CHALMERS
UNIVERSITY OF TECHNOLOGY

Optimal Outbound Minimum Order Quantity (MOQ) in food supply chain

Master's thesis in Supply Chain Management

Nripan Sudas
Ravi Teja Ramineni

DEPARTMENT OF TECHNOLOGY MANAGEMENT AND ECONOMICS
DIVISION OF INNOVATION AND R&D MANAGEMENT

CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2023
www.chalmers.se
Report No. E2023:099

REPORT NO. E2023:099

Optimal Outbound Minimum Order Quantity (MOQ) in food supply chain

Nripan Sudas
Ravi Teja Ramineni

Department of Technology Management and Economics
Division of Innovation and R&D Management
CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2023

Optimal Outbound Minimum Order Quantity (MOQ) in food supply chain
Nripan Sudas
Ravi Teja Ramineni

Supervisor: Ludvig Lindlöf, Division of Innovation and R&D Management (IRDM)
Examiner: Björn Lantz, Division of Innovation and R&D Management (IRDM)
Supervisor: Simon Runefors, IKEA Purchasing Services (Sweden) AB, Sweden
Supervisor: Dragan Blagojevic, IKEA Purchasing Services (Sweden) AB, Sweden

Report no. E2023:099
Department of Technology Management and Economics
Chalmers University of Technology
SE-412 96 Gothenburg
Sweden
Telephone + 46 (0)31-772 1000

Gothenburg, Sweden 2023

Optimal Outbound Minimum Order Quantity (MOQ) in food supply chain

Nripan Sudas
Ravi Teja Ramineni

Department of Technology Management and Economics
Chalmers University of Technology

Abstract

IKEA is a Swedish multinational company that sells furniture, home accessories and food products. The company is spread over 50 countries and is known for its efficient supply chain and cost-effective products. Food has always been important for IKEA and is keen on selling the best quality food and services in all its stores in different cities worldwide. For food products, the central distribution centre is located in Helsingborg, Sweden. This Central distribution acts as a local distribution centre for the Scandinavian market. Products/items from various suppliers are received in the central distribution centre. The orders to the retailer are picked at the central distribution centre and then sent to the local distribution centres/terminals.

The purpose of the master thesis is to analyse an optimal minimum order quantity (MOQ) at IKEA's food sales channels. In addition, the study will focus on analysing the various operations related to ordering, labour, inventory, pallets, storage, and transportation impacted by the MOQ policy. To fulfil this purpose, empirical data on the current situation was collected to observe the process. Interviews and on-site visits were planned to understand the process and operations at different places. The empirical data collected were analysed to identify the problems/ disruptions related to order management.

In conclusion, to stabilise the ordering by retailers, an Optimal Minimum order quantity (MOQ) is implemented, by which irregular ordering quantities by the retailers could be controlled. Meanwhile, the labour and time spent during picking and sorting products at the central distribution centre could also be reduced. Overall, in addition to all these, the costs involved in all these processes could be minimised. Moreover, a real-time and practical implementation method was also suggested to effectively use the analysed solution.

Keywords: Supply Chain Management, Food Supply chain, Minimum Order Quantity, Costs, Product Planning, Inventory Management, Order Management

Acknowledgement

This master's thesis was written at the Department of Technology Management and Economics as the final project of a Master of Science in Supply Chain Management at Chalmers University.

Firstly, we would like to thank IKEA Purchasing Services (Sweden) AB for the opportunity to conduct this master’s thesis in an exciting environment. We heartily express our gratitude to all the employees who spent their time answering our questions, participating in the interviews, and accompanying us during our on-site visits.

We would also like to thank our supervisor at IKEA, Simon Runefors and his colleague Dragan Blagojevic, who provided valuable input and data throughout the travel. Without the guidance and support, the thesis would not have been possible.

We would also like to address special gratitude and support to Ludvig Lindlöf, our supervisor at Chalmers University of Technology. Thank you all for the guidance, support and feedback that has helped us obtain the outcomes of this thesis.

Nripan Sudas & Ravi Teja Ramineni, Gothenburg, June 2023

List of Acronyms

Below is the list of acronyms that have been used throughout this thesis listed in alphabetical order:

3PL	Third-Party Logistic
BD	Business Developer
CDC	Central Distribution Centre
DC	Distribution Centre
DmP	Demand Planner
DP	Delivery Planner
EHUQ	Economic Handling of Unit Quantities
EOQ	Economic Order Quantity
FDC	Food Demand Coordinator
FSC	Food Supply Chain
FSCM	Food Supply Chain Management
FVC	Food Value Chain
LSP	Logistic Service Provider
MOQ	Minimum Order Quantity
NP	Need Planner
SFM	Swedish Food market
SO	Service Office
SPOD	Service Provider Operations Developer

Contents

1. Introduction

1.1 Background

Supply chains are complex systems requiring coordination and collaboration between multiple actors, such as suppliers, manufacturers, distributors, and retailers. Due to globalisation and technological advancements, supply chains have become increasingly complex. Additionally, the COVID-19 pandemic has highlighted the vulnerabilities in global supply chains, leading to shortages of critical goods and disruptions in everyday business operations.

Order management is crucial in ensuring the supply chain's efficient and effective flow of goods and services. According to the article 'Supply Chain Management: Strategy, Planning, and Operation' (Chopra & Meindl, 2015), order management plays a vital role in managing customer demand and inventory levels and coordinating the activities of various players in the supply chain. Effective order management helps companies reduce costs, minimise waste, respond quickly to changes in customer demand and market conditions, and ensure the delivery of the right products to the right place at the right time and in the correct quantity. These benefits contribute to the overall optimisation of the supply chain, which is critical for meeting customer expectations and maintaining the company's reputation.

To manage and maintain relationships effectively between the different stakeholders, companies must clearly understand the factors that affect their supply chains, including order and minimum order quantity (MOQ). Minimum Order Quantity or MOQ refers to the minimum number of goods/ items a retailer needs to order to maintain an efficient supply chain (H. Zhu, 2002). Henceforth, the term 'MOQ' will be expressly used to address the term 'Minimum Order Quantity' in the rest of the document. This requirement can significantly impact a company's supply chain, affecting the amount of inventory a company can hold, the cost of goods, and the lead time between ordering and receiving the goods.

According to a research paper by Hitt and Ireland (1985), MOQ can positively and negatively affect supply chain performance. MOQ can help reduce the cost of goods by allowing suppliers to sell goods in bulk, resulting in lower per-unit prices. On the other hand, MOQ can limit a company's flexibility in terms of the amount of inventory they can hold, negatively impacting the overall performance of a supply chain, as it can increase the risk of keeping higher inventory levels and disrupt the flow of goods.

Setting a minimum order quantity (MOQ) is a common practice in the business world. Organisations face various costs and constraints and aim to ensure that they make a profit from each order. These costs include transportation, holding, handling, and administration expenses, which can account for a small portion of the overall order value. However, smaller order quantities result in a more significant part of these costs being deducted from the profit margin. The study will provide background information on IKEA's supply chain and sustainability efforts, analyse the problem, and develop an optimal solution to address the challenges with the current system.

2. Purpose

Ordering the right quantities can reduce operational expenses and control the investment in inventory, ultimately optimising the total supply chain costs. Through observation, orders placed for smaller and improper quantities often lead to inefficient transport methods, resulting in low truck fill rates and uneven pallets. Additionally, the increased picking frequency leads to higher investment in the working capital, which eventually results in higher holding costs. So, when an optimal minimum order quantity is set, there would be savings on high costs such as delivery, picking, transport, etc.

The purpose of this master thesis is to analyse the ordering processes and implement an optimal minimum order quantity (MOQ) at IKEA's food sales channels. It will comprise a study of information and data on ordering different food articles/ products by retail stores. The research will provide an in-depth analysis of the MOQ policy in IKEA's food supply chain and its impact. In addition, the study will focus on analysing the various operations related to ordering, labour, inventory, pallets, storage, and transportation impacted by the MOQ policy.

2.1 Scope

The topic will mainly focus on the final stages of IKEA's food supply chain, from the local distribution centre to deliveries being dispatched to the retail stores. The study will focus on the Scandinavian markets, with a DC in Helsingborg serving 21 retail stores. The Scandinavian market is selected based on the accessibility for data collection and analysing of the current situation with the support of different stakeholders.

The study will not focus on information and data related to the daily operations between the suppliers and DC. Meanwhile, the study will focus on products as they make their way from the local DC at Helsingborg to the retail stores in the Scandinavian markets.

Upon collecting necessary and relevant data from the Scandinavian market, the objective is to analyse the current situation and conclude how implementing an optimal MOQ would overcome current difficulties. The process will also consider the costs, lead time, and other attributes unique to food products, such as best-before dates, availability, and frequency of replenishments.

3. Case Company

IKEA is a multinational furniture retailer known for its distinctive Swedish design and affordable prices with a vision ‘to create a better everyday life for many people’. Their unique value chain includes everything from product development, design, supply, and sales, which begins and ends with the customer. The company operates in over 50 countries worldwide and is known for its efficient and cost-effective supply chain.

Like creating space for its customers to make their homes beautiful and practical, food has always been important for IKEA. As Ingvar put it: "It’s tough to do business with hungry stomachs”. IKEA is keen on providing the best quality food and services in all their city stores, equipped with the facility to serve their customers. IKEA mainly offers three dining options for customers: the IKEA Restaurant, the IKEA Bistro, and the Swedish Food Market (SFM).

The IKEA Restaurant is a self-service option located in the store's heart, offering affordable meals for breakfast, lunch, dinner, and “fika”. The IKEA Bistro is a quick and convenient option for food and beverages, serving as a cheerful ending to the store experience. The Swedish Food Market is a self-service speciality shop that sells products based on Swedish recipes and traditions, offering customers a chance to taste traditional Swedish food and purchase products used in the IKEA Restaurant to bring home.

As an overview, IKEA’s Food supply chain consists of the Central Distribution Centre (CDC) located in Helsingborg, Sweden, from where most of the products/articles are shipped to the respective Distribution Centres (DC) via different carriers in various markets across the world, such as Europe, Middle East, Asia, and the Americas. From these DCs, the products are again transported to the different retail store units within the respective markets. Additionally, there also exists a purchase order flow that goes directly from the supplier to the local DCs. IKEA’s food supply chain is based on a pull system, where the retailer's place orders for the required quantity, which is then analysed and approved by the Food Demand Coordinators (FDC) and then sent to the DCs for picking. Once approved, the DCs pick the items and quantities per the approved list and are transported to the respective retailers.

Different roles and responsibilities within the IKEA Food supply chain coordinate to create this complex yet well-oiled machine of a supply chain system. Some of them include Supply Planners (SP), Demand Planners (DmP), Need Planners (NP), Delivery Planners (DP), Food Demand Coordinators (FDC), Business Developers (BD), Supply Provider Operations Developer (SPOD), Logistic Service Providers (LSP) to name a few.

The Business Developer and Supply Planners are responsible for business-to-business relations with the LSPs and suppliers, their performance, capacity, and other performance indicators. Delivery planners are the interface between various functions. They are responsible for the distribution order replenishment to the respective DCs and the physical flow of all the purchase orders to the retail stores. There are currently 19 DCs located all over the world. They are replenished with distribution orders 1-3 times per week, and many are replenished with purchase orders daily. The Need Planners align with the business segmentation and different product groups and adjust planned purchases with inputs from the delivery and supply planners. SPOD are responsible for ensuring that the Logistic service providers deliver the goods as expected from the suppliers to the respective retail stores.

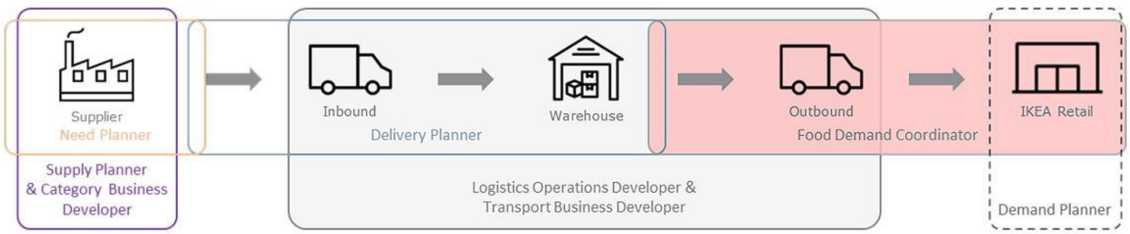

Figure 1: IKEA Food Supply Chain (Image Source: IKEA onboarding presentation)

Food Demand Coordinators at IKEA are responsible for coordinating directly with the DCs and the service offices in their respective markets to maintain the continuous and optimised flow of goods in the Global IKEA Food Supply Chain. They ensure the right amount of food is available at the right time to meet customer demand and support IKEA retail stores. Their role involves forecasting food demand based on sales data, inventory levels, and upcoming promotions and communicating with suppliers to ensure the timely delivery of food products.

