).
- The proportion of customers who order online with pickup in-store (willing to utilize BOPS) assumed 20% of all online customers (B=0.2).
- Following (Guo *et al.*, 2020), the customer acceptance level of the online channel assumed a fixed number ($\theta = 0.8412$).
- The lead-time sensitivity of online customers assumed a fixed number in all regions in all regions ($\varphi = 0.1$).
- Following (Guo *et al.*, 2020), the customer service level sensitivity assumed a fixed number in all regions ($\lambda = 0.16$).
- The number of people living in the zone of each store (ρ) is given in the table below:

N	City	Population
1	Afyonkarahisar	146136
2	Tekirdağ	122287
3	Osmaniye	202837
4	Adıyaman	223744
5	Isparta	172341
6	Erzurum	420691
7	Balıkesir	238151
8	Tarsus	256482
9	Manavgat	99254
10	Ataşehir	361615

Table 4.1: Population of the zone of each store

- The lead time ratio assumed 0.3 for both physical retail stores and dark stores (t=0.3) and 0.45 for showrooms (t=0.45) in all regions in all regions.
- Following (Guo *et al.*, 2020), the range of pre-sales service level of the retailer assumed 0.075 for both physical retail stores and showrooms (S=0.075) and 0.045 for dark stores (S=0.045), in all regions.
- The fixed costs of the store according to scenario1 (W_{ps}) that operates as a physical retail store. The stores' fixed expenditures, including rent, maintenance, and bills, are given in table 4.2.

N	City	PR-store
1	Afyonkarahisar	2100
2	Tekirdağ	2200
3	Osmaniye	2400
4	Adıyaman	1900
5	Isparta	2100
6	Erzurum	2900
7	Balıkesir	2200
8	Tarsus	2300
9	Manavgat	1700
10	Ataşehir	2500

Table 4.2: Fixed costs of the store in to scenario1 (W_{ps})

- The fixed costs of the store according to scenario2 (W_{ds}) that operates as a dark store. The stores' fixed expenditures, including rent, maintenance, and bills, are given in table 4.3.

N	City	dark store
1	Afyonkarahisar	525
2	Tekirdağ	550
3	Osmaniye	600
4	Adıyaman	475
5	Isparta	525
6	Erzurum	725
7	Balıkesir	550
8	Tarsus	575
9	Manavgat	425
10	Ataşehir	625

Table 4.3: Fixed costs of the store in to scenario2 (W_{ds})

- The fixed costs of the store according to scenario3 (W_s) that operates as a showroom. The stores' fixed expenditures, including rent, maintenance, and bills, are given in table 4.4.

N	City	showroom
1	Afyonkarahisar	700
2	Tekirdağ	733
3	Osmaniye	800
4	Adıyaman	633
5	Isparta	700
6	Erzurum	967
7	Balıkesir	733
8	Tarsus	767
9	Manavgat	567
10	Ataşehir	833

Table 4.4: Fixed costs of the store in to scenario3 (W_s)

- Inventory carrying cost in scenario1 (CC_{ps}), which operates as a physical retail store. Inventory cost of physical retail store assumed 3% of revenue according to scenario1 in each region ($CC_{ps}=0.03 \times D_{ps} \times P_p$)

- Inventory carrying cost in scenario2 (CC_{ds}) that operates as a dark store. Inventory cost of dark store assumed 2% of revenue according to scenario2 in each region. There are no in-store sales in the dark store where inventory only fulfills the online orders ($CC_{ds}= 0.02\times D_{ds} \times P_p$).

- In scenario 3, where the store operates as a showroom, there is no inventory cost because of having no in-store and online sales.

$P_p = \$15$	S=0.075 (retail store and showroom)
$C_p = 0.5$	S=0.045 (dark store)
$P_o = 0.8$	B= 0.2
$C_r = 0.1$	t=0.45 (showrooms)
$C_{hd} = 0.1$	t=0.3 (dark stores)
$C_{ps} = 0.05$	$\varphi = 0.1$
C_{eo} =\$500	$\lambda = 0.16$
$C_{er} = \$2000$	$\theta = 0.8412$
$C_{eo} = \$1300$	$\Phi = 0.1$

4.2 Discussion

By applying our model, we describe how we can find the most desirable layout for retail networks to meet offline and online customer demands.

4.2.1 Network design options

In an Omnichannel retail environment, retail networks can operate in different formats. Considering the role of stores in the network, we can categorize the retail network types into two main groups, uniform, and hybrid networks. In the uniform format, stores have the same role, while the hybrid retail network may consist of stores in different applications. As a result, firms can choose the retail network layout regarding their strategic goals considering financial and non-financial factors. This research assumes that firms design their networks to maximize the total profit. In sum, we considered four options that the retailer can choose:

1) All stores operate as retail stores (BMS)

2) All stores operate as dark stores

3) All stores operate as showrooms

4) Stores operate in a hybrid layout based on their most profitable function

4.2.1.1 Option1 (All stores operate as physical retail stores)

According to this network design, all stores operate as BMS. In many cases, firms prefer to continue their existing retailing method by equipping their traditional retail stores to meet online customer orders. In this option, the retail network consists of only physical retail stores while there is no dark store and showroom in the network (the layout and profit of the retail network declined in Table 4.5).

N	City	PR-store	dark store	showroom	Profit
1	Afyonkarahisar	✓			$ 1,447
2	Tekirdağ	✓			$ 955
3	Osmaniye	✓			$ 5,008
4	Adıyaman	✓			$ 6,611
5	Isparta	✓			$ 3,698
6	Erzurum	✓			$ 16,008
7	Balıkesir	✓			$ 7,072
8	Tarsus	✓			$ 7,940
9	Manavgat	✓			$ 240
10	Ataşehir	✓			$ 13,289
10	Total profit				$ 62,268

Table 4.5: All stores operate as physical retail stores

The profit of each store is calculated by equations (7), (8), (9), (10), and (11), then the retail network's profit obtained (Table 4.5).

4.2.1.2 Option2 (All stores operate as dark stores)

According to this network design, all stores operate as dark stores (DS). In some cases, firms prefer to have a network of dark stores to meet online customer orders. Due to the lower cost of opening, dark stores can be established in large numbers compared to hypermarkets. So it may be more proper for firms that intend to develop their retail network with lower expenses (Seidel, 2021). In this option, the retail network consists of only dark stores, while there are no physical retail stores and showrooms in the network. In other words, there are no in-store sales across the network.

N	City	PR-store	dark store	showroom	Profit
1	Afyonkarahisar		✓		$ 3,097
2	Tekirdağ		✓		$ 2,790
3	Osmaniye		✓		$ 5,797
4	Adıyaman		✓		$ 6,715
5	Isparta		✓		$ 4,715
6	Erzurum		✓		$ 13,938
7	Balıkesir		✓		$ 7,187
8	Tarsus		✓		$ 7,857
9	Manavgat		✓		$ 2,041
10	Ataşehir		✓		$ 11,797
	Total profit				$ 65,934

Table 4.6: All stores operate as dark stores

The profit of each store is calculated by equations (12), (13), and (14), then the retail network's profit obtained (Table 4.6).

4.2.1.3 Option3 (All stores operate as showrooms)

In this network design, all stores operate as showrooms. Because of having lower operational costs, besides no inventory cost of the store, retailers can either develop their showroom network that needs lower investment compared to physical retail stores or earn more benefits from reducing the expenditures. Especially first-online retailers that need to extend their network quickly (Li, Zhang, and Tayi, 2020).

In this option, the retail network consists of only showrooms, while there are no physical retail stores and dark stores in the network. In other words, there is no inventory to meet neither online orders nor in-store sales across the retail network (the layout of the retail network declined in Table 4.7).

N	City	PR-store	dark store	showroom	Profit
1	Afyonkarahisar			✓	$ 3,162
2	Tekirdağ			✓	$ 2,879
3	Osmaniye			✓	$ 5,522
4	Adıyaman			✓	$ 6,391
5	Isparta			✓	$ 4,596
6	Erzurum			✓	$ 12,681
7	Balıkesir			✓	$ 6,776
8	Tarsus			✓	$ 7,359
9	Manavgat			✓	$ 2,271
10	Ataşehir			✓	$ 10,828
	Total profit				$ 62,465

Table 4.7: All stores operate as showrooms

The profit of each store is calculated by equations (15), (16), and (17), then the retail network's profit obtained (Table 4.7).

4.2.1.4 Option4 (The stores' roles determine based on the most profitable scenario for each store)

This research aims to maximize the total profit of the retail network. Thus, we calculated the total profit by applying our model to find the layout with the highest profitability for the retail network.

First, the profit of each store calculates in three scenarios by the model based on the given parameters. Afterward, the model compares the results and chooses the scenario with the highest expected profitability for each store. Eventually, we will determine the final configuration of the retail network to maximize the total profit throughout the network.

N	City	PR-store	dark store	showroom	Max- profit
1	Afyonkarahisar	$ 1,447	$ 3,097	$ 3,162	$ 3,162
2	Tekirdağ	$ 955	$ 2,790	$ 2,879	$ 2,879
3	Osmaniye	$ 5,008	$ 5,797	$ 5,522	$ 5,797
4	Adıyaman	$ 6,611	$ 6,715	$ 6,391	$ 6,715
5	Isparta	$ 3,698	$ 4,715	$ 4,596	$ 4,715
6	Erzurum	$ 16,008	$ 13,938	$ 12,681	$ 16,008
7	Balıkesir	$ 7,072	$ 7,187	$ 6,776	$ 7,187
8	Tarsus	$ 7,940	$ 7,857	$ 7,359	$ 7,940
9	Manavgat	$ 240	$ 2,041	$ 2,271	$ 2,271
10	Ataşehir	$ 13,289	$ 11,797	$ 10,828	$ 13,289
	Total profit	$ 62,268	$ 65,934	$ 62,465	$ 69,963

Table 4.8: The profit of stores and total profit of the retail network when the role of stores is determined according to the profitability of scenarios

In this option, the retail network consists of retail stores, dark stores, and showrooms in terms of the profitability of the scenarios (Table 4.9).

N	City	PR-store	dark store	showroom
1	Afyonkarahisar			✓
2	Tekirdağ			✓
3	Osmaniye		✓	
4	Adıyaman		✓	
5	Isparta		✓	
6	Erzurum	✓		
7	Balıkesir		✓	
8	Tarsus	✓		
9	Manavgat			✓
10	Ataşehir	✓		

Table 4.9: The retail network layout when the role of stores is determined according to the profitability of scenarios

As can see in Table 4.9, unlike the other options (1-3), wherein the supply network has a uniform store performance, in this method, the retail network includes stores with diverse performances consisting of physical retail stores, dark stores, and showrooms.

