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Best Practices of Inventory Management Under Uncertain Demand for Fast Moving Consumer  
Goods (FMCG)

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## ABSTRACT

This research addresses the question of optimal inventory management practices for Fast Moving Consumer Goods (FMCG) companies under uncertain demand, particularly in the personal care category. Employing a qualitative methodology, in-depth interviews with FMCG executives were conducted to understand the challenges and identify solutions for managing inventory during high uncertainty.

The findings revealed three key components for effective inventory management: cross-functional teamwork, technology implementation, and agile supply chain practices. Cross-functional teamwork facilitates better coordination and decision-making within organizations. Advanced technologies, including automated forecasting, RFID, smart warehousing, AI, and ML, improve demand forecasting accuracy and real-time inventory visibility. Agile supply chain practices allow FMCG companies to quickly respond to market changes and customer needs, minimizing stockouts and overstocking while optimizing inventory levels.

In summary, successful inventory management under volatile demand in the FMCG industry requires integrating cross-functional teamwork, advanced technology, and agile supply chain practices. Supported by investments in workforce development, data infrastructure, and collaboration between supply chain practitioners, data scientists, and IT professionals, these strategies can enhance customer satisfaction, cost savings, and overall business success.

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## **Chapter 1**

### **Introduction**

FMCG is divided into four main categories: personal care, food and beverage, household care, and alcohol and tobacco (Bala & Kumar, 2011). This paper will discuss and analyze the recent developments and practices in the FMCG industry for inventory management in the personal care category. The FMCG industry is one of the largest industries in the world (CII, 2005). Despite the FMCG industry's seemingly lucrative nature, the industry is fraught with challenges and difficulties. This is because FMCG manufacturers operate in a highly volatile environment where product specifications and customer demand fluctuate on a daily basis. Therefore, proper inventory management is critical to manufacturing companies' success in avoiding high stockout costs. Companies need to pay attention to inventory management and flexibly arrange inventory models to adapt to constantly changing demand to maintain business competitiveness. Failure in inventory management can increase operating costs, lead to lower profits, and negatively affect customer satisfaction, among other things. This research will discuss the best practices of how the FMCG industry could achieve low inventory, low cost, and high customer satisfaction in the face of uncertain demand.

## Chapter 2

### Literature review

#### FMCG

According to Nemptajela, N., & Mbohwa, C. (2017), FMCG are usually traded and consumed within a short period of a year. Usually, FMCG products are considered as necessities and include non-durable products that are not limited to general groceries, beverages, skincare and cosmetics (Nozari et al., 2019). At the same time, FMCG products are in great demand by customers, while manufactured products have a short life span and depreciate quickly (A.I. Moola, C.A. Bisschoff, 2012). As a result, FMCG organizations face great challenges in supply chain management, such as increasing service levels demanded by customers, higher delivery frequency and smaller shipment sizes expected, among others (Ferne & Sparks, 2019). Moreover, the FMCG market environment is unpredictable because of the high degree of similarity of goods, making it difficult to achieve a high level of competitive advantage (Nozari et al., 2019). Published SWOT analysis of the FMCG industry shows that a well-coordinated distribution network as its strength, while low technological aggressiveness as a weakness and irregular tax structure and imports as threats to the industry (Deloitte, 2009; Kumar, 2009). Other features of this industry are the intense competition between organized and unorganized sectors, strong presence of multinational companies, and low cost of operating business (Singh & Acharya, 2013). Therefore, FMCG companies are recognized as leaders in supply chain management (Nemptajela & Mbohwa, 2017).

Moreover, the agility and flexibility of the FMCG supply chain are crucial to meeting customers' needs (Govender et al., 2018). Bala and Kumar also confirmed that the FMCG supply

chain uses complex distribution networks (2011). Therefore, efficient and effective inventory management is essential for the efficacious functioning of their supply chains.

## Inventory Management

In the FMCG industry, manufacturers, transportation companies, and wholesale and retail sectors are engaged in production and service activities in the FMCG supply chain to a large extent (Končar et al., 2021). Equally important, inventory management is a vital link connecting the integrated supply chain operations. The activities of a typical FMCG organization in the whole supply chain area are shown in Figure 1.



Figure 1. Supply chain activities in a consumer goods supply chain (Kumar, 2009)

The role of inventory management is to balance the minimization of total cost and the expansion of customer satisfaction. These roles are not straightforward because of the impact and uncertainty of intermittent events on demand (T. Tanthatemee, B. Phruksaphanrat, 2012). The inventories accumulated by the organization are used to meet the uncertain market demand of temporary needs (Ignaciuk, 2014). In this case, there are many classifications of inventory to be



used in various scenarios, such as Buffer inventory, Cycle inventory, Decoupling inventory, Anticipation inventory, and Pipeline inventory.

Since inventories usually represent twenty percent to sixty percent of the total assets of manufacturing firms (Gümüs & Güneri, 2007), inventory management policies are crucial in determining the profitability of these companies. In today's increasingly competitive business environment, optimal inventory management has become a significant objective to simultaneously reduce costs and improve customer service (Daskin, Coullard, & Shen, 2002). according to P.A. Berling, excessive inventories result in higher inventory holding costs, such as space rental costs, decision costs, unused old inventory costs, damage, theft, etc. (2011). However, the cost of insufficient inventory is also prohibitive because consumers may cease the consumption at the organization and go to a competitor as a replacement. Nemtajela and Mbohwa suggested that the primary purpose of satisfactory inventory management is to excel in customer satisfaction and provide essential customer service while controlling the lowest daily inventory costs: ordering the suitable materials and inventory quantities (2017).

According to Nemtajela and Mbohwa's study in 2017, there is a positive and significant relationship between inventory management and uncertain demand: the higher the uncertainty of demand, the more complex and challenging inventory management is in an organization. When business organizations use inappropriate inventory models, it can lead to poor product quality and production, disappointed customers, and lost profits.

## **Inventory Management Models**

In the present day and age, the FMCG sector has experienced intense competition, leading to an increased focus on optimal inventory management strategies. FMCG companies must strike a balance between keeping inventory levels low to minimize costs, while simultaneously guaranteeing they have enough stock available to meet consumer demand (Ketchen, Hult, & Arrfelt, 2011).