Food Demand Coordinators are also responsible for monitoring food waste and implementing strategies to minimise it, such as adjusting food production levels and identifying food donations or recycling opportunities. Additionally, they work closely with the kitchen and restaurant teams to optimise menu offerings and ensure that the food served meets IKEA's quality standards.

Other responsibilities of a Food Demand Coordinator at IKEA include conducting market research to identify new food trends and customer preferences, developing and implementing food safety protocols, and managing budgets and expenses related to food procurement. Overall, the Food Demand Coordinator is critical in ensuring that IKEA's food service operations run smoothly and efficiently while meeting customer needs and minimising waste.

In conclusion, IKEA’s Food supply chain and the various stakeholders involved in it are crucial for their effective supply chain operations and to ensure that the right amount of food is available in the right quantity at the right time. The next chapter is a Literature review which provides a theoretical framework of different concepts, and theories. This theoretical framework will be beneficial in understanding the practical operations in different areas.

4. Literature Review

The literature review consists of relevant papers, articles, and reports on optimising MOQs during ordering. The primary search terms used to identify relevant literature for this master's thesis were "minimum order quantity," "MOQ," "MDQ," "EOQ," "inventory costs," "holding costs," "transportation costs," "logistic costs," "ordering costs," "order management," and "food supply chains". The search used various resources, including the Chalmers Library and Google Scholar. Through these sources, numerous articles were accessed from databases such as Science Direct and SpringerLink, etc.

4.1 Food Supply Chain

Several authors have focused on the challenges and opportunities presented by sustainable food supply chain management. Bourlakis and Weightman (2018) provide an overview of the key principles and practices of food supply chain management, focusing on sustainability. Similarly, Accorsi et al. (2021) highlight the importance of interdisciplinary methodologies in designing and controlling sustainable food supply chains. Dani (2015) provides an overview of the key elements of food supply chain management, focusing on logistics and distribution. They highlight the importance of effective communication and collaboration among supply chain partners and using technology and data analytics to improve supply chain efficiency.

The article by van der Vorst, Beulens, de Wit, and van Beek (1998) focuses on the importance of supply chain management (SCM) in the food industry and its role in reducing uncertainty to improve performance. In contemporary Supply Chain Management (SCM) literature, there is a growing emphasis on the importance of collaborative efforts among various stakeholders within the supply chain, ranging from primary producers to end-consumers, to meet consumer demands while minimising costs (Scott & Westbrook, 1991; Ellram, 1991; Towill, 1996). Jones and Riley (1985) define SCM as an integrated approach to planning and managing the flow of materials from suppliers to end-users. According to Fearne (1996), Supply Chain Management (SCM) aims to establish mutually beneficial relationships between buyers and sellers by defining organisational structures and contractual arrangements. Historically, these relationships have been regarded as adversarial.

In the food industry, the distribution of products is a crucial aspect in improving the performance of the supply chain, which can be done by ensuring the timely and efficient delivery of products. The distribution system is influenced and affected by various internal and external factors such as logistics management, environmental sustainability, and consumer trends. Karki et al. (2021) suggest that adopting relevant technology in the food supply chain can help optimise the distribution of food products. For instance, using IT can improve the efficiency and effectiveness of distribution. However, adopting a few sustainable practices can positively impact distribution activity. As a result, having an efficient distribution system increases efficiency and delivery times and reduces related costs.

According to Li et al. (2006), managing the ordering and storage of food in the supply chain is a complex task due to various factors. These factors include the limited shelf life and propensity to deteriorate over time of fresh produce, the seasonal nature of production requiring global sourcing, and special storage and transportation to maintain product quality. and compliance with national and international food safety regulations and environmental concerns. Environmental considerations also play an important role in the food supply chain. Distribution and transportation emissions are the main contributors to carbon dioxide (CO2) emissions throughout the supply chain, from suppliers to customers.

Energy consumption is also an important issue in the food supply chain, as the energy used in production, transportation and storage contributes to the overall environmental impact. Additionally, food waste generated throughout the supply chain due to perishable products exacerbates the environmental impact of the food supply chain. Additionally, frequent ordering of products can lead to more emissions and energy consumption in transporting these goods from one point to another. Therefore, efficient food supply chain management is necessary to reduce the environmental impact.

4.2 Food Assortment and Seasonality

The expansion of modern food markets and retailers in developing countries is driven by population growth, increasing urbanisation, a growing middle class, and rising incomes (Neven and Reardon, 2009; Reardon and Berdegué, 2002; Reardon et al., 2003; Ruben et al., 2007; Reardon et al., 2012). This growth is most evident in urban areas, where time-strapped consumers desire convenience in grocery shopping and access to a wide range of foods available year-round.

Modern food markets are successfully expanding the processed and packaged food market by offering a wide assortment (e.g., produce, meats, dairy, and packaged/processed) of products year-round (Reardon et al., 2003; Humphrey, 2005; Reardon and Gulati, 2008). Economies of scale enable the production, marketing, and distribution of packaged/processed foods at low unit prices. These chains also benefit from economies of scale in producing, marketing, and distributing shelf-stable packaged/processed foods (Reardon and Timmer, 2007; Reardon and Gulati, 2008).

Coordination among modern Food Value Chain (FVC) participants allows them to offer a wide range of fresh and processed/packaged foods throughout the year (Reardon and Barrett, 2000). In addition, increasing interaction between medium/large food processing wholesalers, driven by technological developments, allows modern FVCs to cost-effectively manage larger inventories, develop more attractive packaging, and offer various products that meet modern supermarket standards.

In addition, technological developments such as barcode scanning, electronic point-of-sale, and efficient customer service enable modern FVCs to cost-effectively manage larger inventories, develop more attractive packaging, and offer various products that meet modern supermarket standards (Hawkes, 2008; Reardon et al., 2012). Food markets also offer a wide range of ready-to-cook and ready-to-eat frozen, canned, or packaged products that provide convenience to consumers (Burch and Lawrence, 2007). Overall, expanding modern food markets in developing countries provides consumers greater access to a wider variety of food products, especially in urban areas.

The need for quality food in an ever-growing world with diverse dietary needs and preferences poses a considerable challenge. The issues like perishability, shelf times, traceability, and seasonality make food supply chain management (FSCM) a complex problem. Due to its complex nature, effective Food Supply Chain Management (FSCM) has been crucial in addressing these challenges (Sufiyan et al., 2019). Kumar and Nigmatullin (2011) also talk about seasonality and how they affect the changes and trends in demand uncertainty. They describe how seasonality adds more complexity to food supply chains by creating high fluctuations due to consumer demand and the availability of raw materials. They also mention that awareness of these challenges is not enough. Rather seeking and implementing the latest and best practices to help food supply chains become more efficient needs to be paid more attention.

Rojas and Frein (2008) suggest that a value-based assessment of the current business and an understanding how the business can be transformed are required to comprehensively understand the market and industry trends and strategies. For example, Sufiyan (Sufiyan et al., 2019) also state that the number of stock-outs is higher with demand growth, seasonality, and shorter lead times at the retailers.

4.3 Demand and Uncertainties in Supply Chain

Various literature also acknowledge that consumer demand can be subject to variations resulting from weather changes, seasonality, and changing preferences (Nahmias, 2015; Lee et al., 2007). Additionally, inherent process uncertainty, such as fluctuations in process outcomes and production times due to variable process yield, perishable end-products, and machine breakdowns, can contribute to overall supply chain uncertainty (Vlachos et al., 2017; Blackhurst et al., 2005). Furthermore, inherent supply uncertainty may result from variations in supply performance due to natural fluctuations in quality, seasonal patterns, and variable yield (Christopher, 2016). Supply chain management strategies have been developed to reduce the impact of inherent uncertainties by improving the exchange of information upstream and downstream in the supply chain and adapting procedures to better align with supply chain needs (Simchi-Levi et al., 2007). Nevertheless, the most significant benefits of SCM are achieved by reducing other sources of uncertainty within the supply chain (Chopra and Meindl, 2016; Cachon and Terwiesch, 2013).

Efficient supply chain management has become crucial in today's highly competitive marketplace. Researchers have identified several ways in which supply chain processes can be improved. Towill (1996) emphasises the need to simplify decision-making procedures. On the other hand, other authors focus on the information available to supply chain partners and its availability speed to reduce inventories and enhance customer service. For instance, Moinzadeh and Aggarwal (1996), Cachon and Fisher (1997), Bourland et al. (1996), and Kreuwels (1994) suggest that improving the availability and accessibility of information can have a significant impact on supply chain efficiency. Overall, these studies highlight the importance of simplifying processes and improving the flow of information to enhance supply chain management.

Traditionally, uncertainties in the supply chain, such as quality variations, supplier unreliability, and unpredictable customer demand, have been addressed by building inventories or over-providing capacity, which is now considered costly and ineffective. In the current highly competitive market, the ability to respond rapidly to end-consumer demand is a key factor for success. Competition has shifted from individual organisations to competition between supply chains (Stalk and Hout, 1990). Supply Chain Management must consider end-customer service requirements, determine optimal inventory positioning and stocking levels, and develop policies and procedures for managing the supply chain as a single entity (Jones and Riley, 1985).

McGuffog (1997) argues that even under stable customer demand, institutional factors such as structures, computer systems, and capacities of machines or vehicles, as well as random factors, can lead to cyclical and extreme demand variations in each stage of the supply chain. This phenomenon, known as the 'Forrester effect' or bullwhip effect, leads to demand distortion and variance amplification, resulting in significant cost implications. These costs include excess raw materials, additional manufacturing expenses, and warehousing costs due to high stock levels (Towill, 1996). According to Kurt Salmon Associates (1993), these activities can result in 12.5% to 25% excess costs. Forrester (1961) explains that the effect results from the time-varying behaviours of industrial organisations and the absence of correct feedback control systems. In this context, effective supply chain management should focus on minimising the bullwhip effect by recognising end-customer service level requirements, developing appropriate policies and procedures, and positioning inventories strategically along the supply chain (Jones and Riley, 1985).

The bullwhip effect has been a concern in supply chain management literature due to its significant cost implications. Lee et al. (1997) conducted a study on the bullwhip effect using multiple case studies and identified four primary causes. These include demand signal processing, order batching, price variations, and shortage gaming. The authors highlighted that long lead times exacerbate demand signal processing by causing firms to order more in anticipation of further demand increases, thus communicating an artificially high level of demand. Due to fixed costs at one location, order batching was also identified as a significant cause of the bullwhip effect. Additionally, price variations encourage bulk orders, while shortage gaming, which arises from the fear of a shortage or a current shortage, results in firms exaggerating orders with the expectation of receiving a larger share of the available items. These findings suggest that reactions to uncertainties in demand or supply and the complexity and structure of current decision processes cause the bullwhip effect.

According to van der Vorst et al. (1998), the first and most significant source of uncertainty in supply chain management is the total order forecast horizon, which covers the period from order placement to the receipt of goods for the following order. The order lead time, which is the time taken to receive ordered goods from the moment an order is placed, comprises five elements: (1) the time taken for the order to be received and processed by the supplier (information lead time), (2) the time required to generate a production plan, picking lists, and distribution schedules (administration or decision process time), (3) the time needed to produce the products, if applicable, (4) the time needed to pick, load and transport the products (distribution lead time), and (5) waiting times between processes (van der Vorst et al. (1998)). On the other hand, the order sales period refers to the time between two successive deliveries, and the order must be large enough to suffice for sales during this period. Long order lead times and low delivery frequencies may increase uncertainty, resulting in high safety stock levels and non-value-added activities. Reducing the total order forecast horizon, which is the sum of the order lead time and order sales period, can significantly improve supply chain performance.

Much literature has given significant attention to two-echelon supply chain models incorporating stochastic consumer demand and order batch sizes. Researchers such as van Beek (1981), Svoronos and Zipkin (1988), Axsaster (1993), Chen and Zheng (1995), and Cachon (1995) have contributed to the literature in this area. These studies typically assume that retailers have the flexibility to place orders in each period and can be employed to investigate the relationship between batch size and supply chain performance. However, they tend to overlook the impact of human behaviour on decision-making processes. As a result, different outcomes may arise due to cognitive or political influences, such as shortage-gaming and forward buying, which could affect operational performance. Therefore, it is important to consider the potential impact of human behaviour on supply chain decision-making when studying the relationship between batch size and performance.

