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Demand Forecasting in Logistics

Supply Chain Management Strategies and Trends

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Abstract

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In today's complex and ever-evolving global commerce landscape, the importance of demand forecasting in supply chain management (SCM) cannot be ignored. As organizations face everlasting challenges such as geopolitical conflicts, the COVID-19 pandemic, and climate-related disruptions, the critical role of accurate demand forecasting is more apparent than ever. This study explores the dynamics of demand forecasting and its impact on effective supply chain management. By adopting a qualitative approach, the study offers an in-depth analysis of diverse perspectives and strategies from various companies and business houses emphasizing the role of predictive analytics and machine learning in enhancing demand forecasting accuracy.

In order to proactively manage supply chain risks and optimize inventory levels, the study highlights the significance of utilizing modern technologies for real-time data analysis and flexible forecasting models. Adopting AI and machine learning technologies, integrating IoT for real-time data collecting, and using big data analytics for improved visibility and decision-making are suggested ways. The thesis states that effective methods of demand forecasting are essential for companies to thrive in the competitive global market. It offers insightful information that advances our understanding of demand forecasting in supply chain management (SCM) and offers helpful advice on how to handle interruptions, make business operation stable, and competitive.

Keywords: Demand forecasting, Logistics Management, supply chain management, predictive analytics, machine learning, real-time data, inventory optimization, risk mitigation strategy, AI in logistics, IoT in supply chain, big data analytics.

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Glossary

AI	Artificial Intelligence
ERP	Enterprise Resource Learning
IoT	Internet of Things
JIT	Just in Time
MIS	Management Information System
ML	Machine Learning
SC	Supply Chain
SCM	Supply Chain Management
SKU	Stock Keeping Units

1 Introduction

Demand Forecasting is the technique of projecting future customer demand to guarantee smooth and productive supply chain operations during business operations. It helps businesses to manage inventory, production schedules, and transportation needs. It is a very important part of planning and decision-making. Businesses can lower operating costs, prevent overproduction, and lessen the chance of shortages by recognizing possible demand patterns. Precise demand forecasting enables businesses to react to market shifts more skilfully in an increasingly intricate and dynamic supply chain environment.

1.1 Background of Demand Forecasting

Businesses face tough competition in today's time due to the complex chains and systems of product/service delivery. Business needs to handle their supply chains and logistics well to succeed and generate some profit. A key part of the success is guessing what customers will want in the future time from the business. This help make sure products are where they need to be and when people want them. When companies get this right, it has a big impact on how well they run. It helps them cut costs and keep customers happy by avoiding running out of stock or having too much on hand.

The importance of demand forecasting in logistics is very important for the business. The forecasting can be the foundation of supply chain management, influencing key decisions including inventory management, production planning, and transportation scheduling in any business operations. The procedure makes a business ready for the situation of the market in the future (Hart, Lukoszova, & Kubikova, 2013). Businesses that do not have reliable forecasts risk major interruptions, increased operating expenses, and lost sales opportunities during its operations. As a result, mastering the art and science of demand forecasting is critical for any organization seeking to preserve a competitive advantage. The thesis investigates the various applications of demand forecasting in logistics and supply chain management where the core

factors of demand forecasting, such as its goals and the obstacles firms confront when developing reliable projections. Understanding these fundamentals will lay the groundwork for going deeper into the specific strategies and approaches used in the sector.

The thesis examines the current trends that is influencing the future of demand forecasting in business operations. (Demirkan, Bess, Spohrer, Rayes, Allen, & Moghadam, 2015) mentions that with the introduction of data intaking, Internet of Things (IoT), and advanced analytics, the demand forecasting landscape is fast changing and effective. These technology improvements provide new chances for firms to obtain a greater understanding of consumer behaviour, market dynamics, and supply chain performance for business to learn about their performance. The thesis studies how companies are using these tools to improve their forecasting procedures and outcomes for better business performance.

The thesis will look at how demand forecasting can be integrated with other areas of supply chain management such inventory control, supplier relations, and customer service. Effective integration ensures that forecast findings are converted into practical strategies that increase operational efficiency and responsiveness (Grewal & Tansuhaj, 2001). Case studies and real-world examples will be used in the thesis to demonstrate how top firms have effectively deployed integrated demand forecasting systems. The thesis seeks to provide readers with the information and skills they need to grasp demand forecasting and create success in their enterprises. As organizations negotiate an increasingly complicated and uncertain environment, the ability to anticipate and respond to client demand will become more vital than ever.