One of the major challenges of inventory management in the FMCG sector is the unpredictable nature of product demand. This uncertainty can result in stock shortages, overstocking, and waste, all of which can cause substantial financial repercussions (Singh, 2019).

To address these challenges, FMCG companies have adopted several inventory management models, including traditional methods such as Economic Order Quantity (EOQ) and Continuous Review (CR), as well as more advanced methodologies including Demand Driven MRP (DDMRP) and Inventory Management with Sales and Operations Planning (S&OP) (Vidale, 2014).

EOQ is a widely recognized approach aimed at balancing the costs associated with holding inventory and the costs associated with ordering and receiving inventory (Jain & Jain, 2016). CR is a continuous monitoring system that keeps track of inventory levels and orders inventory as necessary to maintain pre-determined levels (Ho & Lee, 2009).

DDMRP, conversely, is a novel methodology that utilizes a combination of forecasting, buffer management, and collaboration to mitigate the effects of uncertain demand (Collier, 2018). S&OP is a process that integrates a company's sales and operations functions, improving decision-making and organizational alignment (Choi & Yu, 2016).

Famous FMCG companies such as Procter & Gamble, Coca-Cola, and Unilever have implemented DDMRP and S&OP to enhance their inventory management practices and respond more effectively to uncertain demand. For instance, Procter & Gamble was able to reduce inventory levels and improve customer service levels by utilizing DDMRP (Collier, 2018), while Coca-Cola utilized S&OP to improve the alignment of its sales and operations functions and respond more effectively to changes in customer demand (Lee & Kim, 2011).

In conclusion, effective inventory management is crucial for FMCG companies, especially given the unpredictability of product demand. Several inventory management models have been adopted by these companies, including traditional methods such as EOQ and CR, as well as advanced methodologies including DDMRP and S&OP (Vidale, 2014). These models have demonstrated effectiveness in enhancing inventory management practices and enabling FMCG companies to respond more effectively to uncertain demand (Singh, 2019).

### **Uncertain Demand**

The phenomenon of uncertain demand, characterized by the variability in customer demand which can be influenced by multiple factors such as market dynamics, competition, customer preferences, and economic conditions (Fisher, 1997), poses significant challenges to the effective management of inventory in the context of FMCG companies. Meanwhile, uncertainty poses significant challenges to production planning and control, such as changes in orders, random supplier capabilities, and unpredictable events such as weather, machine breakdowns, and human error, which can lead to changes in demand at any time (Nemtajela &

Mbohwa, 2017). In order to minimize these risks, FMCG companies need to be able to predict customer demand accurately and respond quickly to changes in the market (Wein, 2011).

In particular, global supply chains are adversely affected during uncertain times, such as the 2019 coronavirus pandemic, where emerging restrictions and business disruptions negatively impacted supply chains in the FMCG industry (Kazancoglu et al., 2021). The FMCG industry, which provides grocery, milk, and hygiene products, experienced a surge in demand during the outbreak (Debata et al., 2020). However, manufacturing companies were severely affected by the blockade and the disruption of public transportation services, which involved the consumption of essential and non-essential goods. As a result, the difficulty of inventory management has also increased dramatically, as supply chain specialists have a problem making consumer demand forecasts in the face of unpredictable pandemic trends.

In the case of an inventory system with uncertain demand, product supply chains experience stockouts, which in turn incur out-of-stock costs and lost profits (Tempelmeier & Bantel, 2015). In order to mitigate the risks associated with uncertain demand, FMCG firms must have a comprehensive understanding of customer demand patterns and the ability to respond to changes in demand in real-time. To this end, several strategies are available to FMCG companies to manage uncertain demand, including safety stock, just-in-time (JIT) inventory management, and demand forecasting (Zheng and Zhang, 2009).

Safety stock, for instance, is a commonly employed strategy by FMCG companies to ensure that they can meet customer demand even in the face of unexpected fluctuations (Kopczak and Lee, 2011). On the other hand, JIT inventory management involves reducing inventory levels and relying on a more efficient supply chain to ensure product availability when needed (Chen et al., 2016). Additionally, demand forecasting, which involves the prediction of

future customer demand and subsequent adjustment of inventory levels, is another crucial strategy for FMCG companies to manage uncertain demand (Lin and Chen, 2009).

Therefore, managing uncertain demand is of utmost importance for the effective management of inventory in FMCG companies. The various strategies available to FMCG companies, including safety stock, JIT inventory management, and demand forecasting, serve as valuable tools in mitigating the risks associated with uncertain demand and ensuring the effective management of inventory.

## **Chapter 3**

### **Methodology**

#### **Research Design Strategy**

This scholarly inquiry shall be undertaken utilizing a qualitative research methodology. This method is deemed fitting for the investigation as it provides the researcher with the capacity to extract ample and comprehensive data from top executives or managers within the FMCG sector. The data procured shall then be dissected and scrutinized to unveil significant understandings about inventory management procedures in the FMCG industry.

#### **Method of Data Collection**

The data for the study will be procured through semi-structured interviews with executives or managers from a minimum of two to a maximum of three FMCG corporations. The sample will be selected utilizing the convenience sampling technique, which entails selecting participants who are readily accessible and eager to participate in the study. The interview questions will concentrate on the difficulties faced by FMCG companies during periods of high unpredictability in managing their inventory and the techniques they employ to overcome these challenges. The interviews may be conducted in person or through a virtual medium, contingent upon the availability of the participants.

### **Data Analysis Procedure**

The data garnered from the interviews shall be analyzed using the thematic analysis approach. Thematic analysis entails identifying and coding the recurring themes that emerge from the data and then organizing and categorizing these themes into broader categories. The data shall be analyzed to uncover prevalent themes and patterns in the inventory management practices of FMCG companies.

### **Personal Care over Food**

The study aimed to investigate the inventory management strategies in coping with uncertain demand for personal care products rather than food. The choice of personal care products over food is due to the fact that food is a necessity, and its stock does not vary significantly in comparison to personal care products (Gaur & Kesavan, 2014). Personal care products, being non-necessities, have a higher level of uncertainty in customer purchasing decisions and delay in demand patterns. This Uncertainty poses a challenge to inventory management in the supply chain. The study sought to explore how firms manage inventory under such uncertain demand patterns in the personal care product sector. The convenience sampling methodology employed may not be applicable to all companies due to its reliance on the availability of companies at the time of research. However, the findings could serve as a valuable reference for those organizations that have experienced the impact of the pandemic.