4.2.2 Most profitable option

In the current competitive retail market, firms seek to design their supply networks to augment the efficiency of the network, which significantly impacts their total profit (Chopra and Meindl, 2013, p.132). As a result, the option is chosen with the highest benefit to increase the firm's efficiency. To this end, we compare the total profit of the retail network based on different options (Table4.10).

configuration	the role of stores		Total profit
uniform	all stores operate as PR-Stores		$62,268
uniform	all stores operate as dark Stores		$65,934
uniform	all stores operate as showrooms		$62,465
hybrid	stores operate according the most profitable scenario		$69,963

Table 4.10. Comparison of the total profit of the retail network in different layouts (options)

expected, while other uniform layouts are less profitable, wherein all stores have the same function.

4.3 Sensitivity analyses

Changes in the factors can drastically affect the result of calculations. In practice, the changing factors change the total profit of the network or/and the network layout. Thus, in this stage, we investigate the effects of each parameter (Table 4.11) on total profit and network layout.

N	Parameter	symbol
1	Transportation cost	C_{hd}
2	Unit sales price	P_p
3	Delivery lead time sensitivity	φ
4	Customers' desire for BOPS service	B
5	Costs of production	C_p
6	Unit retail operating cost for in-store sales	C_r

Table 4.11: The investigated parameters

4.3.1 The impact of changes in transportation cost

Delivery costs are one of the significant factors in the current competitive market environment, where retailers face the challenge of transportation costs' negative impact on both customer retention and profitability. To respond to this challenge, online retailers (e.g., Amazon) try to offer fast delivery services with a free delivery cost for customers, and Omnichannel retailers (e.g., Walmart) leverage their physical store networks to reduce shipping costs (Fisher, Gallino, and Xu, 2015). Furthermore**,** Delivery lead time (DLT), selling price, and the ratio of online customers who prefer BOPS or OSDH services are crucial factors that starkly impact the profitability of the retail networks (Momen and Torabi, 2021).

4.3.1.1 Changes in transportation cost impact on network total profit

Negative externalities (e.g., fuel price, shipping fleet maintaining costs, employee wage) can affect the transportation cost. When the ratio of home delivery costs increases, the total profit of the retailer will change in all options, as shown in (Fig 4.2). Figure 4.2 illustrates that the rate of the changes in the total profit of the retail network is not the same in all cases. When the physical retail stores' total profit does not change severely with increasing delivery costs, the efficiency of online channels (options 2 and 3) is drastically affected due to their inherent dependence on the online orders shipping costs.

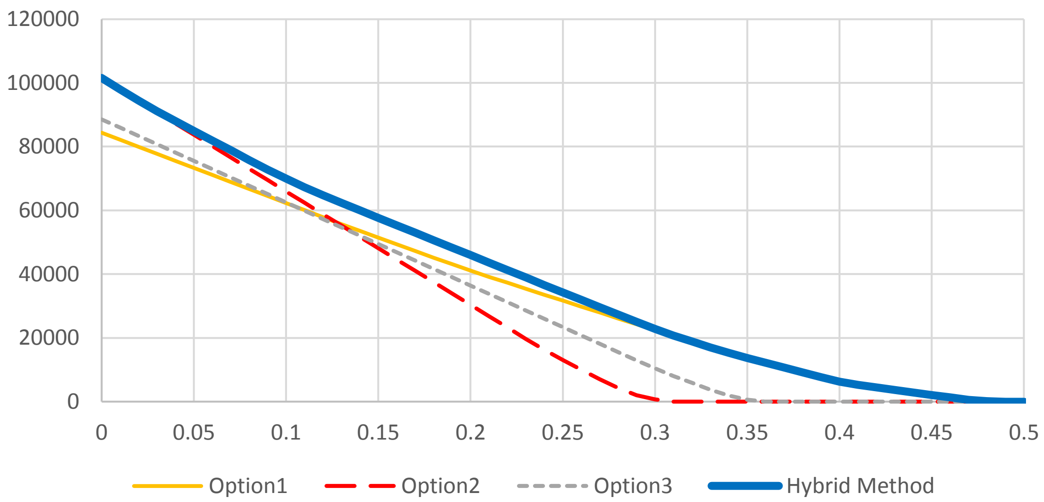

Fig 4.2: Total profit change comparison in all options with increasing delivery costs

As Figure 4.2 indicates, implementing the hybrid configuration mitigates the severe impact of delivery cost changes on total profit. In other words, a hybrid retail network wherein stores have different roles according to their maximum efficiency has minimum changes in its profit with changing delivery costs compared to other uniform layouts (options 1-3).

Our results approved Guo *et al.* (2020) findings that indicated delivery costs severely affect the channel-configuration strategies. Generally, with lower outbound shipping costs, total profit is close to dark stores, while by increasing shipping costs, the profit trend goes to be closed to retail stores. Due to the severe effects of this parameter, managers should pay attention to controlling the shipping costs, especially in the retail network with a dark store majority.

4.3.1.2 The impact of changes in transportation cost (C_{hd}) on network layout

According to our model, transportation cost directly influences the profitability of all scenarios. As a result, changes in transportation costs can affect the configuration of the retail network. Although increasing delivery costs effects on different options are not alike, the delivery cost factor plays a significant role in determining the network's layout.

I) Impact of increasing delivery costs (C_{hd}) on retail network configuration

Figure 4.3 illustrates that the number of active stores in each scenario changes with an increase in the ratio of delivery costs to the sales price. In other words, the profitability of different retailing types will substitute in terms of changes in the proportion of delivery costs to the sales price.

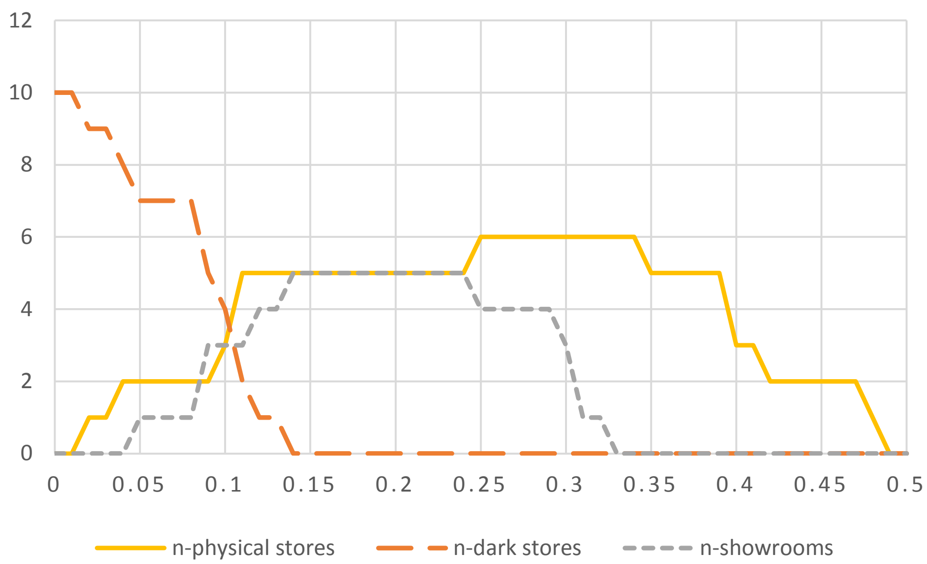

Fig 4.3: The number of active stores in each scenario with increasing in the ratio of delivery costs to the sales price

With increasing the delivery cost ratio to the sales price by up to 15%, will be no dark stores in the hybrid retail network (Fig 4.3). However, a retail network that comprises more dark stores has higher efficiency when delivery costs are somewhat low (Table 4.12). In fact, due to the severe dependency of online-based retailing types on delivery services, the increased delivery cost can remarkably damage their efficiency and role in the retail network configuration.

		C_{hd}=5%			C_{hd} =10%			C_{hd}=15%		
N	City	PR-store	dark store	showroom	PR-store	dark store	showroom	PR-store	dark store	showroom
1	Afyonkarahisar		✓				✓			✓
2	Tekirdag		✓				✓			✓
3	Osmaniye		✓			✓				✓
4	Adyaman		✓			✓		✓		
5	Isparta		✓			✓				✓
6	Erzrum	✓			✓			✓		
7	Balikesir		✓			✓		✓		
8	Tarsus	✓	✓		✓			✓		
9	Manavgat			✓			✓			✓
10	Atasehir	✓			✓			✓		
	Total	2	7	1	3	4	3	5	0	5

Table 4.12: The active stores in each scenario with increasing in the ratio of delivery costs to the sales price

II) Impact of increasing delivery costs (C_{hd}) on the total number of active stores in the retail network

As Figure 4.4 indicates, due to increasing delivery costs, the retail network cannot maintain all stores due to profitability reduction. As given in Figure 4.4, despite enhancing delivery costs to the sales price by up to 28%, all stores (10 stores) are active in the retail network. But, after 28% percent, the network cannot keep all stores open. Therefore, the total number of functioning stores declines in the retail network. Regarding this reduction, when 50% 0f the sales price spend on delivery costs, there is no active store in the retail network (Fig 4.4).

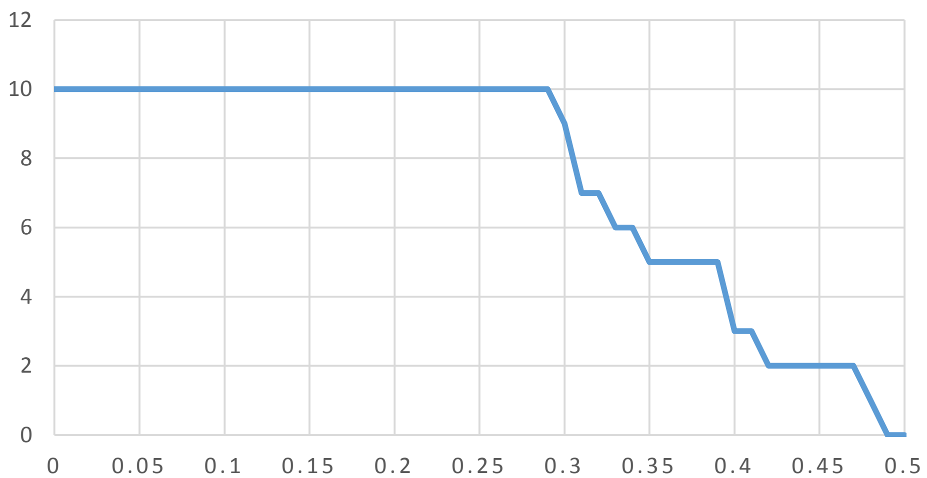

Fig 4.4: The total number of active stores in the retail network with increasing in the ratio of delivery costs to the sales price

4.3.2 The impact of Changes in unit sales price (P_p)

The product sales price is one of the crucial factors that can seriously affect the total profit and layout of a retail network.