1.2 Thesis Objectives and Research Questions

The thesis attempts to provide a thorough grasp of demand forecasting and its importance in logistics and supply chain management during the business operation. This approach focuses on presenting the core concepts and

relevance of demand forecasting, as well as demonstrating how precise projections can improve operational efficiency and customer satisfaction. The main objective is to investigate various demand forecasting techniques. This includes recognizing and comparing traditional techniques like time series analysis and causal models to more current ones like machine learning and artificial intelligence (AI). This thesis intends to study the methods that businesses may use to increase operational efficiency using the prediction accuracy by examining each method's strengths and limitations. Similarly, the thesis will see how the methods affect the demand forecasting in logistics.

The thesis aims to study the most recent trends and technological breakthroughs in demand forecasting. Understanding the patterns of the customer ordering can provide insight into how firms might use new technology to acquire a better understanding of consumer behaviour and market dynamics that exists for the business. The thesis seeks to assess how demand forecasting can be effectively linked with other areas of supply chain management, including inventory control, supplier relations, and customer service. Effective integration ensures that forecast findings are converted into practical strategies that increase operational efficiency and responsiveness.

The thesis also aims to provide useful insights and best practices for firms looking to improve their demand forecasting procedures and overall supply chain efficiency. There are several forecasting models and different stakeholders must carefully consider which method will provide the most accurate results and proper guidance towards implementing the details successfully. Forecasts will be considered as the key components of effective strategies because data gathered may improve or prevent the organization's survival (Subramanian, 2021). The study will demonstrate how prominent firms have effectively deployed and benefited from advanced demand forecasting systems through real-world examples and case studies.

The primary inquiries addressed in the study are as follows:

RQ1 How does demand forecasting impact the efficiency and effectiveness of logistics and supply chain management?

RQ2 What are the traditional and modern concepts/principles of demand forecasting, and what are their strengths and limitations?

RQ3 What are the current trends and technological advancements in demand forecasting, such as big data analytics and the Internet of Things (IoT)?

RQ4 How can businesses integrate demand forecasting with other aspects of supply chain management, such as inventory control, supplier relations, and customer service?

2 Relevance of Demand Forecasting in Logistics

Demand Forecasting helps businesses to predict customer demand, improve inventory levels, and manage the operations, which is important to logistics in business. Precise forecasts of demand enable more efficient distribution of resources, lowering the possibility of overstocking or stockouts, which may result in inefficiencies and increased expenses in the business operations. Effective demand forecasting helps in the management of warehouse space, makes accurate deliveries, and raises overall service standards in the context of logistics and supply chain management. Demand forecasting becomes more important as supply chains get more detailed, allowing businesses to stay competitive and adjust to market changes as per the need.

2.1 Optimization of Inventory Levels in logistics

Optimizing inventory levels refers to the proper system of management where the orders and delivery process of a business are managed for the smooth business operation, and it is critical for good supply chain management because it guarantees the correct balance between serving customer demand

and reducing storage expenses. This optimization relies heavily on accurate demand forecasts. Companies can reduce the dangers of overstocking and stockouts by accurately estimating future demand (Amin & Kushwaha, 2021). Advanced forecasting approaches, such as machine learning algorithms and time series analysis, allow logistics managers to anticipate market variations and modify inventory levels as needed. This proactive strategy not only increases customer happiness by ensuring prompt order fulfilment, but it also improves overall operational efficiency by lowering unnecessary storage expenses and cutting capital held in inventory.

The importance of demand forecasting in logistics extends beyond inventory management to other parts of the supply chain, such as procurement, production planning, and distribution which is the part of inventory optimization. The majority of businesses build their business forecasting strategy on predicting different demand forecasting units which might be stock keeping units (SKUs) or a combination of several SKUs (Mojiballah, 2008). Reliable projections of the product demand are the base for strategic planning and decision-making, allowing businesses to align their supply chain activities with predicted market demands. Accurate demand forecasting allows for better cooperation with suppliers, ensuring that raw materials are obtained in the proper quantities and at the right times to be ready for the demand on right times. Demand forecasting can help optimize transportation and distribution networks, ensuring that commodities are delivered effectively to meet client demand patterns. Having a reliable demand forecasting techniques into logistics operations is very important in developing a timely and cost-effective supply chain.