4.4 Key Factors and Costs in Supply Chain

Supply chain management involves various activities, and information availability and sharing are crucial to its success. Access to real-time information can help optimise operations, reduce costs, and improve customer service levels. Therefore, ensuring that information is readily available and shared efficiently across all supply chain partners is imperative. Information availability and transparency are key factors in reducing costs and improving customer service. According to Van der Duyn Schouten et al. (1994), providing information on the status of upcoming production runs can enable a retailer to reduce inventory costs by up to 30% while still meeting service constraints. However, timely and applicable data exchange is crucial in achieving these benefits. Inventory control systems must be well-managed and up-to-date to provide current information on stock levels and availability (Lewis and Naim, 1995). Failure to do so will result in an even larger order forecast horizon. Additionally, it is important to provide consumer-demand information in a format that eliminates translation problems (Beulens, 1992)

Van der Vorst et al. (1998) provide insights into performance indicators that mainly focus on supply chain costs, which include costs related to average stock levels at distribution centres and retail outlets, costs related to all relevant processes at all stages in the supply chain, and costs of product write-offs and necessary price reductions. In addition to costs, the authors also emphasise the importance of service-related indicators such as the number of out-of-stocks at retail stores, missed sales caused by stock-outs, delivery reliability of producers and retail distribution centres, average remaining product freshness, utilisation degrees of transport carriers, and product assortment. These performance indicators are crucial in evaluating and improving the effectiveness of supply chain management strategies.

Silver (1991) also argues that many inventory models fail to consider the full range of costs associated with the supply chain. Specifically, they tend to overlook costs associated with order processing, handling, and transportation and fail to account for interactions between different factors, such as the utilisation of trucks and their impact on delivery quantities. As such, Silver highlights the need for more comprehensive and integrated models that consider the full range of costs and complexities involved in supply chain management.

4.5 Distribution and Third-Party Logistics

Supply Chain Management generally deals with issues such as what and how to produce, managing the flow of products/goods, how much to store at different locations etc. Most industries or distributing companies focus on ensuring that their supply chain is more efficient in order to avoid disruptions (Savsar, M. 2021). Moreover, to distribute the products/ goods through the chain, optimal physical infrastructure at the right location/ radius is necessary.

Distribution centres are typically large storage places or areas where goods are received from various locations. The products received are distributed to various locations from such facilities/ storage areas. When the supply chain is considered, locating the distribution centres is a major task, as operational efficiency is based on transportation time, inventory levels, operational costs etc (Savsar, M. 2021). Therefore, to avoid flaws in these aspects, most of the companies depending on the products they manufacture/ sell, set up central distribution centres, which primarily serve as a hub to receive, store, and distribute the products/ goods.

The CDCs and DCs of any company increase the operational and overall efficiency without having any impact on customer satisfaction. In addition to these, the risks in the supply chain during logistics and shipment of products are controlled, and the entire process is carried out in a cost-effective manner (Dani, S. 2021). When companies locate their CDCs or DCs at optimal locations, then the main problems related to storage, and transportation in the supply chain can be easily controlled.

Logistics management is how a company integrates internally and externally with suppliers, customers, and service providers. The focus should be the movement of products in a safe and tamper-free environment and simultaneously retaining quality (Dani, S. 2021). However, this can be ensured by proper packaging and handling systems. In today's world, most companies have considered the idea of outsourcing their logistics activities, as it allows companies to concentrate on their core business which eventually results in improving their performance and reducing the related costs (Balcou et al., 2017).

A third-party logistics (3PL) is an agreement/contract between a company with long and varied supply chains made with a logistic service provider company to outsource its logistical operations (Yadav et al. 2020). Nowadays, most companies, especially the food industry and similar firms, outsource their logistic activities to improve efficiency and focus more on their core competence. However, the success of the 3PL provider will be based on on-time delivery, product safety and customer satisfaction (Yadav et al., 2020). Initially, 3PL providers focused mainly on logistics and transportation and warehouse management. Due to the growing demand and scope, in addition to those, they are involved in the tactical management of customer activities in the complex supply chain, which eventually benefits their customers (Yadav et al. 2020).

4.6 Inventory Management

Inventory management is critical to supply chain efficiency, encompassing several cost components, including purchasing, order, inventory holding, and stock-out costs (Bottani et al., 2011). However, the economic value of perishable goods deteriorates significantly over time due to the limited product shelf-life, which can generate additional costs such as shrinkage, spoilage, or obsolescence (Bottani et al., 2014). Perishable products have a limited period during which they can be sold or consumed at a profit due to shelf-life constraints. In addition to the cost of holding stocks, additional expenses are associated with removing perishable foods from the shelf when they expire and disposing of them (Rajan et al., 1992).

Maintaining optimal inventory levels is a crucial aspect of supply chain management, directly impacting the organisation's economic and environmental sustainability. Holding low inventory levels to reduce holding costs can result in potential financial losses in the case of unsatisfied demand. The cost of stockouts, which refers to the loss of potential sales due to the unavailability of products, can significantly impact the organisation's revenue and reputation. On the other hand, holding excessive inventory levels can lead to higher holding costs and additional costs due to the perishability of goods. Perishable products require a controlled temperature environment, which results in higher energy consumption and increased carbon dioxide ($CO2$) emissions due to cooling.

In addition, the waste generated due to expired or damaged inventory results in further $CO2$ emissions, causing an additional environmental burden due to the destruction of energy and other resources. Having said this, the paper will not focus on the $CO2$ emissions or sustainable impacts on the environment with the implementation of minimum order quantity as it is out of the scope of the study.

Effective inventory management minimises supply chain costs while ensuring timely delivery to customers. Holding excessive inventory can lead to higher holding costs and possible product obsolescence or spoilage, while keeping low inventory levels may result in lost sales due to stockouts (Bottani et al., 2011). In addition to these costs, perishable products have a limited shelf-life, which further adds to the complexity of inventory management (Blackburn & Scudder, 2009). Therefore, finding the optimal inventory level that balances the cost of holding inventory and the cost of stockouts is essential for the economic and environmental sustainability of the organisation.

Maintaining optimal inventory levels is crucial for achieving economic and environmental sustainability in supply chain management. Organisations must balance the costs of holding inventory against the costs of stockouts and the environmental impact of excess inventory and waste. Moreover, the ordering patterns in the food industry are influenced by certain factors such as product type, price, the retail environment, and other shipping factors (Van et al., 2010). In addition, other factors like product quality, promotions, time pressure and environment influence the ordering patterns. Van et al. (2010) suggest that retailers consider all these factors to optimise their ordering strategies and improve their overall performance.

4.7 Minimum order quantity

One of the ways to manage inventory levels is by setting a minimum order quantity (MOQ), which refers to the minimum number of products/ items a retailer needs to order to maintain an efficient supply chain (H. Zhu, 2002). The paper by Cai et al. (2022) addresses the capacity allocation problem and discusses how MOQ can help shrink the gap of equilibrium order quantities. Additionally, MOQ has a non-decreasing effect on the supplier and supply chain profit and a non-increasing effect on each retailer's profit. The authors suggest that future research could explore demand competition, multi-period allocation, and allocating multiple products from a common supplier. Overall, the paper contributes to the literature on capacity allocation and provides insights into the impact of MOQ.

The paper by Chow et al. (2012) aims to investigate the impact of the minimum order quantity (MOQ) on supply chains. Using a game theoretic model, the authors analyse the behaviour of a manufacturer and a retailer facing stochastic demand in a two-period setting with and without MOQ. The study finds that MOQ can benefit both the manufacturer and retailer by reducing inventory holding costs and increasing profits. The paper also brings out the perspective of how the optimal MOQ level depends on the tradeoff between cost savings and customer service levels, highlighting the importance of collaborative decision-making between supply chain partners. The paper also discusses the principle of economy of scale and how MOQ can justify the production setup cost of the manufacturer while guaranteeing a certain level of income.

Anupindi and Bassok (1999) suggest that implementing MOQ can reduce uncertainty during the ordering process. It also helps justify production setup costs and guarantee income levels through the economy of scale principle. However, Chow et al. (2012) highlight that MOQ can limit the retailer's ordering flexibility and increase stockout frequency, negatively affecting customer service levels. In a study of the two-stage ordering problem with forecast revisions and uncertain future ordering costs, Choi et al. (2003) explore the impact of MOQ on supply chain efficiency. Chow et al. (2008) analyse the performance of retailers and manufacturers under a QR system with dual ordering flexibility and MOQ imposition at an earlier stage. The authors derive expected profits under different MOQ ranges and demonstrate that an optimal MOQ can improve supply chain efficiency. The optimal MOQ level must balance cost savings and customer service levels, emphasising the need for collaborative decision-making among supply chain partners. These studies provide valuable insights into the impact of MOQ on quick-response supply chains and identify areas for future research.

Another widely used inventory management policy to determine the optimal order quantity is the Economic Order Quantity (EOQ), which considers constant and known demand per time unit and fixed lead time during ordering (Jonsson and Mattsson, 2009). However, suppliers often impose a Minimum Order Quantity (MOQ) to ensure that each specific item's production runs and shipping quantities are economically viable, and additional economies of scale may arise as various items share high joint costs. MOQ and EOQ have different objectives and implications. MOQ serves as a policy that sets a minimum quantity that must be ordered from a business, often to take advantage of economies of scale in production or transportation. At the same time, EOQ calculates the optimal order quantity that minimises total inventory costs, including holding and ordering costs, for a given demand rate and unit cost. While MOQ can reduce uncertainty and justify production setup costs, it may also restrict retailer ordering flexibility and increase stockout frequency. On the other hand, EOQ minimises inventory holding and ordering costs but assumes deterministic demand and constant unit costs, which may not be realistic in practice.

Minimum Order Quantity (MOQ) is a common practice employed by businesses to ensure that production runs and shipping quantities of each specific item are economically viable. Research by Chow et al. (2012) investigated the impact of MOQ on a supply chain using a game theoretic model. In contrast, Harris (1913) developed the classical Economic Order Quantity (EOQ) model, which determines the optimal order quantity that minimises the sum of ordering and holding costs. While MOQ can help manufacturers reduce uncertainty and justify production setup costs (Bassok et al., 2002), it may also limit retailer ordering flexibility and increase stockout frequency (Chow et al., 2012). Conversely, EOQ can reduce inventory holding and ordering costs, but it assumes deterministic demand and constant unit costs, which may not be realistic in practice (Silver et al., 2019). These findings demonstrate the importance of considering MOQ and EOQ as distinct inventory management policies with varying implications for supply chain partners These literatures also suggest that MOQ and EOQ are valuable inventory management policies, but they serve different purposes and have different implications for supply chain partners. Therefore, the study will not dive deeper into the concept of EOQ and rather focus more on the important aspects of packaging and handling orders when deciding on the Minimum order quantity.

Units and quantity handling are major topics in supply chains. It pertains to identifying the nested handling of units, including containers, and pallets, analysed sub-cartons, based on their type and size. Economic Handling of Unit Quantities (EHUQ) is talked about quite well by McDonald (2016). He describes selecting the appropriate container types, loading configuration, pallet and case quantities, warehouse picking profiles and estimating the end-to-end supply chain costs. Additionally, he talks about models affecting the total supply chain costs, attributing to various factors such as packaging, consumables, in- and out-bound transportation, warehouse receiving, picking, and packing costs etc.

On the other hand, packaging plays a vital role in ensuring the safety and quality of products and helps extend the shelf life of certain products. Effective packaging and handling strategies can help reduce costs and improve inventory management in the food industry. Coordination among supply chain players is also important in FSCM as it allows year-round availability of fresh and processed/packaged food.

Packaging can increase warehouse productivity if products are packed in order quantities so that the packaging does not need to be opened or split (Richardson, 1999). A minimum order quantity restriction has been viewed as a way to control costs by reducing the costs related to small orders (Bennion, 1987), and picking and packing activities affect the ordering process (Croxton, 2003). The costs indirectly related to the design of the packaging include packing, handling, storage, transport, and claims, and these costs are relatively high in a retail supply chain where the value of goods is low and the goods are managed by many parties (Hellström and Nilsson, 2011).

Szymonik (2016) divides packaging into various groups considering the requirements associated with participation in the supply chain, the type of unit load (logistic load) and the marking system used. Some of the logistic unit forms he distinguishes are packaged goods, containers, boxes, palettes, packet units etc. Establishing a logistic unit may involve combining products into larger units, standardising their shapes and sizes for mechanical handling, and arranging them for stacking. Molina et al. (2018) investigate the effects of different packing interlocking patterns on pallet deflection and the effect of package orientation and pattern of the bottom layer of the unit load on pallet deflection.

Paciarotti et al. (2021) focus on costs related to ordering and handling orders when deciding on the order quantity. Similarly, managing effective logistics/operations involved in product shipment ensures that products are delivered on time and in good condition. Some essential costs are involved in packaging and operations in the food industry, such as material costs, labour costs, energy and utility costs and transportation costs. Effective packaging and operation strategies can help to reduce these costs and improve inventory management (Paciarotti et al., 2021).