4.3.2.1 Changes in unit sales price (P_p) impact on network total profit

Generally, with increasing sales price, the profit of the retail network enhances in all options. However, for all cases, the profit rise rate is not alike (Fig 4.6).

Figure 4.6 shows that with lower sales prices, online-based channels (dark stores and showrooms) have more profitable options than physical retail stores (up to $15). But, by increasing the sales price, a retail network including retail stores (option1) will become the most profitable option.

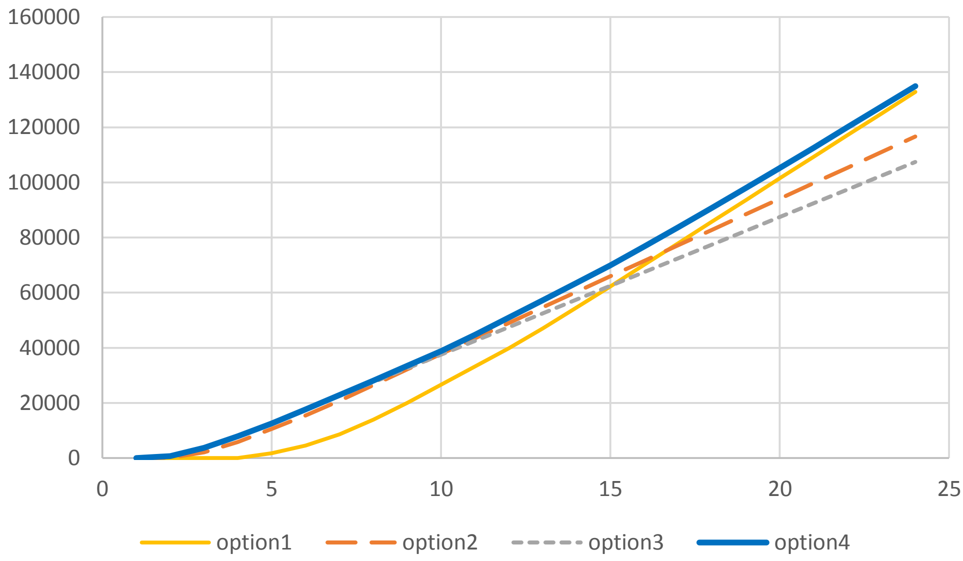

Fig 4.6: Total profit change comparison in all options with increasing the product sales price

As is indicated in Figure 4.6, by utilizing a hybrid retail network (option4), firms can obtain maximum profit in all circumstances compared to other uniform-designed networks (options 1-3).

4.3.2.2 The impact of changes in unit sales price (P_p) on network layout

According to our model, increasing product sales price positively influences the profitability of all scenarios. Albeit, changes in the unit sales price (P_p) can affect the configuration of the retail network. Although, the effects of price changes on different options are not alike. Generally, changes in the unit sales price (P_p) can impact the retail network's layout.

I) Impact of increasing product unit sales price (P_p) on retail network configuration

Figure 4.7 shows the number of active stores for each scenario when the unit sales price (P_p) increases. Therefore, the profitability of different retailing network layouts will change because of changing unit sales prices (P_p).

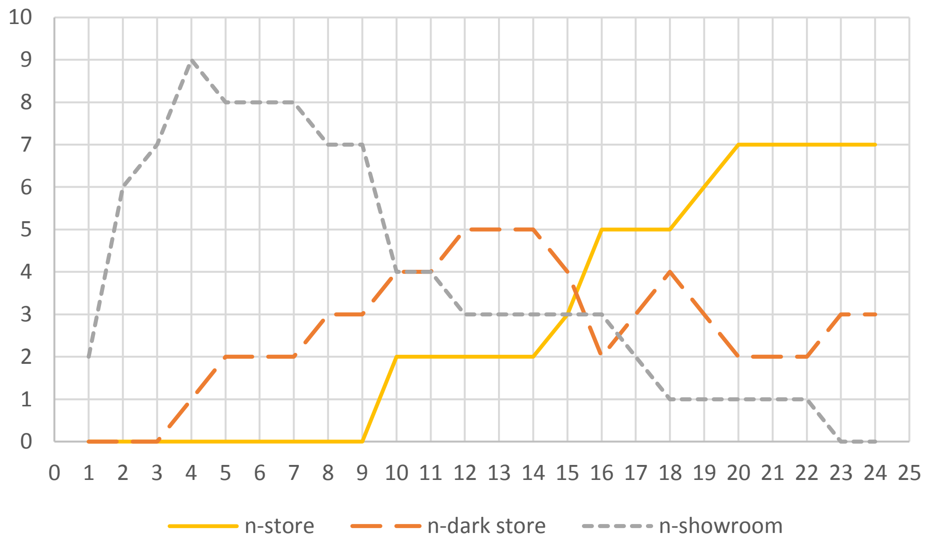

Fig 4.7: The number of active stores in each scenario with increasing in the product sales price (P_p)

When the product sales price is relatively low (up to $9), the retail networks consist of mostly showrooms and somewhat dark stores (showrooms=7, dark store=3), while there is no physical retail store in the hybrid retail network (Fig 4.7). That's to say, a retail network consisting of showrooms has higher efficiency when delivery costs are somewhat low (Table 4.13). On the other hand, with the high operational costs, in-store sales service expenditures, and inventory holding costs, the profitability of inventory-based retailing types will augment remarkably.

		p_p= $9			p_p =$13			p_p=$ 17		
N	City	PR-store	dark store	showroom	PR-store	dark store	showroom	PR-store	dark store	showroom
1	Afyonkarahisar			✓			✓		✓	
2	Tekirdag			✓			✓			✓
3	Osmaniye			✓		✓			✓	
4	Adyaman			✓		✓		✓		
5	Isparta			✓		✓			✓	
6	Erzrum		✓		✓			✓		
7	Balikesir			✓		✓		✓		
8	Tarsus		✓			✓		✓		
9	Manavgat			✓			✓			✓
10	Atasehir		✓		✓			✓		
	Total	0	3	7	2	5	3	5	3	2

Table 4.13: The active stores in each scenario with increasing in the product sales price (P_p)

II) Impact of increasing unit sales price (P_p) on the total number of active stores in the retail network

Figure 4.8 indicates that by increasing the product sales price, the total number of stores in the retail network enhance due to augment profitability. As given in Figure 18, when the product sales price is more than $4, all stores (10 stores) will be active in the retail network, while with lower sales prices (less than $4), the network cannot keep all stores open. Therefore, the total number of active stores rises in the retail network (Fig 4.8).

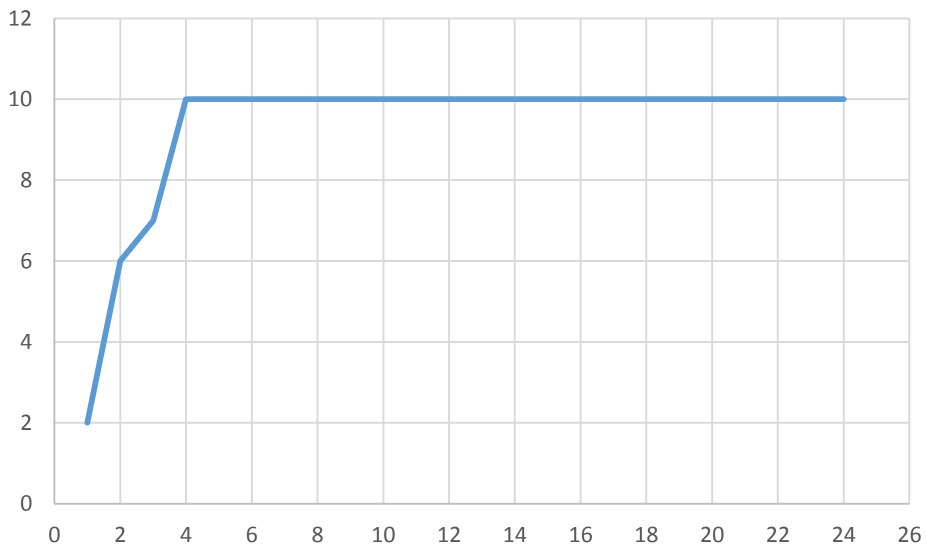

Fig 4.8: The total number of active stores in the retail network with increasing in the product sales price (P_p)

4.3.3 Changes in delivery lead time sensitivity (φ)

Lead time is a key performance indicator for distribution networks, where mitigating fulfillment and delivery time is necessary to augment efficiency (Pereira and Frazzon, 2021). Although the lead-time sensitivity is different from region to region, in this case, the lead time sensitivity factor is at the same level in all zones.

4.3.3.1 Changes in delivery lead time sensitivity (φ) impact on network total profit

With increasing the lied-time sensitivity of customers, the total profit of the retail network will change. However, all options don't follow the same pattern of change. As expected, with increasing the sensitivity of customers to lied time, the total profit of the retail network decrease in online-based sales networks (options 3-4). In contrast, by increasing the lead time-sensitivity level, the total profit of the network will enhance when the network includes the physical retail networks (option4), wherein by in-store shopping, customers can collect the purchased products immediately.

Figure 4.9 illustrates that the rate of the changes in the total profit of the retail network is not the same in all cases because of increasing the lead time sensitivity from 0.09 to 0.11, the retail network profit increases in options 2 and 3.