2.2 Improve Customer Service during business operations

Demand forecasting contributes to better customer service, as timely and precise order fulfilment has a direct impact on customer happiness and loyalty in any business. Demand forecasting is critical to improving these service levels because it gives the knowledge required to anticipate customer needs and

ensure that inventory is available when needed allowing the business to be prepared beforehand for the upcoming events in the business. Logistics managers can use advanced forecasting models to more accurately estimate demand swings, allowing them to maintain ideal stock levels and reduce the likelihood of stockouts. Kerkkänen, Korpela, & Huiskonen (2009) explains that successful demand forecasting initiatives usually result in reduced inventory levels and better customer service. This proactive inventory management ensures that products are ready for distribution, reducing delays and improving the entire customer experience. Reliable demand forecasting aids in scheduling and resource allocation, ensuring that logistics operations are ready to manage peak demand periods effectively.

Demand forecasting is important for refining several elements of customer service in logistics, in addition to inventory management. The elements include things like on time product delivery, product condition, service of the company, etc. According to Chase (2009: 78) improved demand forecasting performance results in more accurate forecasts which in turn lower carrying costs for completed goods inventory, lower backorders on the shelf, fewer inventory returns, higher customer service and much more. Accurate demand estimates allow logistics firms to optimize their routes, schedules, and carrier options, lowering transit times and increasing delivery reliability. This level of precision in logistics operations not only meets, but frequently exceeds, client expectations, resulting in stronger customer relationships and a competitive advantage (Liu, 2024). Demand forecasting aids in the effective management of reverse logistics by estimating return volumes and preparing the resources required to handle them. Including the demand forecasting methodologies into logistics operations is important for providing excellent customer service and ensuring long-term corporate success.

2.3 Cost reduction in business operations

Demand forecasting is an effective method for reducing logistics costs since it allows for more efficient resource and process management. Business can

optimize their inventory levels by accurately forecasting future demand, avoiding the significant expenses associated with overstocking and understocking. Overstocking results in higher storage costs and potential obsolescence, whereas understocking can result in expedited delivery rates and missed sales chances. By maintaining just, the right amount of inventory on hand to meet customer demands without going too far, logistics managers may save costs by lowering inventory and boost customer satisfaction through better supply chain delivery (Agarwal et al., 2021). Demand forecasting enables better planning of production schedules and procurement activities, potentially leading to bulk purchase discounts and lower per-unit manufacturing costs.

Demand forecasting not only helps with direct inventory-related savings but also with cost reduction through better labour and transportation management. Logistics businesses may improve their transportation networks by combining shipments and choosing cost-effective routes, which lowers fuel consumption and freight costs, thanks to accurate demand predictions. Wang (2023) explains that forecasts demands are based on market data and historical data, and that scientific analysis and prediction about the future stage of logistics demand are made using the relevant theories and methodologies. Logistics managers can also more effectively utilize labour resources by scheduling employees based on expected workloads and minimizing the need for expensive overtime or temporary labour by having a strong grasp of demand trends. Businesses can save costs significantly in many areas of their supply chain operations by incorporating demand forecasting into logistics planning. This will eventually result in more competitive pricing and increased profitability.

2.4 Strategic Planning in business logistics

Demand forecasting is needed for long term strategic planning. Logistics companies can make informed decisions about the expansions, investments in technology and overall growth of business based on future demand. An accurate estimate of logistics demand can serve as a crucial foundation for strategic planning of logistics development, determining the size of logistics

infrastructure, creating logistics management programs and offering visible and trustworthy quantitative support for the growth of the logistics sector (Wang, 2023). Businesses may create solid supply chain strategies that complement industry trends and consumer behaviour by accurately projecting future demand. Logistics managers may effectively fulfil expected demand by strategically planning capacity increases, warehouse locations, and transportation networks thanks to this foresight. For example, corporations might strategically invest in more storage facilities or improve their distribution capabilities if estimates show a big growth in demand for a particular product. Demand forecasts will help to ensure smooth operations. Also, it helps to strengthen supplier relationships and strategic alliances by predicting future procurement requirements.