This literature review has facilitated the development of knowledge and insights on the concept of MOQ and how they impact the various areas of supply chains, such as ordering, labour, inventory, pallets, storage, and transportation. With the developed knowledge, the implementation of MOQ is structured using suitable methodologies and analysing the same.

5 Methodology

5.1 Research Approach

This topic's research strategy will include qualitative and quantitative methods. Both qualitative and quantitative methods will be coupled as the results will be obtained based on interviews, MOQ scenarios, surveys, and past and current data.

To analyse the importance of MOQ and implement it, a quantitative approach i.,e. the data collection will be the primary method to understand the product assortments, ordering patterns, various costs in the warehouse, packaging and other valuable data. Collecting the necessary data will help understand and analyse the connection between the ordering processes and evaluate the retailer's requirements. From a qualitative perspective, Interviews and on-site visits will be considered to understand the functions and different operations that happen at both DC and the retail stores.

In addition to these, MOQ scenarios and surveys will be two of the methodologies as a part of the research. MOQ scenarios will assist in understanding how MOQ implementation will be efficient when certain key factors are evaluated. Similarly, Surveys help understand the acceptance and denial levels when trying to implement the MOQ. All these methodologies will be utilised to finally design a roadmap to implement the recommended MOQ.

5.2 Data Collection

This section represents how the necessary data is collected and analysed. The data collection consists of Interviews, Case studies, On-site visits, and company material such as past and current data.

The past and current data collected included the ordering methods and quantities, i.e., the data about product information, the quantity of the product, the volume of the product when stacked on a pallet, product shelf-life etc. In addition to the data about the shipments, the costs involved during the entire process were also collected to analyse the savings that could be done from a cost perspective. However exact cost split for each process was practically difficult to fetch, but an overview of related costs was collected. The data collected was analysed in conjunction with the interviews as information and feedback from the interviews helped to understand the collected data.

5.2.1 IKEA Data

To gain insights into the current ordering patterns and cycles of IKEA, it is essential to collect and analyse data specifically related to the different food assortments and their ordering methods at the retail level. The data will provide a deeper understanding of how retail stores place their orders and the frequency at which they do so.

In addition to the food assortment data, other relevant data collected includes warehouse costs such as picking and handling of the products, food availability information, ordering cycles and patterns, forecast details, and data on volume and number of deliveries.

By examining and analysing these datasets, the study expects to uncover valuable information about the ordering behaviour of retail stores. This includes identifying trends in order frequency, order quantities, and preferred ordering methods for different food assortments. Understanding the ordering patterns will shed light on the demand patterns and enable the implementation of an optimal MOQ solution.

Further, analysing the collected data will help determine most efficient MOQ levels, considering factors such as picking and handling costs, outbound transportation costs, and product availability. By aligning the ordering patterns with the cost implications and overall supply chain dynamics, the analysis will aim to optimise inventory management, minimise costs, and enhance the total efficiency of the supply chain operations.

Finally, a key performance indicator on the drop sizes was collected for further analysis. This data set included the total number of deliveries and their volumes to each of the stores respectively over a period of one month. In addition to this, the order details for a particular retail store was also collected to compare and understand the changes in the KPI before and after the implementation of an optimal MOQ.

The combination of these datasets provides a comprehensive understanding of the supply chain dynamics, ordering behaviour, and cost implications, enabling informed decision-making and the development of effective strategies for inventory management, demand planning, and order fulfilment. Therefore, the analysis of the collected data with a specific focus on ordering patterns will provide valuable insights for the implementation of an optimal MOQ solution and improve the overall performance of IKEA’s food supply chain.

Data Set	Description	Period	Geographical reach
Food Assortment	All food assortment data for the global markets	10-03-2023	Sweden
Food Availability Tool	Global food availability data at Helsingborg DC with respect to their outbound flow to the different markets	24-05-2023	Sweden
Warehouse Price List	Picking, handling and holding services/costs at Helsingborg DC	N/A	Sweden
Domestic Outbound Price List	Per pallet prices from Helsingborg DC to the various retail stores	N/A	Sweden
Stock Transactions and Forecast	Product outbound transactions to different retail stores in Sweden and their forecast	01-01-2023 to 31-03-2023	Sweden
Drop Size KPI	Number of deliveries and volumes from Helsingborg DC to the retail stores that calculates the average shipment/drop size	01-03-2023 to 31-03-2023	Älmhult, Sweden

Table 1: Data Set accessed

5.2.2 Interviews

Face-to-face interviews are considered the most appropriate as the opportunity for rich data collection is comparatively high. Moreover, conducting a face-to-face interview provides the opportunity to gather additional information which would be relevant and helpful for analysis (Cassell, C. 2015).

Semi-Structured interviews with the employees of IKEA's retailers, IKEA's DCs and IKEA's business unit were conducted to understand different perspectives and challenges they face with the current situation. This method was chosen as interviews help elaborate the topic and provide insights into identifying and solving the problem by considering the challenges faced by different stakeholders. In addition, semi-structured interviews allow us to elaborate and understand more about important contexts by having follow-up questions.

Place	Role	Date of Interview	Duration of Interview
Älmhult, Sweden	Food Demand Coordinator 1	15-02-2023	60 Minutes
Helsingborg, Sweden (Central DC)	Logistic Service Provider	07-03-2023	90 Minutes
Älmhult, Sweden	Food Demand Coordinator 2	15-03-2023	60 Minutes
Älmhult, Sweden (Retail Store)	Kitchen Production Manager	22-03-2023	90 Minutes
Bäckebol, Sweden (Retail Store)	Kitchen Production Manager	21-04-2023	60 Minutes

Table 2: Interview Summary

The roles/ employees selected for the interview were Food Demand Coordinator and Logistic service provider (LSP) from IKEA's business area. Staff/ ground workers at the retail stores in Bäckebol and Älmhult were interviewed. These employees/actors were selected to interview as they were more closely related to the topic and worked on a daily basis. The interview form was structured based on the roles and responsibilities performed by the interviewees at their respective work domains to gather relevant information and understand their supply chain better. The interviewees were informed before the interview by explaining the purpose of the discussion.

The interviews were organised and carried out by both researchers, with one being the main interviewer and the other taking notes and asking follow-up questions. Each interview was supplemented by recording to ensure that no significant information was missed when analysing the problem. After each interview, the notes were summarised, and key information was discussed to understand the current process and situation. In addition, discussing the summary helped to draw effective results.

5.2.3 On-Site Visits

Along with the semi-structured interviews, three On-site visits in total were performed. An initial visit to the Central distribution centre at Helsingborg, followed by visits to the retail stores at Älmhult and Bäckebol. The purpose of these on-site visits was to visualise and understand the operations and supply chain processes in detail. The retail stores and Central DC were selected to understand how the information and product flow takes place, i.e., once it is received from the suppliers until it is purchased by the end consumers.

During the visits, an opportunity to interact with key actors, observe the handling and storage of products, and gain insights into various operational aspects was possible. This on-site exploration also provided valuable context and detail to complement the information gathered through interviews and data analysis. Experiencing the operations and supply chain processes on-site aided in developing a more holistic understanding of the challenges, opportunities, and potential areas for improvement within the IKEA distribution network. These insights could then assist in further analysis, recommendations, and potential optimisation strategies for enhancing the efficiency and effectiveness of the supply chain.

Overall, the on-site visits served as a crucial component of the research methodology, bridging the gap between theoretical knowledge and real-world implementation and facilitating a deeper understanding of the complexities and dynamics of IKEA's supply chain operations.

5.2.4 Survey

Another methodology chosen for the thesis topic is conducting a survey. Surveys are mostly used to determine the content and methodology and help understand the opinions of different people with different mindsets (Waters et al., 2007). Despite different survey patterns, web-based questionnaires survey pattern was chosen as a relevant method for this topic.

A web-based questionnaire was formed with questions related to MOQ, implementing MOQ, constraints in implementing MOQ etc., and to understand their knowledge level on MOQ and willingness to implement MOQ.

Before proceeding to analyse MOQ and the optimal solution for the current situation, it would be highly beneficial to examine the understanding level of retailers about MOQ and related content. Since IKEA is based all over the globe, it was practically not possible to reach all the retail stores. Service Office (SO), which acts as the mediator between retailers and the Business unit, was chosen as the right stakeholder to answer the web-based survey. The Service Office (SO) was chosen as they are in close contact with the retailers on a daily basis and have a good understanding of the mindset of the retailers. The survey was sent out to all the Service offices (SO) across the globe, and 12 responses were recorded. Results obtained in the survey will be discussed and analysed in further sections.

5.3 Data Analysis

5.3.1 IKEA Data

When conducting quantitative research, it is crucial to thoroughly review and analyse the data collected. This involves reading the data multiple times to comprehensively understand the content and identify key themes, patterns, and categories. As quantitative analysis is a creative process, it requires careful consideration of what is significant and meaningful in the data. Making thoughtful judgments about the data is essential for effective analysis and presentation of findings.

In addition, it is important to consider how the results obtained from different research methods are related and how the data obtained from each method can be integrated. By doing so, researchers can gain a more comprehensive understanding of the research topic and discover how the results of one approach support or correlate with the results of another. This data integration process is critical for generating meaningful insights from quantitative research and drawing accurate conclusions reflecting the research findings.

5.3.2 MOQ Scenarios

Scenarios are one of the essential ways to analyse the problem by considering situations at different levels/extremes to have a strong argument for the results that will be obtained. There are different types of scenarios, and it is important to use the right one and explain why this scenario is chosen for the research (Hammond et al., 2020). In addition, the study examines the effects in different scenarios by including or excluding certain factors depending on their requirement (Hammond et al., 2020). Since this topic focuses on the MOQ, different scenarios such as Large MOQ, Small MOQ, and No MOQ will be considered to analyse results which would help attain the results for this topic.

To obtain insight and analyse the optimal and feasible MOQ, three different scenarios with various factors were considered. The factors were derived from the observations made during the on-site visits and information received during the interviews and discussions.

The three different scenarios that will be considered for the case study will be '*Full pallet*', '*Full layer in a pallet*' and '*No MOQ*'. To examine the scenarios and check their feasibility, as mentioned, several factors were taken into consideration. The factors were considered based on capacity, costs, time, labour etc. As all factors may not be examined with mathematical figures, the different scenarios are analysed theoretically for better understanding.

6. Analysis

6.1 Data Set

The data analysis involved extensive data collection with the help of IKEA and its stakeholders, who were generous in providing access to various data points and excel files upon request. With this valuable data, the order patterns and trends in the ordering process were identified.

Additionally, an analysis of the costs will help understand the different costs involved in picking, handling, packing and storing the food products. The data on the assortment of food products for the Swedish market were collected as an initial analysis. This data set consisted of various data points related to product assortments, such as the different article names, their stock in the DC, which business area they belong to, storage requirements, pallet, and layer quantities. All this information was considered for further analysis.

6.1.1 Food Assortment

As an initial analysis, the variety of food products available to the Swedish market was observed from the food assortment data. Along with this, the different food products were grouped or classified based on their availability globally, regionally or nationally.

Moreover, different articles were also categorised according to the 'Business area' they were being used for, such as Restaurant, Bistro, and Swedish Food Market (SFM). The IKEA Restaurant is a self-service option located in the store's heart, offering affordable meals for breakfast, lunch, dinner, and "fika". The IKEA Bistro is a quick and convenient option for food and beverages, serving as a cheerful ending to the store experience. The Swedish Food Market, or SFM, is a self-service speciality shop that sells products based on Swedish recipes and traditions, offering customers a chance to taste traditional Swedish food and purchase products used in the IKEA Restaurant to bring home.

The storage requirements for different products based on temperature were another classification depending on whether they are ambient, chilled or frozen products. The number of each item in a pallet and layer was also described for each product. This helped in understanding how many units of each product fit into a layer pallet and a full pallet. As an obvious fact, it was also observed that the layer and pallet numbers were different for different products.

Another interesting factor observed was the 'Service Levels' of the products. Each product assortment was classified into different service levels, such as SL1, SL2, SL3 etc. Service level 1 products are the most important products, and the risk of availability and stockouts for these products were to be given the most attention. Similarly, the lower service levels products at risk of getting stock outs or having availability issues would not be a major concern. As an initial approach, an analysis of considering only higher service level items as a sample size and analysing the ordering patterns was thought of. But, it was soon realised that this wouldn't be the right approach, as the items with higher service levels need not always have an issue with lower levels of ordering patterns. For example, a higher service level item such as meatballs might have higher customer sales and result in retailers ordering higher/ full pallets of these items. Such products might not give the best results while analysing the positive and negative impacts of applying MOQ. Similarly, analysing a lower service-level item might not be recommended as items ordered at lower frequency might not necessarily have a higher impact on the supply chain.

To sum up, the assortment of products was used to understand and analyse the different product assortment in the Swedish market, along with comparing their service levels, storage requirements, layer and pallet units etc.