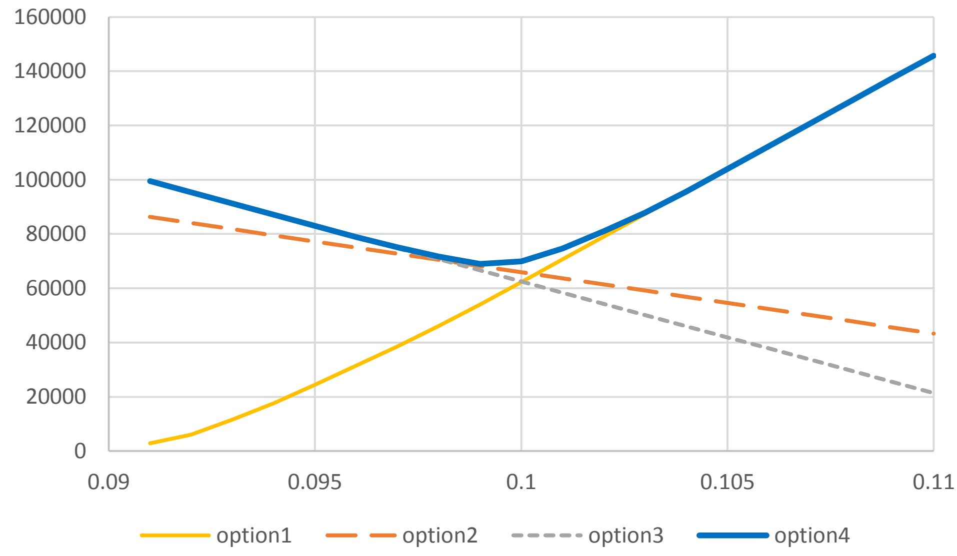

Fig 4.9: Total profit change comparison in all options with increasing the lead time sensitivity (φ)

As Figure 4.9 indicates, implementing the hybrid configuration mitigates the negative impacts of enhancing lead time sensitivity on total profit. That's to say, a hybrid retail network wherein stores have different roles based on their maximum efficiency has minimum changes in its profit with increasing lead-time sensitivity compared to other uniform layouts (options 1-3). In essence, the 0.99 lead-time sensitivity level is a turning point for the profitability of this distribution network.

4.3.3.2 The impact of changes in delivery lead time sensitivity (φ) on network layout

Lead time is a crucial factor that significantly impacts the performance of supply networks, where mitigating fulfillment and delivery time is necessary to augment efficiency (Pereira and Frazzon, 2021). With changing lead time sensitivity of the customer in the areas (in which stores operate), the supply network configuration and the total number of active stores in the retail network will change.

I) Impact of increasing delivery lead time sensitivity (φ) on retail network configuration

As Figure 4.10 indicates, the retail network's layout is severely sensitive to the lead time sensitivity factor (φ). With increasing the lead time sensitivity of the customer by up to 0.096, all stores operate as physical retail stores. On the other hand, by increasing the lead time sensitivity factor (φ), the number of physical retail stores (in the network) starts to decline. To the extent that after 0.104 will be no physical retail stores in the hybrid retail network (Fig 4.10).

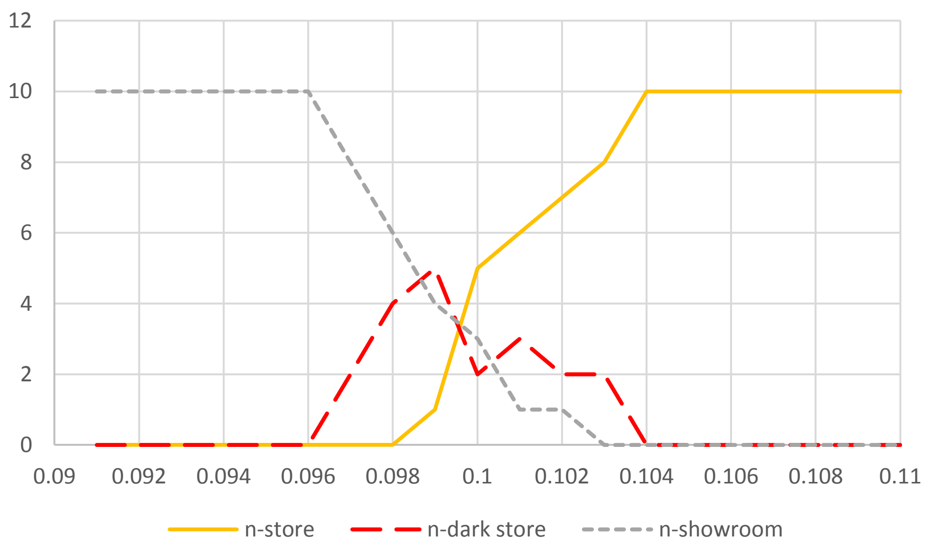

Fig 4.10: The number of active stores in each scenario with increasing in the ratio of lead time sensitivity factor (φ)

In contrast, we can see a major upward after 0.096 in the number of physical retail stores in the network configuration. Surprisingly, we can see active dark stores only between the lead-time sensitivity ratio of 0.096 and 0.104. In fact, due to the severe dependency of online-based retailing types on the lead-time sensitivity of the customer, the increased lead time sensitivity factor can remarkably affect their retail network configuration (Fig 4.10)

		φ=0.096			φ =0.1			φ =0.104		
N	City	PR-store	dark store	showroom	PR-store	dark store	showroom	PR-store	dark store	showroom
1	Afyonkarahisar			✓			✓	✓		
2	Tekirdag			✓			✓	✓		
3	Osmaniye			✓		✓		✓		
4	Adyaman			✓		✓		✓		
5	Isparta			✓		✓		✓		
6	Erzrum			✓	✓			✓		
7	Balikesir			✓		✓		✓		
8	Tarsus			✓	✓			✓		
9	Manavgat			✓			✓	✓		
10	Atasehir			✓	✓			✓		
	Total	0	0	10	3	4	3	0	0	10

Table 4.14: The active stores in each scenario with increasing in the ratio of lead time sensitivity factor (φ)

According to Figure 4.11, by increasing the lied-time sensitivity of the customer factor (φ), the network layout goes toward total heterologous network layouts. That's to say, the interval between 0.096 and 0.104 is critical to channel integration. When $\varphi = 0.096$ stores in all cities operate as showrooms, on the other side, caused by rising lied-time sensitivity of the customer factor, we can see all types of stores in the supply network. And when the lied-time sensitivity of the customer factor is $\varphi = 0.104$, there is no longer another store except physical retail stores (Table 4.14).

II) Impact of increasing delivery lead time sensitivity (φ) on the total number of active stores in the retail network

As Figure 4.11 shows, although the lied-time sensitivity of the customer (φ) has crucial effects on retail network configuration when it comes to the total number of active stores, we witness all stores are proactive for all ratios of lied-time sensitivity of the customer. With increasing delivery costs, the retail network does not vary and maintains all stores. As given in Figure 4.11, despite enhancing the lied-time sensitivity of the customer factor (φ) by up 0.11, all stores (10 stores) are active in the retail network.

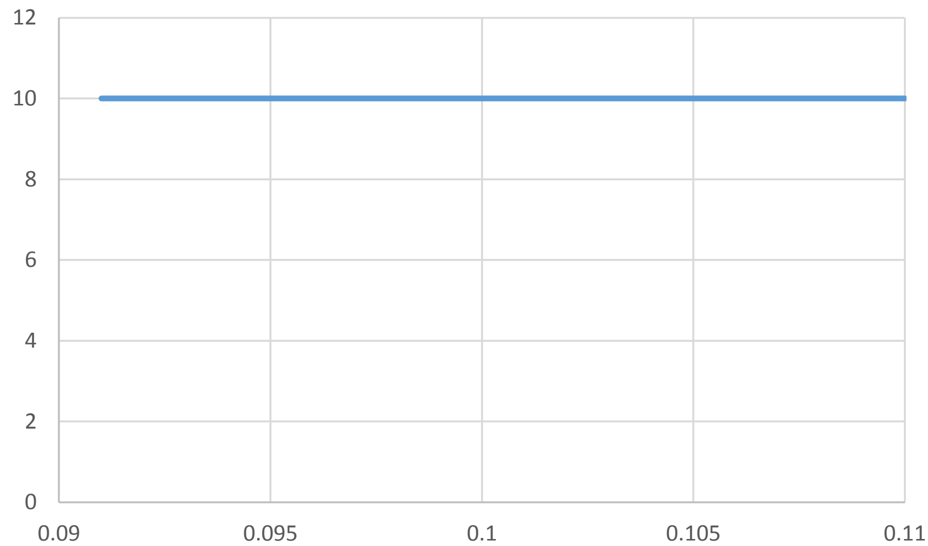

Fig 4.11: The total number of active stores in the retail network with increasing in the ratio of lead time sensitivity factor (φ)

4.3.4 Changes in customers' desire for BOPS service (*B*)

However, accelerating online shopping in recent years has diminished the need for going to physical retail stores, and the importance of last-mile shipping management is a reality that cannot overlook (Halldórsson and Wehner, 2020). Consequently, the proportion of customers who order online with pick-up in-store (willing to utilize BOPS) plays a significant factor in the efficiency of each retail network (Chopra, 2018).

4.3.4.1 Changes in customers' desire for BOPS service (B) impact on network total profit

Altogether, with increasing sales price, the profit of the retail network enhances in all options. However, for all cases, the profit rise rate is not the same (Fig 4.12).

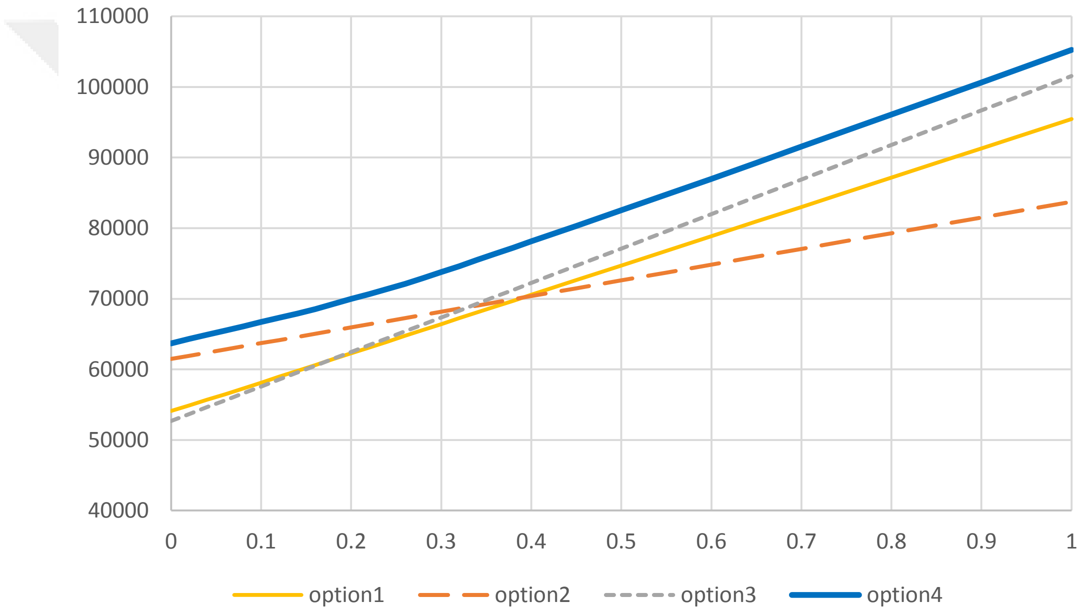

Fig 4.12: Total profit change comparison in all options with increasing the customer desire for BOPS service (*B*)

Figure 4.12 indicates that despite the general increase in the total profit of the retail network, the enhancement rate is not the same in all cases. At first, the network that includes dark stores is the most profitable option. But With increasing the customer desire for BOPS service, the total profit increased, but the dark stores are no longer the most beneficial option. Even after the ratio of 0.4, the order of option profitability reverses when the dark store network has the lowest efficiency.