Helping businesses to proactively adjust to changes in the market, demand forecasting improves strategic planning. Predicting changes in consumer tastes, the state of the economy, and the competitive landscape is crucial in a dynamic corporate environment. Chopra & Sodhi (2004) explains that logistics managers can create backup plans and risk-reduction tactics in response to supply chain outages or unexpected demand surges with the help of accurate demand forecasts. Demand forecasting also aids in matching logistical capacities with marketing and sales plans, guaranteeing that product launches and promotional efforts are backed by sufficient inventory and distribution resources. Logistics organizations can gain a competitive edge, increase customer happiness, and improve operational efficiency by incorporating demand forecasting into strategic planning.

3 Factors affecting Demand Forecasting

Demand forecasting is a complicated but important process in supply chain management and logistics since it is influenced by a number of factors. Factors like historical data sheds light on previous demand patterns, or demand patterns which can be strongly impacted by market factors like competition, economic changes, and consumer behaviour. or seasonality which influences the market for a wide range of items are some of the factors which directly or indirectly affects demand forecasting. Gaining insight into these variables enables companies to produce more precise forecasts, which improves supply chain effectiveness. Some of the factors are discussed below.

3.1 Data Accuracy and Availability in Business

Data accuracy and availability are critical to the effectiveness of demand forecasting in logistics, acting as the foundation for dependable predictive analytics. Accurate data ensures that estimates represent genuine market circumstances, reducing inaccuracies that might result in costly issues like overstocking or stockouts (Karki, 2024). To achieve high data accuracy, logistics organizations must use stringent data validation and cleansing methods to minimize errors, inconsistencies, and redundancies. This entails constantly updating and cross-checking data from multiple sources, such as past sales records, market trends, and consumer feedback. Advanced technologies such as machine learning and artificial intelligence improve data accuracy by automatically detecting patterns and abnormal incidents that traditional approaches may overlook. Accurate data allows businesses to make better decisions, optimize inventory levels, and enhance overall supply chain efficiency while the inaccurate data causes loss to the business.

Data availability is also important as having fast access to essential information which will allows businesses to adapt quickly to changing market conditions. The combination of real-time data from many sources, including as Internet of Things (IoT) devices, social networks, and financial indicators, provides a

complete picture of current demand conditions. The use of event-extracted data in forecasting models helps decision makers by providing a more comprehensive context (White, 2023). Cloud computing and big data analytics have transformed data availability by making it easier to store, process, and retrieve massive amounts of information. These technologies make data available at all times, allowing for more agile and responsive supply chain operations in the business. The usage of collaborative platforms can help in smooth data sharing between departments and stakeholders, which improves forecasting coordination and alignment for the business. Ensuring data integrity and availability enhances the precision of demand projections, and it also strengthens strategic planning capabilities, allowing them to better understand the process of global supply chains.

3.2 Market Understanding of the business factors

Market understanding is an important factor in demand forecasting because it gives the contextual insights required for accurate and actionable projections. A thorough understanding of market dynamics entails considering a variety of aspects such as consumer behaviour, seasonal trends, economic situations, and competitive actions. Demands and intentions surveys are particularly helpful when demand information is unavailable as in the case of new product projections or product expansion into new areas (Armstrong & Green, 2011). Logistics businesses can use these variables to identify patterns and shifts in demand, which will inform more precise forecasting models. Understanding the intricacies of client preferences and purchasing behaviours enables businesses to predict changes in demand for various products and services, allowing them to alter inventory levels and supply chain tactics as needed. This market-centric approach guarantees that demand predictions are not just data-driven, but also reflect real-world market realities.

Market understanding enables logistics organizations to reduce risks and capitalize on possibilities. Monitoring economic indicators such as inflation rates, job levels, and consumer confidence might provide early notice of future

demand swings. Similarly, keeping up with industry trends and technical improvements might lead to new market possibilities or dangers. Competitive analysis is also important for market comprehension; by tracking competitors' behaviour, businesses can anticipate market movements and adjust their tactics to preserve a competitive advantage. Karki (2024) explains that the market insight, when combined with powerful data analysis tools, improves the accuracy and relevance of demand projections, resulting in more effective supply chain management and better alignment with customer expectations for the business supply chain management.

3.3 Continuous Improvement in logistics and operations

Continuous development in demand forecasting is required to keep predictive models accurate and relevant in today's complex logistics world. This process entails analysing and updating forecasting approaches on a regular basis to account for the most recent data, technology improvements, and market trends. Logistics businesses that implement a continuous improvement mindset can systematically discover and address any defects or inefficiencies in the forecasting procedures. Techniques such as feedback loops, which compare forecast outcomes to actual results, enable the detection of patterns and flaws that can be corrected.