6.1.2 Food availability

Moving forward, data on the impact of different food assortments with respect to their availability and their stock transactions from DC were analysed. The product availability file provided valuable information regarding the impact of food assortment availability on the supply chain. This file categorised the availability of different food assortments based on their risk level, ranging from 'No issues' to 'Overstock', 'Risk of being unavailable', and 'Soon to be unavailable'. The items that had no issues usually performed quite stable, and not a lot of action was required on these assortments. The overstock items could be at risk of not being utilised and taking up space in the DC, as well as at the risk of expiring if close to their best-before dates (BBDs). Retail stores must order such products in higher quantities, create offers and sales steers, and be at risk of destruction due to expiry. Products that risk becoming unavailable must be paid attention to and not be over-ordered by the retail stores. Similarly, soon-to-be-unavailable products need to have a future replacement strategy to avoid the risk of dissatisfaction from the customer end.

This data was further used to develop a stock transaction and forecast data dump. Two product assortments under each availability range (i.e., 'No issues', 'Over stock', 'Risk of being unavailable', and all the way to 'Soon to be unavailable') were chosen for further analysis. These products were chosen after discussions and recommendations from the Food demand coordinator responsible for the market (Scandinavian market) according to the importance of these products for the market and the customers. The FDC also provided the forecast details and outbound flow of these products from the DC to the different retail stores.

From these data, a series of order patterns of these products were analysed, along with the operational forecast and outbound flow compared. While comparing the operational forecast and the outbound of these items, it was observed that the items that were soon to be unavailable and items with the risk of being unavailable had a stable forecast vs outbound numbers. The same was observed for the items with no issues as well. On the other hand, the items that were in overstock were having issues with meeting the forecast numbers. They were mostly in very low outbound numbers with respect to the operational forecast, leading to destruction and creating discounts at the end of the shelf life periods.

Furthermore, It was observed that almost all of these products were being ordered in very low quantities by the retail stores. But this was seen more pertinent in the items that were over stock in the DC. The items facing unavailability or were almost at risk of being unavailable were still being ordered close to Layer LHUs and Full Pallet LHU levels. A similar pattern could be found for the items that were stable or had no issues with availability.

Based on the provided comparisons, it can be inferred that the product assortment with overstock in the DC could be the major target for further research and analysis. These products displayed an uneven outflow in relation to their operational forecast, unlike the other products. Therefore, an analysis more into this set of product assortment was done, and a similar ordering pattern was observed.

6.1.3 Warehouse costs

To progress the analysis, the prices for outbound transportation to the Swedish market, specifically the retail stores in Sweden, were gathered and examined. The collected data file included information on the transportation costs per pallet from Central DC Helsingborg to the various retail stores in Sweden. Upon analysis, it was discovered that the per-pallet costs for each retail store decreased as the number of pallets increased. In other words, there was a clear inverse relationship between the number of pallets and the transportation costs per pallet. As more pallets were shipped to a particular retail store, the cost per pallet decreased, resulting in potential cost savings for larger orders.

This finding suggests that there may be an opportunity to optimise transportation costs by consolidating orders and increasing the number of pallets shipped to each retail store. By taking advantage of economies of scale, such as reduced per-unit transportation costs for larger orders, the company can potentially reduce overall expenses and improve profitability in the market.

In the subsequent analysis, the price lists in the warehouse at Helsingborg DC were compared and scrutinised. The focus was placed on various prices associated with services and fees related to picking and other warehouse operations. It was determined that the inbound and storage services into the DC, along with their corresponding prices, were not the primary areas of concern since they primarily pertained to inbound shipments from suppliers, which fell outside the scope of the current study. Furthermore, it was observed that supplier shipments consistently arrived in full pallets, minimising the relevance of implementing Minimum Order Quantity (MOQ) for inbound to the DC.

Delving deeper into the details of picking and other services and fees within the warehouse, certain costs were identified to remain constant regardless of the assortment quantities of different products loaded onto the pallets. These included picking pallet costs, loading pallet costs, and picking start-up costs. These costs remained consistent irrespective of the number of distinct product assortments incorporated into the pallets or how the pallet was handled.

The most notable insights derived from the warehouse cost analysis were central to determining an optimal MOQ solution. These findings encompassed several key aspects:

(i) Pallet break-up costs: Pallet break-up costs refer to the expenses incurred when breaking down inbound pallets received from suppliers into individual items or smaller quantities for the purpose of order fulfilment. These costs are significant because whenever a retail order consists of quantities that are less than a full pallet, these additional costs are incurred in addition to other picking and handling expenses.

Pallet break-up costs contribute to the overall expenses of fulfilling orders that do not meet the full pallet quantity requirement. This could happen when a retailer requests a smaller quantity of a particular product or when different products must be combined to fulfil an order. As a result, each time such a situation arises, the pallet break-up costs are incurred on top of the regular picking and handling costs.

Managing and optimising these costs is crucial for improving operational efficiency and cost-effectiveness. By analysing the frequency and magnitude of these costs and exploring strategies to minimise them, such as optimising order quantities, IKEA can potentially reduce overall expenses and enhance the profitability of order fulfilment processes.

(ii) Wrapping of pallets costs: Wrapping of pallets costs refers to the expenses associated with securing or wrapping pallets for transportation. During the analysis of these costs, it was observed that if pallets needed to be broken up to accommodate retail order quantities and then reassembled with other products before being wrapped, IKEA incurs additional costs for the wrapping process. However, if retail orders are placed in full pallet quantities, where the pallet received from the supplier is directly shipped to outbound for retail, the wrapping of pallets would not be necessary, and thus these costs would not be incurred by IKEA in this scenario.

The observation highlights the potential cost savings when retail orders are placed in full pallet quantities. By avoiding the need to break up and reassemble pallets, the associated costs for wrapping can be eliminated. This streamlines the outbound process, reduces labour and material costs for pallet wrapping, and enhances operational efficiency.

Encouraging retail stores to order in full pallet quantities can have several advantages, such as cost savings, simplified logistics, time efficiency etc.

It is important to assess demand patterns, storage capacity, and shelf-life when promoting full pallet ordering, as it may not be feasible or practical for all product assortments or retail stores. However, where possible, encouraging full pallet orders can optimise operations, reduce wrapping costs, and improve supply chain efficiency for IKEA. To determine which products are suitable for full pallet orders, it is advisable to prioritise assortments with higher demand and sales based on historical data and forecasts, as well as products that hold significant importance for IKEA and its customers. Additionally, these products should have a sufficiently long shelf life.

While ordering in full pallets can often be more cost-effective due to reduced handling and pallet break-up costs, it may not always be the most economical option for every product assortment or retail store. There are several factors to consider when determining the most optimal ordering strategy, such as demand variability, product shelf life or expiration dates, storage capacity constraints etc. By striking the right balance between ordering in full pallets and smaller quantities, the company can optimise costs, maximise customer service levels, and minimise waste.

(iii) Picking order line costs: Picking order line costs refer to the expenses incurred for each individual line item picked during the order fulfilment process. Whenever a retail store places an order for a specific quantity of a product, an order line is generated. Each of these order lines represents a cost for IKEA which is a fixed cost as set by its logistic providers. As the frequency of orders increases, the number of order lines also rises, resulting in higher costs for IKEA with each additional order line created.

The impact of picking order line costs on IKEA's expenses is significant. With a higher frequency of orders or a larger number of individual products ordered, the number of order lines increases proportionally, leading to higher costs incurred for picking and processing each line item. This cost can accumulate quickly as the volume and complexity of orders grow.

By focusing on enhancing picking operations and minimising the number of order lines, IKEA can effectively reduce costs associated with picking order line expenses, improving operational efficiency and profitability in the order fulfilment process.

(iv) Picking costs for unit and layer: Picking costs per unit and layer refer to the expenses associated with picking cases or entire layers of products during the order preparation process. During the analysis of these costs, it was observed that the costs for picking a unit (LHU) were the same as those for picking a layer LHU. This implies that it costs IKEA the same amount whether a certain product was ordered in smaller quantities (less than a full layer) or if the entire layer was ordered.

Based on this observation, it can be inferred that it would be more operationally efficient for IKEA if retail stores ordered in full layers rather than ordering random small quantities. Ordering in full layers allows IKEA to leverage the same picking cost for a higher quantity of products, resulting in improved efficiency and potentially reduced picking expenses per unit.

By encouraging retail stores to order in full layers, IKEA can achieve several benefits, such as reducing picking costs per unit, streamlined picking operations, inventory management etc.

However, it's important to consider demand variability, customer preferences, and product shelf life when promoting full-layer ordering. Retail stores should have sufficient demand for the products in full-layer quantities, and the products should have a longer shelf life or be in high demand to avoid potential inventory issues.

(v) Late order handling costs: Late order handling costs refer to the expenses incurred when orders are processed after the designated order window or when express orders are placed. These costs arise when there are unforeseen stockouts in retail stores, and orders must be placed urgently to fulfil customer demand and avoid customer dissatisfaction.

In such situations, retail stores may resort to panic orders or express orders to procure the necessary products as quickly as possible. These orders are placed outside the regular order window and often require special handling and expedited processing to ensure timely delivery. The late order handling costs can include various factors, such as rush processing fees, expedited shipping costs, priority handling etc.

To mitigate late order handling costs, it is crucial for IKEA to proactively manage stock levels, monitor demand patterns, and maintain effective communication with retail stores. By implementing robust inventory management practices, optimising replenishment processes, and improving demand forecasting accuracy, IKEA can reduce the occurrence of stockouts and minimise the need for express orders. This, in turn, helps to avoid or mitigate the associated costs and challenges of handling late orders.

Efficient communication and collaboration between IKEA and its retail stores can also play a vital role in addressing stockouts promptly, allowing for proactive measures to be taken, such as expedited restocking or alternative product recommendations, to minimise the impact on customer satisfaction and reduce the likelihood of late order situations. By effectively managing late order handling, IKEA can enhance operational efficiency, reduce costs, and improve overall customer service levels. These specific findings present significant areas of interest for further analysis and evaluation, as they have the potential to impact overall warehouse costs and efficiency.

6.1.4 Drop-size

To further analyse the impact on deliveries when MOQ is implemented, a suggestion to compare the drop sizes of monthly deliveries ‘without MOQ’ vs ‘with an optimal MOQ’ was presented. For this, the volumetric data of deliveries to each retail store and the monthly orders to the Älmhult retail store in Sweden were collected initially.

The drop-size file, which calculates the average volume per retail store delivery on a monthly basis, was used in parallel with the analysis of orders for the Älmhult store. The focus was on comparing the orders for different products and their quantities with the corresponding full-layer quantities.

To streamline the data, a clean-up process was performed to isolate the relevant attributes, including product assortments, ordered quantities, product layer and pallet quantities, and estimated order volumes. Upon analysing the orders for Älmhult, it was observed that various product assortments were being ordered in quantities lower than full layers or very low quantities.

6.2 Interviews

From the interviews, key processes and operations were identified. Even though the product assortment was obtained through data collection, a clear explanation of how the products are ordered and categorised for dispatch was inferred when interviewing the logistic service provider at Helsingborg and the food demand coordinators at Almhult. From this, how the products are stacked on the pallets was inferred. As mentioned earlier, at different places, there are several costs involved in the supply chain process. When interviewing the Logistic Service Provider (LSP) and Food Demand Coordinators (FDC), a clear explanation of the various costs involved at each stage was explained. In addition to these, some insights on inventory/holding costs were also shared by illustrating some scenarios that happened in the past.

To understand the complete supply chain cycle at IKEA, the interviewee (Logistic service provider) was asked to explain his role and responsibilities and also the responsibilities of other key stakeholders. This information was helpful in analysing which actors to be considered while implementing MOQ. Similarly, the attributes influencing the order quantity were also explained. The explanation was necessary in analysing all attributes/factors to be considered when setting a certain minimum order quantity.

Likewise, when interviewing the respective actors at retail stores, information on how the operations take place at retail stores was explained. During the interview, the interviewee was asked about the concept of MOQ to know the understanding level of it. Questions relating to specific information like ordering quantity, ordering terms, variations in ordering products (based on seasonality) etc., were asked to deeply understand the process, which would help in analysis. From the inferred information, it was analysed that when implementing a specific MOQ for any product, there shouldn't be a negative impact on the ordering and delivery of products.