Figure 4.12 shows that a hybrid distribution network (option4) which includes physical retail stores, dark stores, and showrooms, will possess the highest efficiency compared to other uniform options (3-4).

4.3.4.2 The impact of changes in customer desire for BOPS service (B) on network layout

The number of customers who prefer purchasing (BOPS) services forms the Omnichannel retail network. Because customers (in an Omnichannel retailing environment) save money due to the elimination of home delivery costs, they can also manage the last part of the last mile. On the retailer side, they can reduce their operational and shipping costs. With proximity between their location and physical store is a remarkable advantage, particularly when they can reach the stores by walking or public transportation (Halldórsson and Wehner, 2020). Furthermore, the firms can obtain more benefits by coming customers to the physical stores who pick up their online-purchased items.

I) Impact of increasing customer desire for BOPS service (B) on the retail network configuration

Figure 4.13 displays that when all online customers prefer to receive their orders at home (B=0), stores majority in the network operate as dark stores. By increasing the ratio of customers who intend to use the BOPS service, we witness more diversity in the store type in the network configuration. In practice, we can see a balance of in-store operational roles between 20% and 30% for the B factor. However, with escalating the ratio of customers who intend to use the BOPS service, the central backbone of the network consists of showrooms.

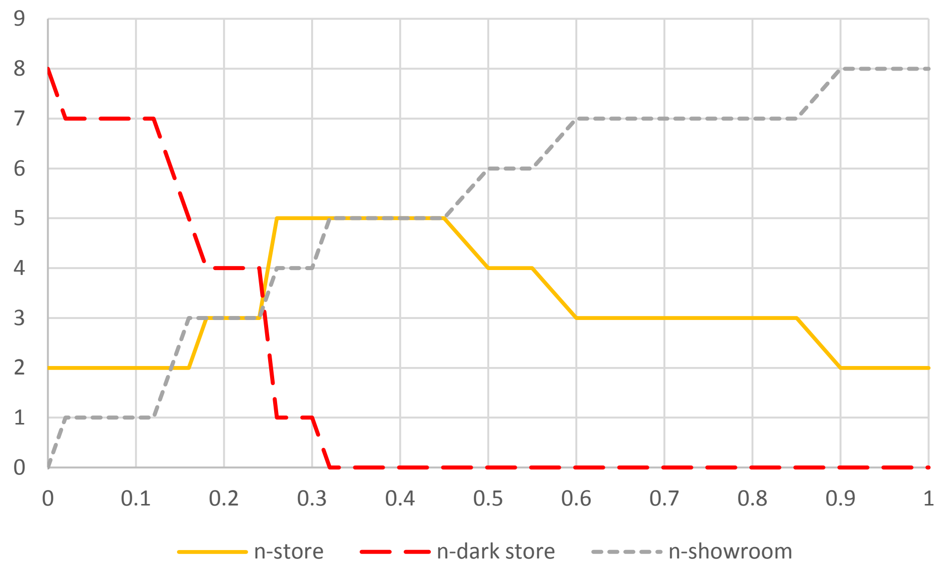

Fig 4.13: The number of active stores in each scenario with increasing in the customer desire for BOPS service (B)

Table 4.15 demonstrates how the retail network's layout changes in various amounts of the B factor. In most cities, when only 10% of customers prefer to pick up their online purchased items at stores, stores operate in the role of dark stores. By increasing the percentage of customers who prefer to use the BOPS service up to 26%, we will witness a remarkable evolution in the network's layout. If half of the customers pick up their online purchased items at stores, operating as a showroom will be the dominant role for stores.

		B=10%			B=26%			B=50%		
N	City	PR-store	dark store	showroom	PR-store	dark store	showroom	PR-store	dark store	showroom
1	Afyonkarahisar		✓				✓			✓
2	Tekirdag		✓				✓			✓
3	Osmaniye		✓			✓				✓
4	Adyaman		✓		✓					✓
5	Isparta		✓				✓			✓
6	Erzrum				✓			✓		
7	Balikesir		✓		✓			✓		
8	Tarsus		✓		✓			✓		
9	Manavgat			✓			✓			✓
10	Atasehir	✓			✓			✓		
	Total	2	7	1	5	1	4	4	0	6

Table 4.15. The active stores in each scenario with increasing in the customer desire for BOPS service (B)

II) The impact of increasing customer desire for BOPS service (B) on the total number of active stores in the retail network

Despite the fluctuating shape of network configuration in various amounts of factor B, when it comes to the total active stores in the Omnichannel retail network, we can see a steady trend for all ratios of customers who prefer to use the BOPS service. As given in Figure 4.14, regardless of the percentage of the customers who prefer to pick up their online purchased items at stores, all stores (10) are active in the retail network, albeit in diverse roles.

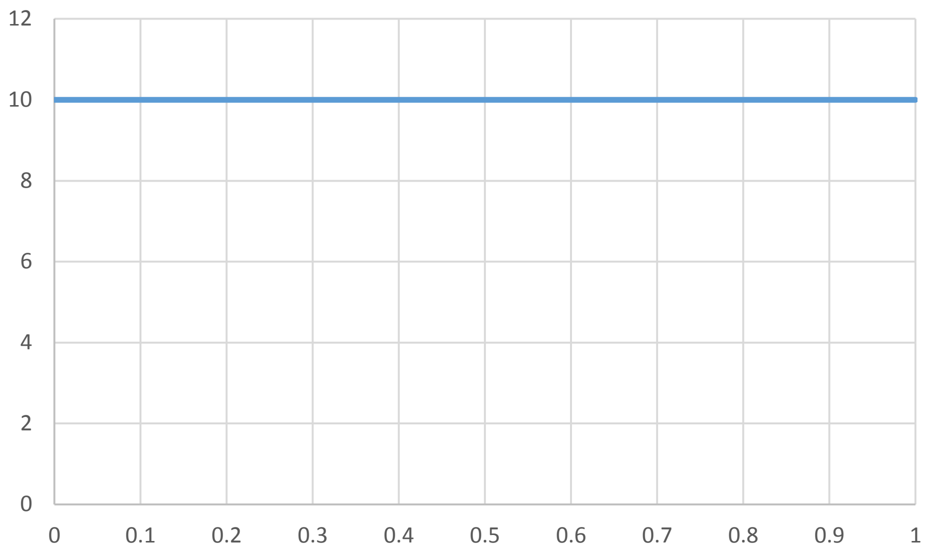

Fig 4.14: The total number of active stores in the retail network with increasing in the customer desire for BOPS service (B)

4.3.5 Changes in costs of production (C_p)

The production cost is one of the crucial factors in determining the profit and configuration of the retail network.

4.3.5.1 Changes in costs of production (C_p) impact on network total profit

Retailers to augment their profitability can reduce the cost of production or wholesaling price (in case the firm does not manufacture the product). This way, they can enhance the margin of the retailing in general.

Figure 4.15 demonstrates that with increasing the ratio of product costs (or wholesale cost for retailers), generally, the network profitability witnessed a major downward in all options. Even with escalating production costs, up to 70% of sales price, the network's total profit will become zero.

That's to say, with a margin of 30%, this business is not beneficial at all. However, the slope of this reduction is not the same for all options. For instance, the rate of profit reduction for a retail network that only includes showrooms (option3) is somewhat smoother than other inventory-based networks (options 1-2).

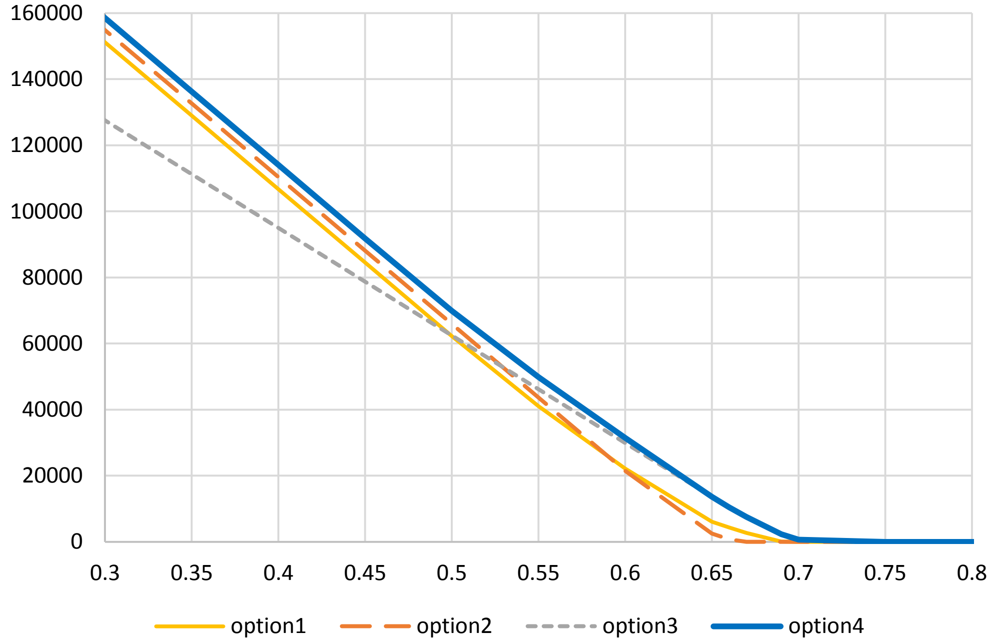

Fig 4.15: Total profit change comparison in all options with increasing the costs of production (C_p)

As Figure 4.15 indicates, profit reduction is unavoidable due to increasing product costs, but implementing the hybrid configuration that includes physical retail stores, dark stores, and showrooms mitigates the rate of profit reduction.

4.3.5.2 The impact of changes in costs of production (Cp) on network layout

Retail store profitability has close engagement with the difference between the revenue and all costs, including production costs (or wholesale costs for retailers). Therefore, changes in this factor can drastically affect any supply network configuration (Chopra and Meindl, 2013, p.403).

I) Impact of increasing costs of production (*Cp*) on retail network configuration

Figure 4.16 demonstrates the significant impact of changes in production cost factor (*Cp*) on the supply network configuration. However, when the cost of production is up to 45% of sales price, the ratio of stores in different roles is approximately consistent, and a conspicuous change appears in the retail network's shape by enhancing the production cost factor (*Cp*). According to our model, if the production cost (or wholesale costs for retailers) includes more than 45% of the unit sales price, the number of showrooms in the retail network configuration will rise. On the contrary, when *Cp*>0.45%, we witness a major downward in the number of dark stores across the supply network. Surprisingly, the number of physical retail stores changes more smoothly than in two other scenarios (dark stores and showrooms).