The incorporation of complex analytics, machine learning, and artificial intelligence makes it easier to improve forecasting models over time, allowing them to better respond to new data and trends that helps further in the demand forecasting sector. We can find some massive improvements and changes in the demand forecasting since the ancient times which is before the industrial era. Demand forecasting, Supply chain management, and inventory management today is far more accurate, systematic, and precise than it was in the previous time (Benhamida, Kaddouri, Ourouche, & Benaichouche, 2021). This means that there has been constant improvement in the demand forecasting and the development will continue in the future era as well. This strategy guarantees that demand projections remain correct, allowing for better

inventory management, lower costs, and improved overall supply chain responsiveness and customer satisfaction. This all leads to better performance of the demand forecasting for the business

3.4 Collaboration between departments

Collaboration is an essential component of good demand forecasting in logistics, increasing accuracy and alignment throughout the supply chain. Companies can achieve a brief overview of demand by encouraging communication and collaboration among multiple departments such as sales, marketing, finance, and operations. Collaborative forecasting entails exchanging information and insights in real time, which aids in synchronizing efforts and ensuring that everyone is working towards the same goals. Forecasting plays a critical role in supply chain cooperation among stakeholders, supply risks and unbalanced cost information (Subramanian, 2021). This method also includes external partners such as suppliers, distributors, and customers, allowing for a more thorough grasp of market conditions and demand drivers. Tools like collaborative planning, forecasting, and replenishment make this integrative process easier by offering platforms for data sharing and shared planning. Collaboration allows logistics firms to reduce uncertainty, enhance service quality and customer happiness by increasing forecast accuracy, optimising inventory levels and improving supply chain efficiency overall. Technological Adaptation in business operations

Technological advancements in demand forecasting have changed the ways of logistics, introducing unparalleled levels of accuracy and efficiency in demand forecasting. The use of artificial intelligence (AI) and machine learning (ML) technologies has been transformative, allowing businesses to handle and analyse massive volumes of data with amazing precision to improve their business (Bharadiya, 2023). These technologies enable the business to make complicated prediction models capable of continuously learning and improving in response to fresh data inputs. Logistics organizations can use AI and ML to understand complex patterns and correlations in data that traditional

approaches may miss, leading in more accurate demand prediction that helps in supply chain management. To put this in the real-world perspective, companies like Amazon, Walmart, and Unilever have embraced AI and machine learning (ML) to better this process. Amazon uses artificial intelligence (AI) and machine learning (ML) to evaluate data, including past browsing and purchase behaviour as well as outside variables like the weather, to better forecast demand.

Supply chain management can be transformed by AI-driven forecasting, as shown by Walmart and Unilever. Walmart can more accurately forecast demand and cut surplus inventory by using machine learning to examine past sales data, seasonal patterns, and economic factors (Cyril, Shu, Gillian, Philip, Adrian, 2024). Unilever anticipates changes in consumer preferences by integrating artificial intelligence (AI) with market trends and social media data. This helps to optimize supply chain operations and stock levels. These businesses can find intricate patterns in data that more traditional approaches might overlook by utilizing AI and ML, which makes supply chains more productive, affordable, and flexible during the business operations.

This helps the business to maximize its inventory, guaranteeing that goods are available in the appropriate amounts and places, which eventually improves delivery times and client pleasure. This improved forecasting capabilities enables organizations to optimize inventory levels, eliminate waste, and increase overall supply chain efficiency. Big data analytics plays an important role by integrating varied data sources such as past sales data market trends, and social media signals, providing a holistic view of the factors influencing demand (Vassakis, Petrakis, & Kopanakis, 2018).

The combination of the Internet of Things (IoT) and cloud computing has further improved demand forecasting in logistics of a business. IoT devices, give real-time data on inventory levels, shipment status, and environmental conditions, which improves the quality and timeliness of forecasting data. Demand forecasting will definitely continue to be a key area of focus as technology advances and companies will appear to become more accurate and flexible

(White, 2023). This real-time data enables more dynamic and flexible forecasting algorithms that can react to changing situations virtually instantly. These technology advancements promote collaboration and data sharing across the supply chain, which ensures that all stakeholders have reach to the most current and accurate information during the business operations. Logistics firms anticipate demand swings, operations, and provide excellent customer service, giving them a competitive advantage in an increasingly data-driven market.