After getting an overview of the interviewee's knowledge of MOQ, a discussion was led to understand why there was no MOQ followed. From those questions, it was inferred that some products in high demand, such as meatballs, are ordered in full pallets. However, for most products, ordering was done based on the store's requirements, and they don't have any MOQ policy. Keeping MOQ implementation in mind, the interviewee was asked more questions about the effects that would arise when MOQ is implemented. From the answers given by the interviewee, it was inferred that key factors like BBD/short shelf life should be considered and analysed when implementing MOQ. Also, to understand in depth, based on the interviewee's experience, it was asked to share for which type/category of products it would be difficult to follow MOQ. This could help in analysing on implementing MOQ, which would be suitable for all types of products. The final phase of the interview was more related to questions that focused on asking the reasons/blocking points for retail stores from ordering products in MOQ. It was inferred that certain key factors BBD, high inventory levels and costs of destroying the products that expire would be the major concerns. From this, it was understood that all these factors/concerns would be analysed before implementing specific MOQ for all the products.

6.3 On-site Visits

6.3.1 Insights from Central Distribution Centre

The Central distribution centre for IKEA is in Helsingborg, Sweden. However, this serves as the local distribution centre for the Scandinavian market. From there, the products/articles are shipped to different locations globally. After receiving the orders from the retail stores, the food demand coordinators share the list of articles/products to be picked from the local distribution centre. The picking process and logistics activities are carried out by a third-party logistics, which carries out the complete logistic activities. The distribution centre has different zones or locations, i.e., receiving area, warehouse, picking zone, final check area, and outwarding zone. The products/articles received from the suppliers are passed through different zones before they are sent to the retailers.

In the receiving area, articles are received from different suppliers from different locations. It is also to be noted that the products/ articles from the suppliers are received in full pallets. In the receiving area, the products received are checked and accounted for. From the receiving area, the articles on the pallets are moved to the warehouse through conveyor belts and forklift operations. From the warehouse, the products are then sent to the picking area. This operation is again carried out with forklifts and conveyor belts. There are ambient, chilled, and frozen storage areas. Depending on the characteristics of the product, they are moved to the respective storage location and picked from there. Once the articles/ products are moved to the picking area in full pallets, the pickers pick the required quantity. Picking activity is performed with a forklift with a monitor attached to it. The monitor is programmed in such a way that the picker finds the product name, quantity to be picked, location of the product etc., on the monitor.

Each picker picks a complete order for a particular retail store. Once a particular product, along with the required quantity, is picked, the picker scans the barcode on the location to ensure that the right product is picked and the current stock level is updated. Different products are stacked on a pallet depending upon the ordered quantity. After the products are picked and stacked on the pallets, they are sent to the final check area, where the pallet is wrapped to ensure there are no safety issues/mishandling of the products. Also, a complete description of the products and their quantity on the pallet is pasted in the form of a barcode. Once this is done, the pallets are moved to the outwarding zone. From there, they are loaded into the containers to be transported to the respective retail stores.

Upon examining the operational processes of the warehouse, it was discovered that the workers employed a methodical approach of stacking heavier products at the lower levels of the pallets and lighter items at the upper levels. However, the ultimate responsibility for product segregation into outbound pallets rested with the picker. To place and receive orders from suppliers, the responsibility rested with the Need planners along with the Demand planners and supply planners, who analyse the order quantities and make adjustments based on monthly meetings with retail stakeholders and previous order forecasts.

The warehouse's major expenses are picking and handling costs, which comprised forklift usage for moving products from the warehouse to the picking area, labour expenses, and other similar costs. These expenses are included in the Retail Purchase Price (RPP) charged to IKEA's retail stakeholders rather than being segregated separately for the products. In cases where products were ordered inefficiently, resulting in uneven fill rates, the costs would be accumulated and added to the next cycle. The handling charges were found to be lower for larger shipment orders received from retail stakeholders, as opposed to several smaller ones.

A review of the data provided by the stakeholders revealed that the storage costs varied depending on the pallet units used. However, overall, the cost of storing frozen and chilled goods was found to be higher than that of ambient products. To obtain clarity on transportation costs, it was essential to determine whether the cost was based on the weight or volume of the goods being transported. Such information would aid in better logistics planning and decision-making. The interview with the stakeholders confirmed that the transportation costs were fixed and determined based on the weight or volume of the pallets.

6.3.2 Insights from Retail Store

A visit to the retail store at Älmhult and Bäckebol was planned to understand how the operations take place once the products are received from the distribution centre. The operations at both the retail stores are the same, and thus observations from the Älmhult store alone are described. The Älmhult retail store can place orders thrice a week depending on their requirement and storage capacity. Their ordering days are Mondays, Wednesdays, and Thursdays, and the order has to be placed before 10:00. Once they order the necessary products, they receive them on the alternate working day, i.e., the products ordered on Monday are received on Wednesday, and products ordered on Wednesday are received on Friday, whereas the products ordered on Thursday are received on Monday.

The operations at the retail store are similar to the operations at DC in Helsingborg. Since the Älmhult store is geographically close to DC, the shipment is sent directly to the retail store. Whereas for some stores (for example, Bäckebol), it is first sent to a terminal and from there, it is shipped to the respective retail store. Once the shipment (in trucks) is received from the DC, the shipment is unloaded in the receiving area. After the unloading process, the products (in pallets) are moved to the respective storage areas (ambient, chilled, and frozen).

The Älmhult store has business for all sectors (SFM, Bistro and Restaurant), where the necessary products are ordered and received. The products that are moved to the storage areas are then handled and moved to the respective sectors. For instance, the SFM products are directly moved to the shelves from the main storage area so that customers can buy required products. Similarly, for the Bistro and Restaurant, there are individual storage areas. From the main storage area, the products are segregated and moved to the respective individual storage areas. There are individual storage areas for all three different types of products (ambient, chilled, and frozen). From these individual storage areas, the required and necessary product and quantity is moved for further usage.

6.4 MOQ scenarios

On analysing the information gathered from Data collection, Interviews and On-site visits to implement specific MOQ, different scenarios were considered by including some key factors. To analyse and evaluate the efficient MOQ, three different situations were considered, No MOQ, Full layer, and Full Pallets as the different scenarios. From the literature and insights at different instances, it is clear that MOQ should be common for all the products to have a feasible and efficient supply.

	Scenario 1	Scenario 2	Scenario 3
FACTORS	No MOQ	Full Layer	Full Pallets
Destruction Costs	Low	Moderate	High
Picking costs	High	Low	Low
Wrapping Cost	High	High	No
Sorting/Moving at Retail	High	Moderate	Low
Picking/Handling at Retail	High	Moderate	Low
Capacity constraint at Retail	Low	Moderate	High
Inventory Levels at Retail	Low	Moderate	High
Streamlined order patterns	No	Yes	Yes
"Split Orders" of products close to BBD	High	Moderate	Low
Late order handling (Express order)	High	Moderate	Low

Fig 1: MOQ Scenarios

‘No MOQ’ is chosen as one scenario to compare and understand how the current situation is and how it would differ from other MOQ solutions. A ‘Full layer’ is chosen as another MOQ scenario as it is an intermediate to No MOQ and Full pallets. From the MOQ scenarios, we can infer that No MOQ and Full pallets are two extremes, and the Full layer seems to be a balance between both extremes.

When costs are considered while choosing an optimal MOQ solution, in the case of IKEA, *Picking costs*, *Destruction costs,* and *Wrapping costs* are the major expenses. Picking cost and wrapping cost are incurred at the warehouse and Destruction cost is incurred at the retail store. However, all the costs are borne by the retail stores as all the different costs are included in the Retailer Purchase Price (RPP). When there is no MOQ implemented (current situation), the picking and wrapping costs are relatively very high. This is because when there is no MOQ set, the retailer orders products based on their requirements and does not follow any specific ordering policy. Due to this the picking process becomes tedious and as a result the picking cost is high. This was inferred from the data collection i.e., picking cost for picking smaller quantities is comparatively higher than picking larger quantities. Therefore, when MOQ is set to full layer/ full pallet, the picking cost is comparatively less. Likewise the wrapping cost is high when there is no MOQ policy as the products stacked on the pallets are uneven and not uniform, to ensure safety of products during transport and ensure that the products are not damaged, the pallet has to be wrapped on multi-levels to avoid all the concerns/ product defects. Whereas, when MOQ is set to full layer/full pallet the products stacked on the pallets will be even and balanced. Furthermore, during the visits it was also observed that for the products sent in full pallets, additional wrapping is not required as they are already wrapped at the supplier end.

In addition to the costs, some key processes at the retail stores should also be considered when analysing, to conclude the optimal MOQ solution. ‘Sorting/Moving’, ‘Picking/Handling’, ‘Capacity constraint’ and ‘Inventory levels’ are the key factors (from the retail perspective) to be considered when setting up an optimal MOQ. These factors were selected for analysis as they are highly impacted when a MOQ is set. When sorting/moving and picking/handling is considered, the time and labour spent on the processes should be evaluated. For instance, when the products are not ordered in MOQ, the sorting and handling would be tedious as there would be different varieties of products stacked on a single pallet. In such situations dedicated manpower to sort and handle the products is required which results in additional costs and time. Whereas when ordered in Full layer/ Full pallets the situation is different i.e., when ordered in full layer the time and labour spent is moderate as there would be comparatively less variety of products stacked on single pallet.

Other than costs and handling operations, Capacity constraints and Inventory levels highly influence the MOQ solution. During the interviews and on-site visits it was inferred that retail stores place orders by ensuring that these two factors are not disturbed/affected. This is the reason why retailers place orders based on the requirement. When a full pallet is set as an MOQ solution, the retail stores would not agree as they would hold huge inventory and would end up with capacity constraints. When this happens, their business would be affected, and operations would be inefficient and difficult. From this it could be inferred that when these two factors are considered, a full layer could be the optimal solution as the quantity wouldn't be too high.

In addition to all these factors, there are other general key factors which are to be considered and analysed with implementing MOQ. Whenever the products are ordered and processed for delivery, the complete process has to be streamlined and uniform. When there is no MOQ, there would be irregular deliveries and ordering of products. On the other hand, when MOQ is implemented, the ordering is streamlined, and delivery is efficient. Also, late order handling/ ordering products at the last moment can be controlled when MOQ is implemented. When there is no MOQ policy, there are high chances of making express orders which again results in additional costs.

In the ordering and delivery process at IKEA, for the products close to BBD, there are 'Split orders' of products. This is because the products are received from the supplier in full pallets but are sent to the retail stores based on their requirement as there is no MOQ. In such cases, there would be products left at the DC close to expiry. So those products are sent to the retail stores even though they have not ordered the product. Therefore, when MOQ is implemented this 'Split order' of products can be avoided and retailers would relatively be less obliged to take products that are not required.

From the figure, full pallets might seem to be the optimal MOQ, but upon deep examination by taking all the different factors, full layer would be the optimal MOQ solution. As explained above, considering, and analysing full pallets might seem efficient but there are certain factors like capacity constraints and inventory levels which would be a threat in setting up full pallets as an optimal MOQ.

6.5 Survey

The survey was conducted to gather data from various markets for IKEA's Food Supply Chain. The survey aimed to discover IKEA's retail stores' characteristics, preferences, opinions, and knowledge about MOQ. The main aim was also to have market research and to find out the customers' (IKEA's retail stores) knowledge level about the concept of MOQ and the changes that they might or might not have to incur during the implementation process.

As mentioned, the survey was sent out to various markets across the globe, and feedback was received from more than 70% of the markets. Through the survey, it was inferred that almost all the markets were familiar with the concept of MOQ. From this, it can be inferred that a training session/ educating the retailers about the MOQ concept was not necessary.

To understand the willingness of retailers to implement the full layer as optimal MOQ, questions related to adjusting the order quantity to order in MOQ and also adjusting the ordering cycles were asked in the survey. From the feedback, it was inferred that a full layer could be the optimal solution but at the same time, it may not be suitable for all the products. From this, it can be analysed that setting up a full layer as optimal MOQ would work but for some products, alternate ideas/recommendations have to be made to adjust those special products also to be ordered in

MOQ. However, for a few markets adjusting the order quantity and ordering cycles was not an issue.

Also, to understand the negative impacts when full layer is implemented as MOQ, questions related to the same were asked in the survey. This was initiated to see the negative aspects and provide recommendations/alternatives for a smooth MOQ implementation. From the answers to those questions, it was analysed that encountering capacity issues would be the major challenge when implementing full layer as an optimal MOQ. It was also inferred that this capacity constraint has to be taken into consideration and recommendations have to be given to implement the MOQ solution. From this survey it was analysed that there would be other minor issues that can arise when any MOQ solution is implemented which can be overcome by providing alternate suggestions.

Moreover, from the survey it was analysed that most of the retail stores are experiencing difficulties when receiving pallets with mixed products and uneven pallets. From this, it can be reasoned that implementing MOQ is important to overcome all such issues and have a streamlined order and delivery process. In addition to questions about full layer as MOQ and supporting/arguing questions, the timeline for implementing MOQ was also asked to know how much time the retail stores would need to adapt to start ordering in MOQ. From this, it was understood that most of the markets can adapt to ordering in MOQ in less than three months.