## **Chapter 4**

### **Analysis and Results**

#### **A Case Study of Company U**

During an interview with Executive A from Company U, he discussed the challenges that the organization faces in inventory management. Executive A identified two primary challenges: materials and capacity.

Executive A explained that long lead times and uncertainty of demand make it arduous for the company to react promptly to spikes in demand. For instance, if a social media trend involving a specific product were to emerge, responding would be challenging due to the extended lead times for numerous essential materials. Moreover, the company's current setup lacks the flexibility required to support sudden spikes in demand. Executive A cited recent product demand surges as an example of a situation where the company grappled with keeping up due to these material challenges.

Concerning capacity, Executive A noted that adjusting production schedules internally is less complicated than collaborating with third-party manufacturers. External factors, such as competing customers with their lead times, make it difficult to rapidly modify capacity to accommodate fluctuations in demand. Consequently, the company encounters significant challenges in maintaining equilibrium between production and demand, particularly when it comes to physical purchase orders and third-party manufacturing.

Executive A emphasized that both materials and capacity are critical factors in Company U's supply chain management. Any increase or decrease in demand must be meticulously aligned



with production schedules to minimize the risk of waste or inventory issues. These challenges highlight the need for the company to prioritize flexibility and responsiveness in its supply chain management approach.

Executive A noted that an increase in demand could negatively impact the company's performance as it may not capture total sales, leading to lost sales and ultimately affecting the top-line revenue. Conversely, a decrease in demand could result in excess inventory, adversely impacting the company's cash flow and bottom line.

In support of Executive A's observations, research suggests that long lead times and supply chain uncertainty can pose significant challenges for companies. According to Simchi-Levi et al. (2008), organizations can mitigate these risks by building flexibility into their supply chain design and concentrating on responsive planning and execution. Furthermore, as noted by Ho and Zheng (2016), the utilization of advanced analytics tools can assist companies in better forecasting demand and allocating resources accordingly, potentially reducing the impact of spikes and drop-offs in demand.

In conclusion, Executive A from Company U illustrated the intricacies and challenges that organizations face in inventory management with regard to materials and capacity. By prioritizing flexibility and responsiveness in supply chain management and employing advanced analytics tools, companies like Company U can better navigate these challenges and successfully adapt to unpredictable demand fluctuations.

## A Case Study of Company J

Executive J from Company J shared insights on the challenges of inventory management and the strategies that her company used to solve these challenges. She emphasized that inventory management is affected by uncertainty in the marketplace and that volatile demand can impact inventory management adversely. While it is possible to predict market trends using historical data, unforeseeable events such as natural disasters or pandemics can create ripple effects in the supply chain that lead to compounding impacts on supplies. The fear factor in the consumers' minds regarding the availability of a product in the future can lead to overconsumption and overbuying habits, which can cause shelves to become empty overnight, creating further inventory challenges.

To overcome these challenges, Executive J recommends holding additional safety stock for products that are expected to fluctuate in demand. She also suggests working with the sourcing sites to reduce the end-to-end lead time of materials, such as pivoting from ocean transit to air transit. This can help to improve agility and responsiveness when dealing with unpredictable demand. However, every decision made in inventory management has a consequence, and there is always a tradeoff between cost-effectiveness and responsiveness.

Executive J emphasized the importance of understanding the demand and evaluating the product or profit that it brings to the company when designing inventory management strategies. She recommends looking at the product mix, revenue generation, and portfolio of the company and then prioritizing based on these factors. Technology, such as IT tools and analytics, can also be useful in identifying errors and improving the planning process. However, ultimately, it is the planners that know best about their products, and it is essential to listen to them at all levels of the supply chain to make the best decisions possible.

Executive J notes that inventory management is a complicated process with many inputs that affect the health of the inventory and the company's portfolio. While technology can help improve the process, it is crucial to use human expertise to zoom out and predict the environment's impact on the inventory. As a result, Executive J recommends using a combination of technology and human expertise to develop the best possible inventory management strategy.

In summary, Executive J from Company J faced several challenges with inventory management due to the uncertainty in the marketplace and volatile demand. She recommended holding additional safety stock, reducing lead times, and evaluating the product's profitability when designing inventory management strategies. Technology and human expertise can help improve the process, but ultimately, it is the planners who know best about their products.

### **A Case Study of Company P**

In another interview with Executive C from Company P, a personal care products manufacturer's director, noted that they faced numerous challenges during the past decade, particularly in managing inventory under volatile demand. A decade ago, Company P had one production plant and two distribution centers (DCs). However, to respond faster to customer needs and ship lower quantities, the company expanded to six distribution centers (DCs) in the U.S. This significantly increased the complexity of the supply chain and made inventory management more challenging.

She noticed that different DCs had varying safety levels and did not communicate with each other. This led to the production of unnecessary minimum order quantities (MOQs) in some

cases when there was surplus inventory in other DCs. Furthermore, there was a lack of proper data flow, which is crucial for reducing inventory and lowering carrying costs.

The COVID-19 pandemic created a volatile demand for personal care products as well. While some items, such as toilet paper and diapers, experienced a surge in demand, others like deodorants and skincare products witnessed a slump. Company P had to adapt to these external factors affecting demand, which proved challenging.

Moreover, Executive C outlined the three core factors of inventory - core cycle stock, safety stock, and frozen inventory. Managing these inventory categories effectively was a significant challenge, especially considering the volatile demand during the pandemic.

In order to address these issues, one of the first steps taken by Company P was to improve communication among the DCs and the production plant. This allowed for better visibility of the inventory across the entire network, enabling the company to balance inventory across the DCs and avoid producing unnecessary MOQs. Additionally, the company focused on improving its master data to ensure better data flow in multiple directions.

Besides, Company P implemented a minimum safety stock level for pallets to prevent stockouts caused by moving pallets to different storage locations for display production. They also developed a tool that updates safety stock every week based on shipments to manage safety stock more effectively.