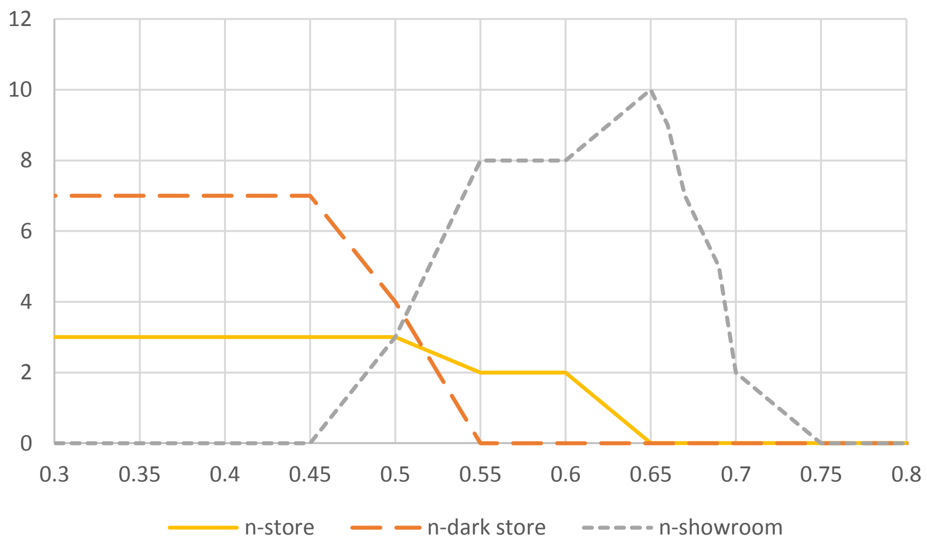

Fig 4.16: The number of active stores in each scenario with increasing in the costs of production (*Cp*)

Despite the lower product costs factor (*Cp*<45%), by augmenting the production cost (or wholesale costs for retailers), the retail network's layout will not stay alike. When the product costs factor increases up to 55%, the retail network's form will be fundamentally different. Albite, we can see a relative balance in the supply network configuration.

		Pc=45%			Pc=50%			Pc=55%		
N	City	PR-store	dark store	showroom	PR-store	dark store	showroom	PR-store	dark store	showroom
1	Afyonkarahisar		✓				✓			✓
2	Tekirdag		✓				✓			✓
3	Osmaniye		✓			✓				✓
4	Adyaman		✓			✓				✓
5	Isparta		✓			✓				✓
6	Erzrum	✓			✓			✓		
7	Balikesir		✓			✓		✓		
8	Tarsus	✓			✓			✓		
9	Manavgat		✓				✓			✓
10	Atasehir	✓			✓			✓		
	Total	3	7	0	3	4	3	4	0	6

Table 4.16: The active stores in each scenario with increasing in the costs of production (Cp)

As Table 4.16 illustrates, when the product costs factor is 45% of the sales price (Cp=45%), most stores will play dark store roles (scenario2). Reviewing the retail network's layout, when the Pc factor is 50%, a relative balance in the scenarios is recognizable. Eventually, if Cp=55%, showrooms are the main components that constitute the supply network. We inferred that the interval between Cp=45% and Cp=55% is critical in the retail network configuration context.

II) Impact of increasing costs of production (*Cp*) on the total number of active stores in the retail network

Figure 4.17 indicates that by growing the production cost (or wholesale costs for retailers), the total number of active stores across the retail network severely decline (*Cp*>65%). As figure 4.17 shows, for *Cp*>75%, there will be no active store in the retail network.

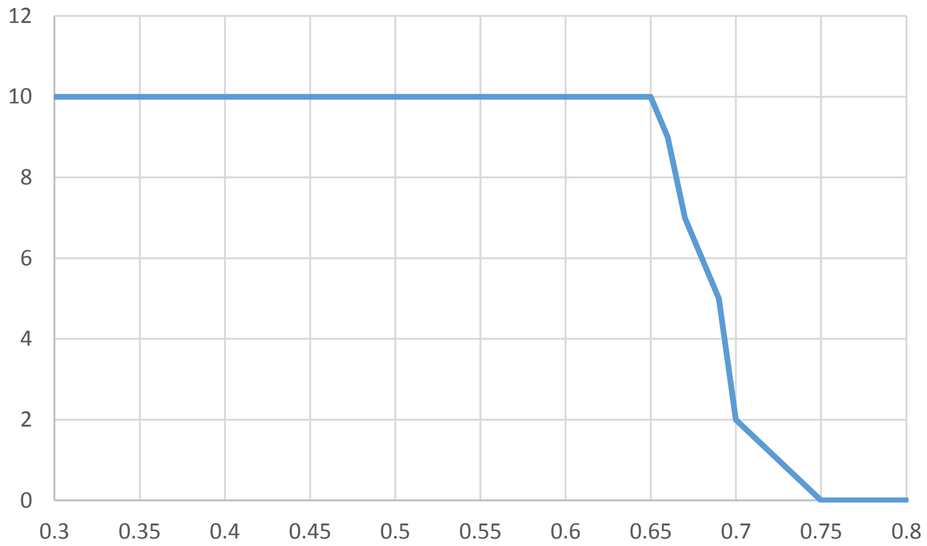

Fig 4.17: The total number of active stores in the costs of production (*Cp*)

4.3.6 Changes in unit retail operating cost for in-store sales (C_r)

Operation cost for in-store sales contains introducing the products to customers, while for online businesses, the operation cost comprises orders preparation or/and home delivery. For casual sales where customers purchase in-store, the unit retail operational cost for in-store sales, including inbound transportation, holding, and replenishment, significantly impacts the retail network profitability.

4.3.6.1 Changes in unit retail operating cost for in-store sales (C_r) impact on total profit of network

In practice, retail operation costs negatively affect the efficiency of retail networks, while other network layouts (option2-3) doses not face this issue. As expected, the retail network profit that includes only physical retail stores will drastically decrease with increasing the operational costs for in-store sales.

As given in Figure 4.18, when 60% of the product selling price is operating expenditures for in-store selling, this retail network layout (option1) will have no profit.

On the other hand, the efficiency of retail networks, which have no in-store sales (option2-3), is not affected by the increasing costs of in-store selling (Fig 4.18).

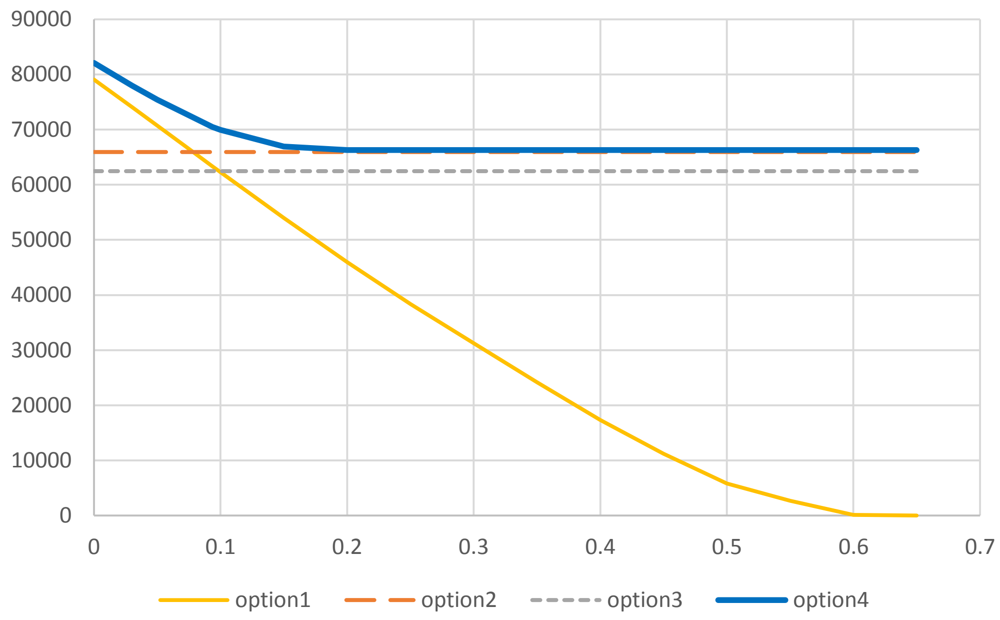

Fig 4.18: Total profit change comparison in all options with increasing in unit retail operating cost for in-store sales (C_r)

Figure 4.18 indicates that despite the initial downward in hybrid network layout following the reduction in profitability of physical retail stores, total profit will be constant by increasing the operational costs for in-store sales.

4.3.6.2 The impact of changes in the ratio of retail operational cost for in-store sales (C_r) on network layout

In the Omnichannel retailing networks, physical retail stores have a crucial role because of their ability to improve retailing service levels. On the other hand, physical retail stores holding costs negatively affect the store profitability (Mkansi and Nsakanda, 2021). As a result, changes in the ratio of retail operational costs for in-store sales (C_r) can seriously diminish the efficiency of physical retail stores more than other online-based store types (dark stores and showrooms).

I) Impact of increasing the ratio of retail operational cost for in-store sales (C_r) on retail network configuration

Figure 4.19 displays a significant impact of changes in operational costs for in-store sales (C_r) on the supply network configuration. However, when the cost of production increases to 20% of sales price, the ratio of stores in different roles will completely change. It is indicated in Figure 4.19 that the retail network's shape by enhancing the retail operational costs for in-store sales (C_r) goes toward an online-based retailing format. According to our model, if the ratio of retail operational costs for in-store sales (C_r) increases to 20% of the unit sales price, the number of physical retail stores in the supply network configuration will drastically decrease. In practice, for operational costs more than 20% of the unit sales price, there will be no physical retail store in the supply network layout. In this regard, by increasing retail operational costs for in-store sales (C_r), we witness a major upward in the number of dark stores across the supply network. While, when it comes to the number of showrooms, there is no change in its number.