The survey thus helped in understanding the willingness of the retail stores, knowing their concerns when implementing the MOQ and provided an analysis on how the recommendations/ alternatives have to be drawn to implement a full layer as an optimal MOQ.

7. Results

In this chapter, the solution/findings of the study will be discussed based on the analysis and literature review that was performed to understand MOQ and related topics. Analysing the different suitable methodologies that were chosen resulted in finding the optimal MOQ solution. Even though the purpose and scope of the thesis were to find an optimal MOQ solution, the On-site visits and Interviews helped understand the importance of implementing an optimal MOQ solution. Moreover, these two methodologies directed on how the solution should be obtained and which key factors to be considered when concluding the solution.

Based on data collection, Interviews and On-site visits, MOQ scenario was structured. From the MOQ scenario, it can be analysed that *'Full layer'* would be an optimal solution for IKEA's various food assortments. This conclusion that the *'Full layer'* would be an optimal solution was derived by considering various factors from different perspectives. To check if the solution is optimal or not, calculating the drop size activity was also performed to check the impact, as Drop size is one of the KPIs as mentioned earlier.

7.1 Drop Size

Based on the findings from previous analyses, which indicated that full-layer would be the optimal MOQ, the Älmhult store's ordering data was adjusted to reflect only full-layer orders for all products. This involved replacing the existing orders, which had lower quantities, with a single order for the full layer quantity. For example, if a certain 'Product A' was being ordered in quantities of 3 for the next four ordering cycles, and the full layer quantity of 'Product A' was 12, these orders were now replaced with a single order of 12 quantities.

Similarly, products that were ordered close to the full layer quantities were replaced with the respective full layer quantities for subsequent orders in that month. For example, if a product has a full layer as 8 quantities, and 6 or 7 quantities were ordered, then the order was replaced by their respective full-layer quantity, i.e., 8. This was done for all the consequent orders in that month. Finally, once all the order quantities were replaced by their subsequent full-layer quantity, the total volume delivered for the month and the number of deliveries was calculated.

The findings from the projection using full layer as a MOQ indicated positive outcomes. The estimated volume for the subsequent month, based on the new numbers reflecting full-layer MOQ, was higher compared to when MOQ is not followed. Additionally, the number of deliveries to the retail stores decreased, resulting in an increase in the average volume per store delivery at the Älmhult store. This represented a significant increase of 23.95% in the drop size key performance indicator (KPI).

Furthermore, upon closer observation, it was noted that there were deliveries where only a single product was ordered when the full layer as MOQ was implemented. In this case, assuming that these deliveries would not occur, the number of deliveries would be further reduced. This reduction in the number of deliveries would proportionally increase the average volume per store delivery even more.

Overall, the implementation of full layer as optimal MOQ will lead to improved drop size metrics, with higher estimated volumes, decreased number of deliveries, and increased average volume per store delivery. These findings indicate the potential benefits of implementing an optimal MOQ strategy in the food supply chain.

8. Conclusion & Recommendation

This chapter will start by concluding the recognition of the potential benefits of implementing an optimal Minimum Order Quantity (MOQ) to enhance the efficiency and cost-effectiveness of supply chains, followed by the recommendations that are suggested to minimise the negative effects of MOQ. Finally, the chapter ends with a proposed time plan for IKEA to implement a full-layer MOQ strategy.

As often discussed in pieces of literature, especially by Paciarotti et al. (2021), implementing an optimal MOQ is shown to improve operational performance, reduce costs, and optimise inventory management. By aligning order quantities with full-layer pallets, IKEA can streamline logistics processes, increase order consolidation, and reduce handling and transportation costs. The implementation of Minimum Order Quantity (MOQ) can bring several benefits to both distributors and retailers. One key advantage is the reduction of uncertainty during the ordering process. By setting a minimum quantity for orders, the DC and retailer can establish a more predictable demand pattern, which leads to better planning and inventory management. Furthermore, an optimal MOQ will help understand and reduce the uneven outflow of the products that are in overstock in the DC as well as mitigate certain warehouse costs by ordering in full layers.

When considering the implementation of an optimal Minimum Order Quantity (MOQ), certain key factors such as the Best Before Date (BBD), high inventory levels and costs associated with destroying expired products need to be taken into account. Addressing these concerns is crucial for the successful implementation of an optimal MOQ strategy. BBDs play a significant role in determining the shelf life of products. It is important to consider the BBDs when establishing MOQ to ensure that the ordered quantities can be consumed or sold within the given time frame. Failure to manage BBDs effectively can result in expired products, leading to financial losses and potential customer dissatisfaction. High inventory levels can also pose challenges when implementing an optimal MOQ. Excess inventory ties up capital and warehouse space, which can lead to increased holding costs and inefficiencies, even at retail stores. Moreover, if products with shorter shelf lives are ordered in large quantities, there is a higher risk of excess inventory and potential waste. The costs of disposing of expired products can be substantial and negatively impact profitability.

For products and stores where the BBD and capacity constraints are not significant, ordering in full-layer Load Handling Units (LHU) could be seen as feasible. Implementing a full-layer MOQ can help fast-moving products that are predominantly ordered in multiples of layer units, with occasional irregular quantities. Setting the minimum ordering requirement as a full layer and ordering in multiples of the layer unit is recommended in such cases as these products or shipments will have reduced picking and order line costs per unit.

Specific instances, such as products being ordered in half layers or random numbers, highlight the importance of retailers placing a single order for a minimum of the full layer unit or its multiples to align with optimal MOQ practices. Another key benefit of ordering in full layer MOQ is the reduction in the frequency of deliveries, leading to lower transportation and handling charges. By consolidating orders into full layers, the number of shipments can be minimised, resulting in cost savings and a reduced environmental impact.

Furthermore, adopting a full layer MOQ ensures better stock availability in retail stores. With larger order quantities, the risk of stockouts and inventory shortages is significantly reduced. This helps to prevent customer dissatisfaction and avoids the negative consequences of unfulfilled orders. By maintaining sufficient stock levels, IKEA can meet customer demand promptly and efficiently.

In addition, implementing a full layer MOQ strategy helps to mitigate the challenges associated with late orders. By ordering in larger quantities, the likelihood of encountering delays in order handling is minimised. This helps to avoid the costs and complexities that arise from managing late orders, such as expedited shipping, rush processing, or the need for alternative sourcing.

On the other hand, full-layer as the optimal MOQ solution may not be suitable for all the products and all the retail stores. This is because the forecast and requirements are not the same for all products, and all the stores do not hold the same storage capacity. Few retail stores are big enough to store larger quantities, and few retail stores are smaller in size and cannot order all the products in MOQ. In such cases, where the capacity constraint is the major issue, retail stores can plan to increase the storage capacity by altering the available area as storage rooms to accommodate the products ordered in MOQ. From the interviews and on-site visit, it was inferred that creating space (storage area) for ambient products is quite easy and feasible.

Based on the survey findings, it is theorised that the majority of retail stores can implement the full layer MOQ within a three-month time frame. The Business Unit (BU) can initiate the implementation plan by first discussing it with the Service Office (SO) as they are in close contact with the retailers. Since most of the SO's and retailers are already aware of the MOQ concept, special training/educating about MOQ is not required. The SO's can initiate it at the retailer end by informing them to start ordering as per MOQ (*Full Layer*) or in multiples of full layer as per their demand. In the initial phase, ordering in MOQ's can be followed for the products that don't have any hindrance to the MOQ concept. Going forward it can be implemented for all other products by finding alternative solutions with the suggested recommendations.

The analysis and results from the 'MOQ Scenarios' and 'Drop Size' performances provide further evidence to support the implementation of an optimal Minimum Order Quantity (MOQ) for IKEA. These findings reinforce the notion that implementing an optimal MOQ can significantly contribute to a more efficient and cost-effective supply chain. These analyses and their results likely demonstrate how implementing a *'Full Layer'* as an optimal MOQ, i.e., ordering in full layers or multiples of full layer Load Handling Units (LHU), can lead to increased drop size, higher estimated volumes, reduced number deliveries and potential cost savings for IKEA.

The findings highlight the potential impact of an optimal MOQ strategy on the supply chain's efficiency and cost-effectiveness. By aligning order quantities with optimal MOQ levels, IKEA can streamline its logistics processes, minimise waste, and enhance resource utilisation. This, in turn, can result in improved customer satisfaction, reduced costs, and increased profitability for the company. Overall, the analysis and results provide strong support for the implementation of an optimal MOQ in IKEA's supply chain. It reinforces the notion that adopting such a strategy will lead to a more efficient and cost-effective operation, ultimately benefiting the company and its stakeholders.

9. Reference

Accorsi, R., & Manzini, R. (Eds.). (2019). Sustainable food supply chains: planning, design, and control through interdisciplinary methodologies. Academic Press.

Balcou, C., & Yadavalli, V. S. S. (2017). A supply chain management model to optimise the sorting capability of a 'third party logistics' distribution centre. South African Journal of Business Management, 48(1), 77-76.

Barnes-Schuster, D., Bassok, Y., & Anupindi, R. (2002). Coordination and flexibility in supply contracts with options. Manufacturing & Service Operations Management, 4(3), 171-207.

Blackburn, J., & Scudder, G. (2009). Supply chain strategies for perishable products: the case of fresh produce. Production and Operations Management, 18(2), 129-137.

Bennion, M. L. (1987) Creating Channel Dependence through the Use of Minimum Order Quantities. International Journal of Physical Distribution & Materials Management, vol. 17, no. 6, pp. 3-14.

Bottani, E., Ferretti, G., Montanari, R., & Rinaldi, M. (2014). Analysis and optimisation of inventory management policies for perishable food products: a simulation study. Int. J. Simul. Process. Model., 9, 16-32.

Bottani, E., Montanari, R., Vignali, G., & Guerra, L. (2011). A survey on packaging materials and technologies for commercial food products. International Journal of Food Engineering, 7(1).

Bourlakis, M. A., & Weightman, P. W. (Eds.). (2008). Food supply chain management. John Wiley & Sons.

Bourland, K., Powell, S. and Pyke, D. F. (1996) Exploiting timely demand information to reduce inventories. European Journal of Operational Research 92 (2), 239-253.

Burch, D., Lawrence, G. (Eds.), 2007. Supermarkets and Agri-food Supply Chains: Transformations in the Production and Consumption of Foods. Edward Elger, Cheltenham.

Cachon, G. P. and Fisher, M. (1997) Supply chain inventory management and the value of shared information. Furqua School of Business, Working paper.

Cai, X., Li, J., Song, X., Yuan, F., & Luo, X. (2022). Capacity allocation with minimum order quantity: Fixed allocation and turn-and-earn allocation. Computers & Industrial Engineering, 172, 108507.

Cassell, C. (2015). Conducting research interviews for business and management students. Conducting Research Interviews for Business and Management Students, 1-120.

Chopra, S., & Meindl, P. (2021). Supply Chain Management: Strategy, Planning, and Operation. Pearson.

Chow, P. S., Choi, T. M., & Cheng, T. C. E. (2012). Impacts of minimum order quantity on a quick response supply chain. IEEE Transactions on Systems, Man, and Cybernetics-Part A: Systems and Humans, 42(4), 868-879.

Croxton, K. L. (2003) The Order Fulfillment Process. The International Journal of Logistics Management. Vol. 14, no. 1, pp. 19-32.

Dani, S. (2015). Food supply chain management and logistics: From farm to fork. Kogan Page Publishers.

Dani, S. (2021). Food Supply Chain Management and Logistics: Understanding the Challenges of Production, Operation and Sustainability in the Food Industry. Kogan Page Publishers.

Doğru, M. K., De Kok, A. G., & van Houtum, G. J. (2009). A numerical study on the effect of the balance assumption in one-warehouse multi-retailer inventory systems. Flexible services and manufacturing journal, 21, 114-147.

Fearne, A. (1996) Editorial note. Supply Chain Management 1 (1), 3-4.

Forrester, J. W. (1961) Industrial Dynamics. MIT Press, Cambridge, Massachusetts.

Harris, F.W. (1990). How Many Parts to Make at Once. Oper. Res., 38, 947-950.

Hammond, M., & Wellington, J. (2020). Research methods: The key concepts. Routledge

Hawkes, C., 2008. Dietary implications of supermarket development: a global perspective. Development Policy Review 26 (6), 657–692.

Hellström, D., & Nilsson, F. (2011). Logistics-driven packaging innovation: a case study at IKEA. International Journal of Retail & Distribution Management, 39(9), 638-657.

Hitt, M. A., & Ireland, R. D. (1985). Strategy, Contextual Factors, and Performance. Human Relations, 38(8), 793–812. https://doi.org/10.1177/001872678503800807

Humphrey, J., 2005. Shaping value Chains for Development Global value Chains in Agribusiness, Deutsche Gesellshaft fur International Zusammenarbeit (GIZ). Exchborn.