On the other hand, to manage frozen inventory, Company P streamlined quality processes, reducing the paperwork processing time from seven to three days. This helped save on inventory costs and prevented stock from being stuck in transit or having quality issues. In this case, Inventory Program Managers actively managed non-productive inventory (red and orange inventory) by identifying the root cause of blockages and taking appropriate action, such as

returning the inventory to the supplier, scrapping it, or finding an alternative solution. They also negotiated deals with remnant customers like Big Lots to take on orange inventory at discounted prices. For unproductive inventory, Company P worked on deals with customers like Family Dollar and Dollar General to take on extra inventory. They also collaborated with the production plant to lower production quantity by identifying the root cause of high MOQs. This may involve working with suppliers to reduce order quantities, upgrading quality systems, or finding ways to increase demand.

To mitigate the "bullwhip effect" throughout their supply chain, Company P engaged in extensive communication and collaboration with their suppliers to manage delivery schedules, assess inventory levels, and make necessary adjustments. Company P also worked closely with their DCs to move current inventory to external warehouses, making room for essential products that were still in high demand during the pandemic.

Meanwhile, Company P used the slowdown in demand as an opportunity to reassess their data and plan for the future. They anticipated that the pandemic would not last forever and began strategizing on how to adapt and improve their operations when demand eventually returned.

Company P faced several challenges in managing inventory under volatile demand, particularly during the COVID-19 pandemic. The company responded by implementing strategies to improve communication, enhance data flow, manage various inventory categories, collaborate with suppliers and distribution centers, and adapt to external factors affecting demand. These strategies have helped the company overcome the challenges and improve its inventory management practices, ultimately maintaining a resilient supply chain during a period of unprecedented uncertainty. By staying vigilant and being personally invested in the products

they manage, Company P continues to navigate the dynamic nature of inventory management and successfully adapt to ever-changing customer behavior.

## **Solutions and Practices**

### **I. Cross-functional teamwork:**

Effective inventory management is crucial for FMCG companies, given the industry's rapid turnover, narrow profit margins, and highly volatile demand (Lavassani, Movahedi, & Kumar, 2009). Cross-functional teamwork, which involves collaboration between different departments and functions within an organization, has emerged as a valuable approach for improving inventory management in this context (Mentzer, Min, & Bobbitt, 2004).

Cross-functional teamwork refers to the collaboration between individuals from different departments, such as sales, marketing, production, and logistics, to achieve common goals and improve overall organizational performance (Mello & Stank, 2005). In the context of inventory management, cross-functional teams can help align the objectives and actions of different functions, leading to more accurate demand forecasting, improved inventory control, and better responsiveness to changes in demand (Gattorna, 1998).

Accurate demand forecasting is vital for effective inventory management, particularly in the FMCG industry, where demand is often volatile and difficult to predict (Christopher, 2000). Cross-functional teamwork enables the integration of diverse perspectives and insights from different departments, resulting in more accurate and comprehensive demand forecasts (Chen, Drezner, Ryan, & Simchi-Levi, 2000). For instance, collaboration between sales, marketing, and

logistics teams can help identify patterns and trends that may not be apparent when each function works in isolation (Moon, Mentzer, & Smith, 1998).

Cross-functional teams can contribute to better inventory control by ensuring that inventory decisions are based on a holistic understanding of the organization's goals, processes, and constraints (Axsäter, 2006). This can lead to more effective inventory policies and procedures, reducing the risk of stockouts, overstocks, and obsolescence (Gaur, Fisher, & Raman, 2005). Additionally, cross-functional collaboration can facilitate the identification and resolution of inventory discrepancies and inefficiencies, thereby enhancing overall inventory performance (Lee, Padmanabhan, & Whang, 1997).

In the FMCG industry, companies must be able to quickly adapt to fluctuations in demand to maintain high levels of customer satisfaction and avoid stockouts (Christopher, 2000). Cross-functional teamwork can enhance an organization's responsiveness to demand changes by fostering better communication, coordination, and decision-making across departments (Fisher, 1997). This can lead to faster and more effective responses to changes in demand, enabling FMCG companies to maintain optimal inventory levels and minimize stockouts (Gattorna, 1998).

While cross-functional teamwork offers significant potential for improving inventory management in FMCG companies, it also presents several challenges, such as overcoming functional silos, ensuring effective communication, and managing potential conflicts between departments (Mello & Stank, 2005). To address these challenges, organizations can adopt best practices such as establishing clear goals and performance metrics for cross-functional teams, promoting a culture of collaboration and trust, and providing ongoing training and support to team members (Mentzer et al., 2004).

Cross-functional teamwork can play a critical role in enhancing inventory management for FMCG companies under volatile demand conditions. By fostering collaboration between different departments, cross-functional teams can contribute to more accurate demand forecasting, improved inventory control, and increased responsiveness to demand changes.

## **II. Technology:**

Regarding the role of technology in inventory management in the FMCG industry, executives emphasized its significance in catching issues before they arise. They noted that the companies' planning technology is automated and leverages history to identify potential challenges proactively. Executives highlighted the importance of investing in technology to be more predictive and proactive in managing inventory.

The use of technology in inventory management is critical in mitigating demand challenges and uncertainty. A study by Chen et al. (2019) found that technology-enabled inventory management systems improve forecasting accuracy and help organizations respond quickly to changes in demand. Similarly, a study by Hu et al. (2020) highlighted the importance of leveraging advanced analytics and artificial intelligence to support decision-making in inventory management.

### **a. Automated Forecasting and Planning Technology**

FMCG companies face significant challenges in managing their inventory due to rapid turnover, slim profit margins, and highly volatile demand (Lavassani, Movahedi, & Kumar, 2009). Automated forecasting and planning technology has emerged as a promising solution to improve inventory management in this industry (Syntetos, Babai, Dallery, & Teunter, 2011).

Automated forecasting and planning technology employs advanced algorithms and computational techniques to predict future demand and optimize inventory management



(Hyndman & Athanasopoulos, 2018). Such technology can analyze historical sales data, market trends, and other relevant factors to generate accurate demand forecasts and make informed decisions on inventory replenishment and allocation (Moon, Mentzer, & Smith, 1998).