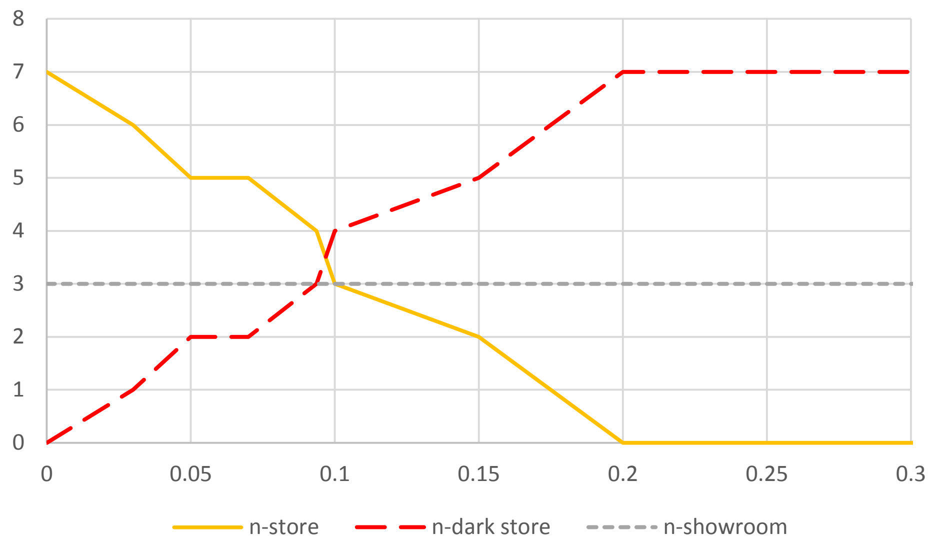

Fig 4.19: The number of active stores in each scenario with increasing in the ratio of retail operational cost for in-store sales (C_r)

Generally, the permutation happens in the retail network configuration when the retail operational costs for in-store sales (C_r) rise to 20% of the unit sales price. The interval between C_r=5% and C_r=15% is critical in the retail network configuration determination. Because in this range, the retail network layout has changed.

		C_r=5%			C_r =10%			C_r=15%		
N	City	PR-store	dark store	showroom	PR-store	dark store	showroom	PR-store	dark store	showroom
1	Afyonkarahisar			✓			✓			✓
2	Tekirdag			✓			✓			✓
3	Osmaniye		✓			✓			✓	
4	Adyaman	✓				✓			✓	
5	Isparta		✓			✓			✓	
6	Erzrum	✓			✓			✓		
7	Balikesir	✓				✓			✓	
8	Tarsus	✓			✓				✓	
9	Manavgat			✓			✓			✓
10	Atasehir	✓			✓			✓		
	Total	5	2	3	3	4	3	2	5	3

Table 4.17: The active stores in each scenario with increasing in the ratio of retail operational cost for in-store sales (C_r)

As we can see in Table 4.17, when the retail operational costs for in-store sales (C_r) is 5% of the sales price (C_r=5%), most stores play physical store roles (scenario1). Reviewing the retail network layout, when the C_r factor is 10%, we can see a relative balance in the scenarios. Moreover, if C_r=15%, dark stores are the main components that form the supply network. We inferred that the interval between C_r=5% and C_r=15% is critical in the retail network configuration. Moreover, due to the showroom's independency from the retail operational costs for in-store sales, there is no change in the showroom's profitability (scenario3).

II) The impact of increasing the ratio of retail operational cost for in-store sales (C_r) on the total number of active stores in the retail network

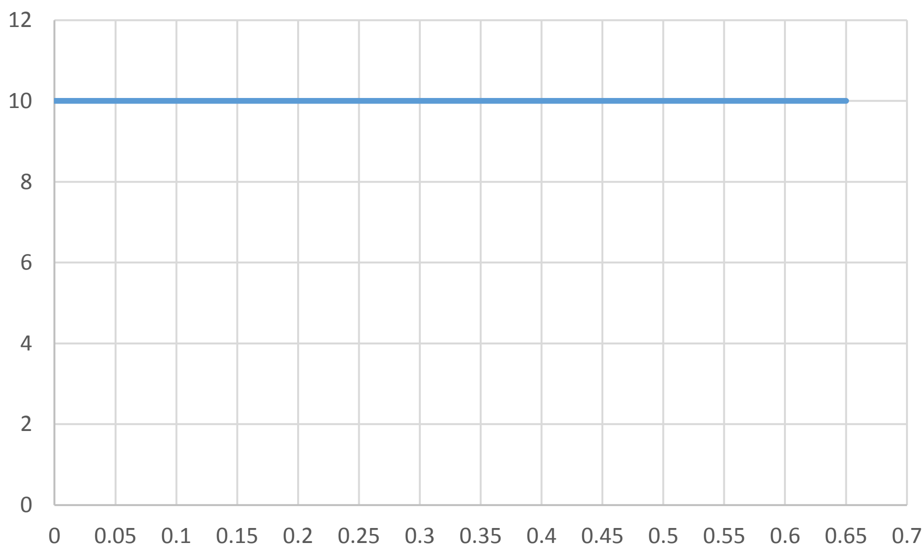

Fig 4.20: The total number of active stores in the retail network with increasing in the ratio of retail operational cost for in-store sales (C_r)

However, increasing the ratio of retail operational cost for in-store sales causes a fluctuating shape of network configuration. But in the total number of active stores in the Omnichannel retail network, we can see a steady trend for all ratios of retail operational cost for in-store sales. Figure 4.20 demonstrates that regardless of the operation cost augmentation, all stores (10) are active in the retail network, while some store keeps their roles and some change.

CHAPTER V

CONCLUSION

In recent years, with accelerating online shopping, Omnichannel retailing will be the future of retailing because pure offline retailers have been adding online channels to their traditional channels (Wollenburg *et al.*, 2018).In the new retailing paradigm, Omnichannel retailers provide a seamless shopping experience by fully integrating retail channels, while internal and external factors collectively impact channel integration evolution (Hajdas, Radomska, and Silva, 2022).

In an Omnichannel retailing framework, stores play a significant role. Particularly, if stores as fundamental components of the retail network operate according to their most profitable performance, the efficiency of the retail network will augment.

Reviewing relevant literature shows that the stores can adopt three types of roles that scholars have focused on the store's functions. But previous studies do not comprehensively investigate the network efficiency considering all mentioned roles (physical retail store, dark store). The study in hand investigates to find the most profitable retail network configuration. To this end, reviewing relevant literature, we tried to figure out the main factors that significantly impact store performance. Additionally, we determined the crucial factors for evaluating the retail stores according to their new role in the Omnichannel retail network. This research has considered factors including product sales price, cost of production, online sales price, the operational cost for in-store sales (e.g., inbound transportation, holding, and replenishment), additional profit of in-store customers, home delivery cost for retailer, Pick-up in-store service costs for retailers, equipment cost of in-store sales (e.g., sales associates, cashiers, customer service, lighting, and decoration), equipment and operation costs to fulfill online orders, showroom equipment cost, the proportion of customers who order online with pick-up in-store (willing to utilize BOPS), the customer acceptance level of the online channel, lead-time sensitivity of online customers, customer service level sensitivity, the population in the zone of each store, pre-sales service level, and inventory carrying cost.

After determining the crucial factors, we consider three main scenarios that define the role of stores in a distribution network. According to the first scenario, the physical store operates as a place for in-store shopping, a center for shipping online orders, and a pick-up location for online orders. In the second scenario, the store only fulfills online orders while operating as a center for shipping to home and a pick-up location for online orders, where the products are only accessible to pickers. In the third scenario, customers can collect product information in-store (showroom) before making an online purchase, while there is no inventory for in-store sales. Plus, the store operates as a center for shipping to home and a pick-up location for online orders.

In the second step, we developed a model to evaluate and compare the profit of stores. Hence, optimizing each store's role will be necessary. Thereinafter, calculating the total profit of the retail network in each scenario, we realigned the function of stores according to the evaluation of the results. In doing so, we assume four options for an Omnichannel retailer to design its distribution network as follows:

Option1: All stores operate as physical retail stores (PRS) in the distribution network.

Option2: All stores operate as dark stores (DS) in the distribution network.

Option3: All stores operate as showrooms in the distribution network.

Option4: The stores' roles determine based on the most profitable scenario for each store in the distribution network. In this option, the retail network consists of retail stores, dark stores, and showrooms in terms of the profitability of the scenarios.

A numerical example sheds light on the purpose of this research and illustrates how our model can find the best retail network layout. Calculation based on our model revealed that the retail network obtains the highest profit under option four configurations, where it has a non-uniform structure.

Afterward, we conducted a sensitivity analysis to investigate how different parameters affect the distribution network configuration and total profit. To this end, we calculated the profit of all four possible options in a logical interval. We increased the factors including product sales price, cost of production, the operational cost for in-store sales, home delivery cost for retailers, the proportion of customers who order online with pick-up in-store (BOPS), and lead-time sensitivity of online customers.

Then, we computed the profit of a hybrid retail structure (option 4) compounded by physical retail stores, dark stores, and showrooms. Widely observed in results, despite having the highest efficiency, option 4 has the minimum change than other uniform retail networks (options 1-3).

Generally, networks with hybrid retail structures face a lower profit reduction than uniform retail networks. The results demonstrate that by increasing product sales price and BOPS service willing, the total profit enhances in all retail network layouts, albite with different rates. Conversely, raising delivery and production costs negatively affects the total profitability at different levels. Also, we found out that lead-time sensitivity has various effects on the retail network structures. As expected, by increasing the operational cost for in-store sales, physical retail stores are severely affected, while the profit of online-based stores is unchanged.

Omnichannel retailers face the challenge of keeping open their local stores under different circumstances. Results illustrated that the total number of functioning stores in uniform distribution networks (options 1-3) strongly depends on several elements (e.g., sales price, production cost, operational cost, delivery costs, and lead-time sensitivity of online customers). In contrast, the total number of active stores in a hybrid distribution network structure is less dependent on those factors. Our findings underline that retailers having a hybrid retail network can keep many of their stores open.

Overall, in the new retailing paradigm, utilizing a hybrid retail network moderates the changes in firm profit. And profit is influenced by parameters such as product sales price, cost of production, the operational cost for in-store sales, home delivery costs, the ratio of customers who order online with pick-up in-store, and lead-time sensitivity of online customers. This way, retailers can protect them against the detrimental effects of mentioned parameters.

Like a road map, the presented approach helps Omnichannel retailers enhance their efficiency by optimizing the structure of their distribution network. Hence this study enables retail industry managers to properly design their Omnichannel retail networks by seeing the issues in a bigger picture. Recall the supply chain efficiency depends on proper distribution network design (Prabhuram *et al.*, 2020). However, from a practical perspective, this study possesses several constraints that may diminish its results, for example, ignoring non-financial factors, product characteristics, local markets' differences, and fluctuating internal or/and external parameters.