J.P. Sepulveda Rojas, Y. Frein, Coordination and demand uncertainty in supply chains, Production Planning & Control 19 (7) (2008) 712–721.

Jones, T. C. and Riley, D. W. (1985) Using inventory for competitive advantage through supply chain management. International Journal of Physical Distribution and Materials Management 15 (5), 16-26.

Jones, T. C. and Riley, D. W. (1985) Using inventory for competitive advantage through supply chain management. International Journal of Physical Distribution and Materials Management 15 (5), 6-26.

Jonsson, P. and Mattsson, S-A. (2009), Manufacturing planning and control. McGraw-Hill: London.

Kreuwels, C. M. A. (1994) External logistical integration and EDI: to multi-level supply control between supplier and buyer. Ph.D. Dissertation, Eindhoven University of Technology, The Netherlands (in Dutch).

Kumar, S., & Nigmatullin, A. (2011). A system dynamics analysis of food supply chains–Case study with non-perishable products. Simulation Modelling Practice and Theory, 19(10), 2151-2168.

Lee, H. L., Padmanabhan, V. and Whang, S. (1997) Information distortion in a supply chain: the bullwhip effect. Management Science 43 (4), 546-558.

Li, D., Kehoe, D., & Drake, P. (2006). Dynamic planning with a wireless product identification technology in food supply chains. International Journal of Advanced Manufacturing Technology, 30.

McDonald, C. M. (2016). Integrating packaging and supply chain decisions: Selection of economic handling unit quantities. International Journal of Production Economics, 180, 208-221.

McGuffog, T. (1997) The obligation to keep value chain management simple and standard. Supply Chain Management 2 (4), 124-133.

Moinzadeh, K. and Aggarwal, P. K. (1996) An information based multi-echelon inventory system with emergency orders. Operations Research, to appear.

Molina, E., Horvath, L., & White, M. S. (2018). Investigation of pallet stacking pattern on unit load bridging. Packaging Technology and Science, 31(10), 653-663.

Muriana, C. (2016). An EOQ model for perishable products with fixed shelf life under stochastic demand conditions. European Journal of Operational Research, 255(2), 388-396

Neven, D., Reardon, T., 2009. The rise of Kenyan supermarkets and evolution of their horticulture product procurement systems: implications for agricultural diversification on smallholder market access programs. Development Policy Review 22 (6), 669–699.

Ngatilah, Y., Rahmawati, N., Pujiastuti, C., Porwati, I., & Hutagalung, A. Y. (2020, July). Inventory Control System Using Distribution Requirement Planning (DRP)(Case Study: Food Company). In Journal of Physics: Conference Series (Vol. 1569, No. 3, p. 032005). IOP Publishing.

Paluch, W. (2019). The use of the EOQ model in inventory management in the supply chain on the example of Bahlsen Polska. Logistics and Transport, 43(3), 41-46.

Pan, F. B. (2016). Perishable product inventory model based on the food supply chain. Journal of Interdisciplinary Mathematics, 19(1), 111-127.

R. Anupindi and Y. Bassok, “Supply contracts with quantity commitments and stochastic demand,” in Quantitative Models for Supply Chain Management, S. Tayur, R. Ganeshan, and M. Magazine, Eds. Boston, MA: Kluwer, 1999, pp. 197–234.

Reardon, T., Barrett, C., 2000. Agroindustrialization, globalization, and international development: an overview of issues, patterns, and determinants. Agricultural Economics 23 (3), 195–205.

Reardon, T., Berdegué, J., 2002. The rapid rise of supermarkets in Latin America: challenges and opportunities for development. Development Policy Review 20 (4), 371–388.

Reardon, T., Gulati, A., 2008. The Supermarket Revolution in Developing Countries: Policies for Competitiveness and Inclusiveness, IFPRI Policy Brief 2, June. International Food Policy Research Institute, Washington, DC.

Reardon, T., Timmer, C., Barrett, C., Berdegué, J., 2003. The rise of supermarkets in Africa, Asia, and Latin America. American Journal of Agricultural Economics 85 (5), 1140–1146.

Reardon, T., Timmer, C., Minten, B., 2012. Supermarket revolution in Asia and emerging development strategies to include small farmers. Proceedings of the National Academy of Sciences of the United States of America 109 (31), 12332–12337.

Reardon, T., & Timmer, C. P. (2007). Transformation of markets for agricultural output in developing countries since 1950: How has thinking changed?. *Handbook of agricultural economics*, *3*, 2807-2855.

Richardson, H.L. (1999) Packaging solutions. Transportation & Distribution. vol. 40, no. 5, pp. 59-64.

Ruben, R., van Tilbur, A., Trienekens, J., van Boekel, M., 2007. Linking market integration, supply chain governance, quality, and value added in tropical food chains. In: Ruben, R., van Boekel, M., van Tilbur, A., Trienekens, J. (Eds.), Tropical Food Chains: Governance Regimes for Quality Management. Wageningen Academic Publishers, pp. 13–46.

Savsar, M. (2021, June). Optimization of Location of a Distribution Center for an Automobile Supply Chain System. In 2021 3rd International Congress on Human-Computer Interaction, Optimization and Robotic Applications (HORA) (pp. 1-6). IEEE.

Scott, S. and Westbrook, R. (1991) New strategic tools for supply chain management. International Journal of Physical Distribution and Logistics Management 21 (1), 23-33.

Shen, H., Tian, T., & Zhu, H. (2019). A two-echelon inventory system with a minimum order quantity requirement. Sustainability, 11(18), 5059.

Silver, E. A. (1991) Modelling in support of continuous improvements towards achieving world class operations. In: Perspectives in Operations Management, ed. R. K. Sarin. Kluwer.

Silver, E. A., Pyke, D. F., & Peterson, R. (1998). Inventory management and production planning and scheduling (Vol. 3, p. 30). New York: Wiley.

Stalk, G. and Hout, T. M. (1990) Competing against time; how time-based competition is reshaping global markets. New York: Free Press.

Sufiyan, M., Haleem, A., Khan, S., & Khan, M. I. (2019). Analysing attributes of food supply chain management: a comparative study. In Advances in Industrial and Production Engineering: Select Proceedings of FLAME 2018 (pp. 515-523). Springer Singapore.

Szymonik, A. (2016). Packaging in logistics. URL: https://www.researchgate.net/publication/297368732_PACKAGING_IN_LOGISTICS

T. M. Choi, D. Li, and H. Yan, "Optimal two-stage ordering policy with Bayesian information updating," J. Oper. Res. Soc., vol. 54, no. 8, pp. 846–859, Aug. 2003.

Towill, D. R. (1996) Time compression and supply chain management guided tour. Supply Chain Management 1 (1), 15-27.

Tuncel, O., Taneri, N., & Hasija, S. (2022). Why are minimum order quantity contracts popular in practice? A behavioral investigation. Manufacturing & Service Operations Management, 24(4), 2166-2182.

van der Vorst, J. G., Beulens, A. J., de Wit, W. V., & van Beek, P. (1998). Supply chain management in food chains: Improving performance by reducing uncertainty. International Transactions in Operational Research, 5(6), 487-499.

Waters, E., Davis, E., & Mehmet-Radji, O. (2007). Population surveys of children's health and wellbeing: Parental views on data collection content and methods. International Journal of Social Research Methodology, 10(3), 167-180.

Yadav, S., Garg, D., & Luthra, S. (2020). Selection of third-party logistics services for internet of things-based agriculture supply chain management. International Journal of Logistics Systems and Management, 35(2), 204-230.

Zhang, Q., Tsao, Y. C., & Chen, T. H. (2014). Economic order quantity under advance payment. Applied Mathematical Modelling, 38(24), 5910-5921.

Zhu, H. A simple heuristic policy for stochastic inventory systems with both minimum and maximum order quantity requirements. Ann Oper Res 309, 347–363 (2022). https://doi.org/10.1007/s10479-021-04441-1

10. Appendix

10.1 Interview Question

10.1.1 Kitchen Production Manager (Retailer)

1. What business area do you manage?
2. Have you ever heard of the term/ concept called Minimum Order Quantity (MOQ)?
3. How is the ordering plan for different products (are there any deadline (day/time/season))
4. On what basis do you come with the ordering number? (If it is forecast, then how to do you decide on the forecast/ inputs from the distributor)
5. What attributes Constitute the order quantity? (Short shelf life, seasonality, future availability)
6. Which are the products that are most ordered and least ordered?
7. Is there an MOQ that is already set to be ordered for different products, or can you order as per your demand?
8. If there is MOQ to be followed and it is not followed, what are the reasons for not placing orders according to the respective MOQs?
9. For products where shelf life (BBD) is not relevant, are MOQs followed or is the ordering done according to the forecast/demand.
10. What are the major products that you think are difficult to follow the MOQ? (Difficult to order in layers or full pallets)
11. If yes, what are the main reasons/ challenges stopping from following the MOQ? (Stopping them from ordering layers/ full pallets)
12. What are all the different costs that are involved in ordering and storage of the food products?
13. Are all the costs to be borne by the retailers, or is it split among different actors? (Central DC's, Business units)
14. How do you manage inventory levels and costs related to it while meeting minimum order quantity requirements?
15. What is the usual lead time after placing the order?
16. How does a daily pallet order look like? (Ask if they can show)
17. Are all the products received in pallets, or are there other packaging methods too? (Boxes, Kartons)
18. What do you do with the products that are about to expire? Are they sent back or wasted/ destroyed?

19. What does the storage capacity look like? How many items or units can the store hold? (Frozen, Chilled, Ambient)
20. Why do you not recommend ordering one-layer LHUs?
21. Are there any costs for destroying the items/ products if the BBD expires? How often do you get these?
22. How do you handle situations where the store has excess inventory due to minimum order quantity requirements?
23. Can you tell us about the various costs involved (handling costs, holding, storage, inventory)? Any extra costs apart from the usual?
24. Is the inventory costs for frozen, chilled, and ambient different? If so, how?

10.1.2 Logistic Service Provider (Central Distribution Centre)

1. Can we have a look at how the pallets are dispatched, as we were made aware of the phenomena called non-stacked pallets for almost all the retailers?
2. How are the goods categorised for dispatch i.e., how do the workers handle the products?
3. What are the different costs that are related when performing these activities?
4. For the products stored in DC, do you have to bear any inventory or holding costs? If yes, how do you segregate and manage these costs?
5. Is there any effect/charge for the retailers/ DC when the pallets are not fully utilized? For example, the supplier sends 100 boxes in 1 pallet and the retailer orders 60 boxes in one pallet. Then to segregate that do you have to bear any costs? How much is that?
6. On what basis do you place orders/receive orders from suppliers?
7. What attributes will affect the order quantity?
8. Do the DCs have any MOQ set by the suppliers for the products they order? If there is MOQ to be followed and if it is not followed, what are the reasons for not placing orders according to the respective MOQs?
9. What are the transport costs? Does it depend upon frozen, chilled, or ambient?
10. How are the transportation costs fixed? Is it by volume or by weight?
11. How are the delivery methods fixed?
12. Who has to bear the transportation costs?
13. Are there scenarios where the trucks are not fully loaded and still have to pay for the whole truck? If yes, how are these losses currently handled?
14. Are the pallet sizes the same across the Scandinavian markets?
15. How are the picking costs calculated? (Is it the same for picking a few boxes in the pallets compared to a whole pallet?)

10.2 Survey Questions

1. Please specify which market you handle.
2. Are you familiar with the concept of minimum order quantity (MOQ)?
3. Do you think the retail stores would be willing to adjust their ordering quantity to meet MOQ (full-layer LHU)?
4. If MOQ (full-layer LHU) is implemented, ordering cycles will be changed (Increase/decrease). Would that be suitable for the retail stores?
5. If MOQ (full-layer LHU) is implemented, there might be capacity constraints. If there are any such capacity constraints, do you think it is possible for the retail stores to manage them?
6. If "No" please specify why?
7. Apart from capacity concerns, are there any other issues that might arise if MOQ (full-layer LHU) is set for all products?
8. How much time would the retail stores need to adjust their ordering practices and internal processes to start ordering as per MOQ (full-layer LHU)?
9. Do you think the retail stores have experienced any difficulties or challenges when receiving pallets with mixed articles and uneven pallets?
10. If "Yes" please specify why?
11. Are there any specific concerns or challenges that you foresee with the MOQ (full-layer LHU) concept? If yes, how can we work together to address those concerns?
12. Do you think MOQ (full-layer LHU) can be followed for Short BBD products?
13. If "No" please specify why?

DEPARTMENT OF TECHNOLOGY MANAGEMENT AND ECONOMICS
DIVISION OF INNOVATION AND R&D MANAGEMENT
CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden
www.chalmers.se

CHALMERS
UNIVERSITY OF TECHNOLOGY