Automated forecasting technology can significantly enhance the accuracy of demand forecasts by employing sophisticated algorithms that account for various factors, such as seasonality, trends, and promotions (Eroglu & Hofer, 2011). Improved forecast accuracy allows FMCG companies to better anticipate demand fluctuations, thus reducing the likelihood of stockouts and overstocks (Fildes, Goodwin, Lawrence, & Nikolopoulos, 2009).

By providing accurate demand forecasts, automated planning technology enables FMCG companies to maintain optimal inventory levels (Axsäter, 2006). This can lead to reduced holding costs, increased inventory turnover, and improved cash flow for these companies (Rajeev, Pati, & Padhi, 2018). Moreover, optimized inventory levels can enhance customer satisfaction by ensuring product availability and reducing the risk of stockouts (Gaur, Fisher, & Raman, 2005).

Automated forecasting and planning technology allows FMCG companies to respond more quickly to changes in demand (Christopher, 2000). By continuously updating demand forecasts based on real-time sales data, these companies can adjust their production, distribution, and replenishment strategies accordingly (Lee, Padmanabhan, & Whang, 1997). This increased responsiveness can help FMCG companies to better cope with volatile demand patterns and minimize the impact of demand fluctuations on their inventory management (Chopra & Sodhi, 2004).

Despite the benefits, implementing automated forecasting and planning technology in FMCG inventory management is not without challenges. High implementation costs, the need

for skilled personnel, and the complexity of integrating the technology with existing systems can hinder the widespread adoption of these solutions (Hyndman & Athanasopoulos, 2018).

Additionally, the accuracy of automated forecasts can be affected by the quality and completeness of historical sales data, which may be challenging to obtain in some cases (Chen & Kang, 2007).

Automated forecasting and planning technology offers significant potential for improving inventory management in FMCG companies under volatile demand conditions. By enhancing forecast accuracy, optimizing inventory levels, and increasing responsiveness to demand fluctuations, these technologies can help FMCG companies overcome the challenges associated with rapid inventory turnover and fluctuating demand. While there are limitations and challenges in adopting automated forecasting and planning technology, the benefits are expected to outweigh these drawbacks, making it a valuable investment for FMCG companies seeking to improve their inventory management practices and remain competitive in the industry. As technology continues to advance, it is likely that the costs and challenges associated with implementing these solutions will decrease, making them more accessible and beneficial to a greater number of FMCG companies.

#### b. RFID

The FMCG industry is characterized by rapid inventory turnover, low profit margins, and highly volatile demand (Lavassani, Movahedi, & Kumar, 2009). Consequently, companies in this sector are continuously seeking ways to improve their supply chain performance, particularly inventory management. Radio-Frequency Identification (RFID) technology has emerged as a promising solution for addressing these challenges (Meyer & Cunow, 2006).

RFID technology involves the use of radio waves to identify and track objects (Finkenzeller, 2010). It comprises three main components: RFID tags, readers, and a software system (Wamba, Lefebvre, & Lefebvre, 2006). RFID tags store information about a product, while readers capture this data and transmit it to the software system for processing and analysis (Ngai, Moon, Riggins, & Yi, 2008). By integrating RFID technology with inventory management systems, FMCG companies can achieve real-time visibility of their stock levels, enabling them to optimize their inventory management processes (Chopra & Meindl, 2007).

RFID technology enables real-time tracking and monitoring of inventory items throughout the supply chain (Attaran, 2007). This increased visibility and traceability can lead to reduced stockouts, overstocks, and shrinkage, which are common challenges in FMCG inventory management (Sarac, Absi, & Dauzère-Pérès, 2010). Moreover, RFID systems can improve the accuracy of demand forecasts by providing access to real-time sales and inventory data (Lee & Ozer, 2007).

RFID systems can automate inventory management tasks, such as counting and tracking items, leading to increased operational efficiency (Bottani & Rizzi, 2008). By eliminating the need for manual data entry and reducing human errors, RFID technology can help FMCG companies save time and labor costs associated with inventory management (Hardgrave, Aloysius, & Goyal, 2008).

Access to real-time inventory data through RFID systems allows FMCG companies to make informed decisions regarding replenishment and inventory control (De Kok & Fransoo, 2001). RFID technology can also enhance the responsiveness of FMCG companies to demand fluctuations by providing visibility into customer buying patterns and enabling them to adjust production and distribution accordingly (Christopher, 2000).

Despite its benefits, the adoption of RFID technology in FMCG inventory management is not without challenges. High implementation costs, technological limitations, and privacy concerns can hinder the widespread adoption of RFID systems in the industry (Wu, Chuang, & Hsu, 2006). However, as technology advances and costs decrease, these barriers are expected to diminish, allowing more FMCG companies to reap the benefits of RFID technology (Srivastava, 2004).

RFID technology offers significant potential for improving inventory management in FMCG companies under volatile demand conditions. By enhancing visibility, traceability, operational efficiency, and decision-making, RFID systems can help these companies optimize their inventory management processes and overcome the challenges associated with rapid inventory turnover and fluctuating demand. While there are limitations and challenges to adopting RFID technology, its benefits are expected to outweigh the costs and challenges as technology continues to advance. As a result, FMCG companies should consider investing in RFID technology to remain competitive and effectively manage their inventory in the face of volatile demand.

### c. Smart Warehousing

FMCG companies face considerable challenges in managing their inventory due to rapid turnover, narrow profit margins, and highly volatile demand (Lavassani, Movahedi, & Kumar, 2009). Smart warehousing technology, which integrates advanced technologies such as IoT, robotics, and artificial intelligence, has emerged as a promising solution to improve inventory management in this industry (Manavalan & Jayakrishna, 2019).

Smart warehousing technology refers to the integration of advanced technologies, such as IoT devices, robotics, artificial intelligence, and data analytics, to optimize warehousing

operations, including inventory management, order picking, and material handling (Rouwenhorst et al., 2000). These technologies enable real-time visibility, increased automation, and data-driven decision-making, thereby improving the efficiency and accuracy of warehouse operations (Kärkkäinen & Holmström, 2002).