From a literature point of view, this study can be a starting point for scholars that extend this method by considering multi-product companies, non-financial factors, and local markets' differences. Moreover, future research can explore other functions for stores. Specifically, this study tries to provide a vast perspective of Omnichannel retailing by investigating three possible roles of stores in an Omnichannel retail network. But many previous studies focused on the role of stores in a uniform retail configuration.

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APPENDIX

```
$title Omnichannel3
sets
        i index of stores /Afyonkarahisar, Tekirdag, Osmaniye, Adiyaman, Isparta, Erzurum,
          Ballkesir,     Tarsus, Manavgat, Atasehir/
        j index of scenarios /BMS, DARKSTORE, SHOWROOM /
       ;
scalar
       PP unit selling price          /15/
       Cp ratio of unit production cost/0.5/
       Pr Unit selling price ratio for in-store shopping    /1/
       Cr unit opperational cost ratio for in-store sales   /0.1/
       Pd Unit selling price ratio for online orders       /0.8/
       Ap Unit Additional profit ratioof in-stores customers /0.1/
       m  Unit home delivery cost                  /0.1/
       n  Unit Pick-up in-stores costs(Picking & Packing)/0.05/
       SLS Service level sensitivity parameter /0.16/
       Ceo equipment cost to fulfill online orders      /1300/
       Ces equipment cost to operate as a showroom      /500/
       Cer equipment cost of in store sales           /2000/
       B   Proportion of customers who order online with pick-up in-store /0.2/
       CAL Customer acceptance level of the online channel /0.8412/
       LTS Lead time sensitivity of online customers /0.1/
       max /0/
       BMstores /0/
       darkstores /0/
       showrooms /0/
       ;
parameter
```

pop(i) Population of zone /Afyonkarahisar 129702, Tekirdag 122287, Osmaniye 202837,

Adiyaman 223744, Isparta 172341, Erzurum 420691,

Ballkesir 238151, Tarsus 256482, Manavgat 99254, Atasehir 361615/

a(i) Proportion of customers who order online

t(j) Lead time ratio /BMS 0.3, DARKSTORE 0.3, SHOWROOM 0.45/

S(j) Pre-sales service level of the retailer /BMS 0.075, DARKSTORE 0.045, SHOWROOM 0.075/

CC(i,j) inventory carrying cost

Qr(i,j)

Qd(i,j)

Qt(i,j)

x(i,j) profit of the store i in scenario j

D(i,j) Total demand in area of store (regional demand)

P1 Total profit when all stores operate as retail stores

P2 Total profit when all stores operate as dark stores

P3 Total profit when all stores operate as showrooms;

table W(i,j) fixed costs(rent and bills)

	BMS	DARKSTORE	SHOWROOM
Afyonkarahisar	2100	525	700
Tekirdag	2200	550	733
Osmaniye	2400	600	800
Adiyaman	1900	475	633
Isparta	2100	525	700
Erzurum	2900	725	967
Ballkesir	2200	550	733
Tarsus	2300	575	767
Manavgat	1700	425	567
Atasehir	2500	625	833;

```
variables
        z;

Qr(i,"BMS")=(1-CAL-Pr+S("BMS")*SLS+Pd+LTS*t("BMS"))/(1-CAL);
Qd(i,"BMS")=(CAL*Pr-S("BMS")*SLS*CAL-Pd-LTS*t("BMS"))/((1-CAL)*CAL);
Qt(i,"BMS")=Qr(i,"BMS")+ Qd(i,"BMS");
D(i,"BMS")=pop(i)*Qt(i,"BMS");
a(i)= Qd(i,"BMS")/Qt(i,"BMS");

Qd(i,"DARKSTORE")=1-((Pd+LTS*t("DARKSTORE"))/CAL);
Qt(i,"DARKSTORE")=Qd(i,"DARKSTORE");
D(i,"DARKSTORE") =pop(i)*Qt(i,"DARKSTORE");

Qd(i,"SHOWROOM")=1-((Pd+LTS*t("SHOWROOM")-SLS*S("SHOWROOM"))/CAL);
Qt(i,"SHOWROOM")=Qd(i,"SHOWROOM");
D(i,"SHOWROOM") =pop(i)*Qt(i,"SHOWROOM");

CC(i,"BMS")=0.03*pop(i)*Qt(i,"BMS")*PP;
CC(i,"DARKSTORE")=0.02*pop(i)*Qt(i,"DARKSTORE")*PP;
CC(i,"SHOWROOM")=0;

x(i,"BMS")=(a(i)*Pd-(1-B)*a(i)*m-B*a(i)*n+B*a(i)*Ap+(1-a(i))*Pr-(1-a(i))*Cr-
Cp)*PP*D(i,"BMS")-(W(i,"BMS")+CC(i,"BMS")+Cer+Ceo);
x(i,"DARKSTORE")=(Pd-(1-B)*m-B*n-Cp)*PP*D(i,"DARKSTORE")-
(W(i,"DARKSTORE")+CC(i,"DARKSTORE")+Ceo);
x(i,"SHOWROOM")=(Pd-(1-B)*m-B*n+B*Ap-Cp)*PP*D(i,"SHOWROOM")-
(W(i,"SHOWROOM")+Ces);

P1=sum(i, X(i,"BMS"));
P2=sum(i, X(i,"DARKSTORE"));
P3=sum(i, X(i,"SHOWROOM"));
```

```
loop
    ((i,j),
    if (x(i,j)<0, x(i,j)=0);
    );
loop
    (i,
    if (x(i,"SHOWROOM")>x(i,"DARKSTORE") and x(i,"SHOWROOM")>x(i,"BMS"),
     showrooms=showrooms+1;
     x(i,"DARKSTORE")=0;
     x(i,"BMS")=0;
    else
    if (x(i,"DARKSTORE")>x(i,"BMS")and x(i,"DARKSTORE")>x(i,"SHOWROOM"),
    darkstores=darkstores+1;
    x(i,"BMS")=0;
    x(i,"SHOWROOM")=0;

    else BMstores=BMstores+1;
    x(i,"DARKSTORE")=0;
    x(i,"SHOWROOM")=0;
    );
    );
    );

equations
    objectivefunction;

    objectivefunction .. z=e= sum (i,smax(j, x(i,j)));

model   omnichannel  /all/;
option   lp=cplex;
solve   omnichannel using lp max z;
```

display z.l, P1, P2, P3, showrooms, darkstores, BMstores, x;

```
----    131 VARIABLE z.L              =    69962.762
          PARAMETER P1                =    62267.231 Total profit when all stores operate as retail stores
          PARAMETER P2                =    65934.225 Total profit when all stores operate as dark stores
          PARAMETER P3                =    62465.683 Total profit when all stores operate as showrooms

          PARAMETER showrooms          =       3.000
          PARAMETER darkstores         =       4.000
          PARAMETER BMstores           =       3.000

----    131 PARAMETER x profit of the store i in scenario j
```

	BMS	DARKSTORE	SHOWROOM
Afyonkarahisar			3161.947
Tekirdag			2879.576
Osmaniye		5796.811	
Adiyaman		6715.143	
Isparta		4714.616	
Erzurum	16007.978		
Ballkesir		7186.828	
Tarsus	7939.502		
Manavgat			2270.964
Atasehir	13289.398		

CV

Mazdak Hooshyar Azar

Education:

- **Master of Business Administration** (in English) 2020-2022
  Istanbul Sabahattin Zaim University, Istanbul, Turkey
  CGPA: 3.71/4.0, Thesis title:
  "*The Retail Stores and their changing Role in Omni-channel Retailing*"
- **Bachelor of Science in Civil Engineering** 2010
  Azad University (IAU), Tehran, Iran

Research Interests:

- Supply Chain Management and Logistics
- Distribution Network Design and Modeling
- E-commerce and Omni-channel Retailing
- Operations Management
- Inventory Control and Management
- Digitalization and Remote-work

Publications:

- Isac,N. Dobrin,C. karahan celik**,**B. **Hooshyar Azar,M.** Oct. 2021
  (2021) '*Does working from home influence motivational level of employees? The analysis of gender differences in Turkey*', Review of International Comparative Management, 22(4),458-469
  DOI: 10.24818/RMCI.2021.4.458
  http://www.rmci.ase.ro/no22vol4/03.pdf

International Conference Presentation:

- **Hooshyar Azar, M**. Bilir,C**. '*Evaluating the Role of Retail Stores in Omni-Channel Retailing* ',** 12th Annual International Conference on Industrial Engineering and Operations Management, Istanbul, Turkey March 2022
  http://www.ieomsociety.org/program-istanbul2022.pdf
- karahan Celik**,** B. **Hooshyar Azar, M. '*The Effect of Covid-19 on Work Motivation in Remote Work*',** INTERNATIONAL JOINT RESEARCH EXPERIENCE PROJECT FEAA UVT Timisoara Romania-IZU Istanbul Turkey-GUT Poland May 2021
  https://drive.google.com/file/d/1FpP7oitpxDhLTCR0GeWEg2jwJNEH-zB3/view

Work experience:

- **Reviewer** IEOM International Conferences Nov. 2021-Present
  Industrial Engineering and Operations Management
- **English Teacher**, Part-time, Istanbul, Turkey 2020-Present
- **Foreign Sales & Marketing Representative**, 2016-2019
  Parsian Afzar Tiraje Co, Istanbul, Turkey
- **Sales & Marketing Manager**, 2013-2015
  Parsian Afzar Tiraje Co, Tehran, Iran
- **Sales Trainer** (part-time), Tehran, Iran 2013-2015
- **CEO**, Parsian Afzar Pasargad Co, Tehran, Iran 2010-2013
- **Sales & Marketing Manager**, 2005-2010
  Parsian Afzar Pasargad Co, Tehran, Iran

Workshops:

- **Academic Writing Workshop**- How to write an article for an international journal Chairman: AGATA PIERSCIENIAK May 2021
  Associate Professor Dr. Habil,Gdansk University of Technology, Poland
- **Merchandizing Workshop** Oct. 2013
  Distribution Conference, Tehran, Iran
- **Capillary Distribution Workshop** Oct. 2013
  Distribution Conference, Tehran, Iran

Certifications:

- **Certificate of Merit /International Joint Research Experience Project** May 2021
- **TPC /Teaching Practice Certificate** Nov. 2020
  (Accredited by TESOL OXFORD LTD)
- **TESOL Certificate /** Nov. 2020
  Teaching of English to Speakers of Other Languages
  (Accredited by TESOL OXFORD LTD whit a score of A2)
- **Certificate of Sales Engineering** Nov. 2010
  (Affiliated to Ministry of Commerce of Iran)
- **Certificate of Sales and Marketing Management** Dec. 2008
  (Faculty of Management, University of Tehran)