Smart warehousing technology enables real-time inventory visibility through IoT devices and sensors, which collect and transmit data on inventory levels, product locations, and warehouse conditions (Zhong et al., 2017). This real-time visibility allows FMCG companies to monitor and manage their inventory more effectively, reducing the risk of stockouts and overstocks, and enhancing their ability to respond to volatile demand (Harrison & van Hoek, 2008).

Order picking is a critical aspect of inventory management in FMCG companies, as it directly affects order fulfillment times and customer satisfaction (De Koster, Le-Duc, & Roodbergen, 2007). Smart warehousing technology can improve order picking efficiency through the use of robotics, automated storage and retrieval systems (AS/RS), and advanced picking algorithms (Frazelle, 2002). These technologies minimize human errors, reduce labor costs, and increase the speed and accuracy of order fulfillment (Meller & Gue, 2009).

Smart warehousing technology can enhance demand forecasting and replenishment by leveraging data analytics and artificial intelligence (Gunasekaran, Patel, & Tirtiroglu, 2001). These advanced technologies can analyze historical sales data, market trends, and other relevant factors to generate accurate demand forecasts and make informed decisions on inventory replenishment and allocation (Chen, Drezner, Ryan, & Simchi-Levi, 2000). This can help FMCG companies to better anticipate and respond to volatile demand patterns, ensuring optimal

inventory levels and reducing the likelihood of stockouts and overstocks (Van Donselaar et al., 2006).

Despite the benefits, implementing smart warehousing technology in FMCG inventory management is not without challenges. High implementation costs, the need for skilled personnel, and the complexity of integrating the technology with existing systems can hinder the widespread adoption of these solutions (Manavalan & Jayakrishna, 2019). Additionally, data security and privacy concerns may arise due to the increased reliance on IoT devices and cloud-based systems (Al-Fuqaha et al., 2015).

Smart warehousing technology offers significant potential for improving inventory management in FMCG companies under volatile demand conditions. By enabling real-time inventory visibility, improving order picking efficiency, and enhancing demand forecasting and replenishment, these technologies can help FMCG companies overcome the challenges associated with rapid inventory turnover and fluctuating demand. As technology continues to advance, it is likely that the costs and challenges associated with implementing these solutions will decrease, making them more accessible and beneficial to a greater number of FMCG companies.

#### d. Artificial intelligence (AI) and machine learning (ML)

With volatile demand and rapidly changing market conditions, accurate demand forecasting is a key element of efficient inventory management. Artificial intelligence (AI) and machine learning (ML) offer powerful tools to help FMCG companies achieve more accurate demand forecasting and optimize inventory management, which is also in accord with the executives' opinions. This section will explore how the development of AI and ML techniques

can significantly enhance demand forecasting and ultimately improve inventory management under volatile demand in the FMCG industry.

Accurate demand forecasting is a complex process due to the multitude of factors that influence consumer behavior, such as seasonal variations, promotions, and market trends (Wang & Zhang, 2012). Traditional forecasting methods, such as time-series analysis and regression models, often fall short in capturing these complexities. AI and ML, on the other hand, can analyze vast amounts of data, identify patterns, and adapt to changing conditions, providing more accurate forecasts (Makridakis, Spiliotis, & Assimakopoulos, 2018).

One way AI and ML can improve demand forecasting is through the use of deep learning techniques, such as recurrent neural networks (RNNs) and long short-term memory (LSTM) networks (Hochreiter & Schmidhuber, 1997). These techniques have demonstrated the ability to capture complex patterns in time-series data and make accurate predictions, even in the presence of high volatility and nonlinearity (Yao et al., 2018). LSTM networks, in particular, have shown promising results in demand forecasting for FMCG companies, capturing both long-term and short-term dependencies in the data (Bandara, Bergmeir, & Smyl, 2021).

Another promising approach is the use of ensemble methods, which combine multiple ML models to generate more accurate predictions. Ensemble methods, such as bagging, boosting, and stacking, have proven effective in demand forecasting applications by reducing the risk of overfitting and improving generalization (Opitz & Maclin, 1999). A study by Chen, Li, and Gou (2019) demonstrated the effectiveness of ensemble methods in demand forecasting for FMCG products, achieving superior performance compared to single ML models.

AI and ML can also be used to incorporate external factors, such as weather, economic indicators, and social media data, into the forecasting process. These factors can have significant

impacts on consumer behavior and demand for FMCG products (Fildes & Goodwin, 2007). By leveraging AI and ML algorithms, companies can analyze and integrate these external factors into their demand forecasting models, resulting in more accurate predictions (Nikolopoulos et al., 2018).

Moreover, AI and ML can support the development of prescriptive analytics, which not only predict future demand but also provide actionable recommendations for optimizing inventory management (Bertsimas & Kallus, 2020). By incorporating AI and ML into their supply chain decision-making processes, FMCG companies can optimize safety stock levels, replenishment policies, and production plans, leading to significant improvements in inventory management under volatile demand (Kourentzes, Barrow, & Crone, 2014).

The integration of AI and ML into demand forecasting and inventory management processes requires a strong data infrastructure and skilled data scientists. FMCG companies must invest in the development of data management systems and the training of their workforce to effectively implement these technologies (Waller & Fawcett, 2013). Furthermore, collaboration between supply chain practitioners, data scientists, and IT professionals is essential to ensure the successful deployment of AI and ML solutions (Kelleher, MacCormack, & Murray, 2016).

Hence, AI and ML have the potential to revolutionize demand forecasting and inventory management under volatile demand for FMCG companies. By leveraging deep learning techniques, ensemble methods, and the integration of external factors, AI and ML can significantly improve the accuracy of demand forecasts. Furthermore, the use of prescriptive analytics can help FMCG companies optimize their inventory management strategies, leading to reduced costs and increased customer satisfaction. To successfully implement AI and ML solutions, it is crucial for FMCG companies to invest in data infrastructure and workforce



development, as well as foster collaboration between supply chain practitioners, data scientists, and IT professionals. By embracing these advanced technologies, FMCG companies can better navigate the challenges of volatile demand and maintain a competitive edge in the ever-changing global marketplace.

### **III. Agile Supply Chain:**

FMCG companies face increasing demand volatility due to factors such as changing consumer preferences, economic fluctuations, and global events like the COVID-19 pandemic (Lüthje & Herstatt, 2004). An agile supply chain can enable FMCG companies to respond effectively to these uncertainties and improve inventory management, ultimately enhancing the firm's competitiveness and profitability (Lee, 2004). Below will be a discussion on how to develop an agile supply chain and how it improves inventory management under volatile demand for FMCG companies.

An agile supply chain is characterized by its ability to respond quickly and efficiently to changes in demand, emphasizing flexibility, adaptability, and responsiveness (Swafford, Ghosh, & Murthy, 2006). There are several strategies that FMCG companies can implement to develop an agile supply chain:

- **Enhancing supply chain visibility:** Improving information sharing and communication between supply chain partners enables better coordination and faster response to demand fluctuations (Barratt & Oke, 2007). Information technology (IT) systems, such as enterprise resource planning (ERP) and supply chain management (SCM) software, can facilitate this process (Gunasekaran, Patel, & Tirtiroglu, 2001).

- **Supplier relationship management:** Developing strong relationships with suppliers is crucial for maintaining an agile supply chain. Collaborative planning, forecasting, and replenishment (CPFR) initiatives can help synchronize production and inventory management across the supply chain, ensuring that suppliers can respond to changes in demand more effectively (Simatupang & Sridharan, 2002).
- **Flexible manufacturing:** Implementing flexible manufacturing systems allows companies to quickly adjust production levels in response to fluctuations in demand. Techniques such as modular production and cellular manufacturing can help achieve this flexibility (Zhang & Sharifi, 2000).
- **Postponement strategies:** Postponement strategies involve delaying certain supply chain activities, such as final assembly or packaging, until customer demand is known. This approach can help FMCG companies reduce inventory carrying costs and the risk of stock obsolescence (Yang, Burns, & Backhouse, 2004).
- **Risk management:** Identifying and mitigating supply chain risks, such as supplier disruptions or transportation delays, can help maintain an agile supply chain. Strategies include diversifying supplier bases, building redundancy into transportation networks, and implementing real-time monitoring systems (Manuj & Mentzer, 2008).

#### Improving Inventory Management under Volatile Demand

As a result, an agile supply chain can significantly improve inventory management for FMCG companies under volatile demand through the following ways:

- **Reducing stockouts and overstocks:** Enhanced visibility and coordination across the supply chain allow for more accurate demand forecasting and inventory planning

(Croxton et al., 2001). This can reduce the occurrence of stockouts and overstocks, ensuring that products are available when needed while minimizing inventory carrying costs.

- **Optimizing safety stock levels:** Agile supply chains can better respond to demand fluctuations, reducing the need for high safety stock levels (Axsäter, 2006). Companies can maintain lower safety stock levels while still ensuring product availability, leading to cost savings and improved customer satisfaction.
- **Minimizing obsolescence:** The ability to quickly adjust production levels and implement postponement strategies can help FMCG companies reduce the risk of holding obsolete inventory (Van Hoek, Harrison, & Christopher, 2001). This is particularly important for products with short shelf lives or rapidly changing consumer preferences.
- **Enhancing responsiveness to demand fluctuations:** An agile supply chain enables companies to better cope with sudden changes in demand, such as demand spikes driven by promotions or seasonal variations (Christopher, 2000). By responding more effectively to these fluctuations, FMCG companies can capture additional sales opportunities and avoid lost sales due to stockouts.
- **Supporting new product introductions:** The flexibility of an agile supply chain allows FMCG companies to introduce new products to the market more rapidly, meeting changing consumer preferences and staying ahead of the competition (Lüthje & Herstatt, 2004). This can result in higher market share and increased profitability.

Developing an agile supply chain is essential for FMCG companies to effectively manage inventory under volatile demand. By enhancing supply chain visibility, building strong supplier

relationships, implementing flexible manufacturing systems, adopting postponement strategies, and managing supply chain risks, companies can create a more responsive and adaptable supply chain. An agile supply chain can lead to improved inventory management, reducing stockouts and overstock, optimizing safety stock levels, minimizing obsolescence, and enhancing responsiveness to demand fluctuations. Ultimately, this can result in increased competitiveness and profitability for FMCG companies in a rapidly changing market environment.

## Chapter 5

### Conclusion

In conclusion, inventory management under volatile demand presents multiple challenges for FMCG companies, such as shortage of materials and capacity (Executive A, Company U), difficulty in demand forecasting (Executive J, Company J), and overstocking and understocking issues (Executive C, Company P). To overcome these challenges, cross-functional teamwork, technology implementation, and agile supply chain practices are essential. Cross-functional teamwork is crucial in addressing the challenges faced by FMCG companies. Bringing together professionals from various disciplines, such as supply chain management, sales, marketing, and finance, can facilitate better coordination and decision-making within the organization (Trent & Monczka, 2003). This approach enables organizations to better manage their inventory levels, respond to volatile demand, and mitigate the risk of stockouts and overstocking (Gattorna, 2010). Implementing advanced technologies, such as automated forecasting and planning technology, RFID, smart warehousing, AI, and ML, can significantly improve inventory management in FMCG companies. Automated forecasting tools enable more accurate demand predictions (Choi et al., 2017), while RFID and smart warehousing can provide real-time visibility of inventory levels and location (Sarac et al., 2010). AI and ML, on the other hand, can improve demand forecasting by incorporating various factors, such as seasonality, promotions, and external events, into the prediction models (Zhang et al., 2018). These technologies ultimately lead to more informed decision-making, better resource allocation, and improved inventory management practices. Developing an agile supply chain is another key strategy for overcoming inventory management challenges in FMCG companies. Agility in the supply chain enables organizations to respond quickly to market changes and customer needs (Christopher, 2000). It encompasses

various aspects, such as supplier flexibility, information sharing, and responsive production (Stevenson & Spring, 2007). By implementing an agile supply chain, FMCG companies can better adapt to volatile demand, minimize the risk of stockouts and overstocking, and optimize their inventory levels (Lee, 2004). To successfully adopt these strategies, FMCG companies must invest in workforce development, data infrastructure, and collaboration between supply chain practitioners, data scientists, and IT professionals. Integrating cross-functional teamwork, advanced technology, and agile supply chain practices will not only help FMCG companies overcome inventory management challenges under volatile demand but also contribute to increased customer satisfaction, cost savings, and overall business success. In summary, inventory management in FMCG companies under volatile demand presents significant challenges that can be addressed through the implementation of cross-functional teamwork, technology, and agile supply chain practices. By adopting these strategies and investing in the necessary resources, FMCG companies can successfully navigate the complexities of inventory management and maintain a competitive edge in the global marketplace.

## **Appendix**

### **Interview Agenda**

#### I. Introduction

- A. Explanation of the study and purpose of the interview
- B. Brief overview of the research question and objectives

#### II. Background Information

- A. Overview of the participant's role in the FMCG company and experience with inventory management
- B. Relevant details on the company's structure and operations related to inventory management

#### III. Challenges in Inventory Management under Uncertain Demand

- A. Identification of the major challenges faced by the company in managing inventory under high uncertainty
- B. Discussion of the impact of these challenges on the company's operations and performance

#### IV. Inventory Management Strategies

- A. Exploration of the strategies used by the company to address the challenges identified in III

B. Discussion of the effectiveness of these strategies and any potential limitations

V. Use of Technology in Inventory Management

A. Discussion of the role of technology in inventory management in the FMCG industry

B. Assessment of the impact of technology on the company's inventory management

practices

VI. Best Practices for Inventory Management under Uncertain Demand

A. Identification of best practices for inventory management under uncertain demand

B. Comparison of these best practices to the company's current inventory management

practices

VII. Conclusion

A. Summary of the key findings from the interview

B. Reflection on the significance of these findings for the research

**General Questions:**

I. Background Information

1. Can you provide an overview of your role in the FMCG company and your experience with inventory management?

2. Can you provide details on the structure and operations of the company related to inventory management?



## II. Challenges in Inventory Management under Uncertain Demand

1. What are the major challenges faced by the company in managing inventory under high uncertainty?
2. How have these challenges impacted the company's operations and performance?

## III. Inventory Management Strategies

1. Can you discuss the strategies used by the company to address the challenges in inventory management under uncertain demand?
2. How effective have these strategies been and what are their potential limitations?

## IV. Use of Technology in Inventory Management

1. How does technology play a role in inventory management in the FMCG industry?
2. How has technology impacted the company's inventory management practices?

## V. Additional Information

1. Are there any additional topics you would like to discuss related to inventory management in the FMCG industry?

### **Data or Sources Needed from Participants for Future Analysis:**

- Detailed information on the company's inventory management policies, procedures, and systems used
- Data on the company's inventory levels and demand patterns during periods of high uncertainty

- Relevant documents and reports related to the company's inventory management practices and performance
- Information on the company's supply chain management practices and their impact on inventory management
- Details on the company's use of technology in inventory management, including any relevant software and systems used

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## ACADEMIC VITA of Jiaqi Luo

### EDUCATION

THE PENNSYLVANIA STATE UNIVERSITY, Schreyer Honors College & Smeal College of Business  
*Bachelor in supply chain management,* Aug. 2018-May. 2023

- Dean's List – all semesters
- 2019 PSU President's Freshman Award
- 2019 PSU Outstanding Program Award

#### **Other Honors and Awards:**

- Sigma Chi Mu Tau Supply Chain Honor Society, 2021
- Beta Gamma Sigma International Honor Society, 2020
- Ted<sup>x</sup> Suzhou Certificate of Public Speech, 2017

### WORK EXPERIENCE

**BOSCH AUTOMOTIVE PRODUCTS CO., LTD.** *Suzhou, China*  
Business Unit Development Intern Aug. 2021-Dec.2021

**GOODWILL PRECISION MACHINERY CO., LTD.** *Suzhou, China*  
Marketing Research Intern May. 2020-Sep. 2020

**SIGNIFY (PHILIPS LIGHTING) CHINA LTD.** *Shanghai, China*  
Strategic Sourcing Intern May. 2019-Aug. 2019

### PROJECT EXPERIENCE

**HONOR THESIS, PSU, PA** Jan. 2022-Apr.2023

- Worked with a thesis adviser and an honors adviser to complete a year-long thesis project on the best inventory management techniques for Fast Moving Consumer Goods (FMCG) under uncertain demand
- Conducted in-depth interviews with industry experts to gather raw data, read literature, and summarized company-specific and information-heavy resources
- Assessed and analyzed primary and secondary data to accomplish a thesis essay to address the best implementation process and appropriate inventory models for FMCG companies undergoing digital transformation

**BOEING INVENTORY OPTIMIZATION, PSU, PA** Jan. 2021-May. 2021

- Provided Boeing's supply chain system with better measurement, calculation methods, and models to help them more effectively handle inventory management, reaching the lowest optimal quantity to reduce costs and meet customer needs
- Regularly exchanged messages with Boeing technical experts to learn about recent developments and requirements
- Created an ideal plan for Boeing's inventory of airplane components to balance supply and demand while accounting for demand volatility to establish the appropriate quantity per package

**UNILEVER COVID-19 STRATEGIES, PSU, PA** Aug. 2020-Dec. 2020

- Carried out a thorough analysis of the COVID-19 pandemic's effects on the US supply chain market and Unilever's supply chain system there
- Leveraged data analysis, researched and created a targeted reaction plan for Unilever from various angles
- Communicated with Unilever executives and updated on the project's status, delivered a dialysis report, and suggestions for Unilever's future growth

### LEADERSHIP EXPERIENCE

**Chief Executive Director**, Online Fashion Magazine: *Artemoda*, China Aug. 2017-Present

**Founder and President**, PEP-U (Non-profit global education organization), China May. 2016-Present

**Team member**, L'Oréal campus recruitment US team, China Mar.2021-Dec.2021

**DEI(Diversity, Equity, and Inclusion) Chair**, Smeal Student Council, PSU, PA Dec. 2020-Dec.2021

**Vice-President**, Asian Student Association, PSU, PA May. 2019-Aug. 2020

### RELEVANT SKILLS

**Languages:** Chinese (Native), English (Fluent)

**Software skills:** Microsoft Office Suite (Proficient), Python (Proficient), Stata (Intermediate), SAS(Intermediate)