4 Historical Context of Demand Forecasting

Demand forecasting is a fundamental aspect of business and supply chain management for centuries, evolving in response to change in economic, technological and market dynamics (Merkurveya & Valberga, 2019). While as the methods and tools used in logistics have become easier to understand and easy to use which as well has made it more convenient in predicting customer demand without decline.

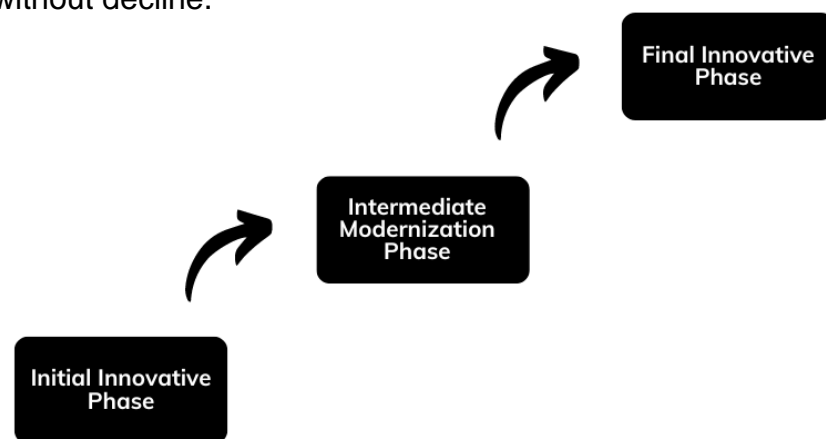


Figure 1 Steps of Production Revolution

The above figure represents the steps in production revolution. In Step 1, there is the initial innovative phase of the production revolution which marks the onset

of significant technological advancements and industrialization. When steam power and mechanization were introduced in the late 18th and early 19th centuries, this phase got underway. The power loom, steam engine, and mechanized spinning wheels were among the major inventions that transformed production processes and replaced manual labour with machine-based manufacturing. The development of factories at this time led to a concentration of production and an increase in output efficiency. The first creative phase created the notion of mass production and encouraged the emergence of early supply chain management techniques, laying the foundation for contemporary manufacturing. Demand forecasting was primitive at the time, mostly based on previous sales data and basic trend analysis.

The Step 2 includes intermediate modernization phase which builds upon the mechanization of the initial phase with the introduction of more advanced technologies and organizational strategies. During the late 19th and early 20th centuries, assembly line manufacturing, electricity, and early automation technologies were adopted. The electric motor, conveyor belts, and mass production techniques invented by Henry Ford revolutionized the efficiency of manufacturing and the standardization of products. Productivity and efficiency were prioritized in the development of management techniques like Frederick Taylor's Scientific Management. During this stage, demand forecasting advanced to incorporate more methodical data gathering and the projection of future demand using statistical techniques.

The Step 3 includes final innovative phase which represents the current and future state of the production revolution, characterized by the integration of digital technologies and advanced automation. The widespread use of advanced robots, machine learning, Internet of things (IoT) and Artificial Intelligence (AI) in supply chain and manufacturing processes characterizes this period. Predictive analytics, adaptable production processes, and real-time data collection are made possible by these technologies. IoT-enabled smart factories continuously track and optimize output in response to real-time demand signals. Demand forecasting is improved by AI and machine learning algorithms, which

analyze large datasets to find patterns and trends that enable very precise and dynamic predictions.

4.1 Pre-industrial Revolution

In this era the demand forecasting was often based on simple observation and personal experiences. To predict the future demand the merchants were dependent on their own experiences and word of mouth recommendations and casual market analysis.

Prior to the Industrial Revolution, demand forecasting in logistics was primitive, relying mostly on historical patterns, intuition, and experience. Demand was very predictable due to seasonal cycles and local consumption habits (Borucka, 2023). Farmers and merchants used annual harvests and conventional trading procedures to forecast demand for their products. Formalized forecasting techniques were rarely used during this time period since economies were mostly self-sufficient and confined, with few external influences on demand. Inventory management was equally rudimentary, with simple stockpiling methods based on previous experiences and urgent community requirements.

Trade routes throughout the pre-industrial age, such as the Silk Road and marine spice routes, necessitated some sort of demand forecasting, albeit in a crude form. As a result, traders' personal experiences and historical information passed down through generations had a significant impact on the forecasting process. When macroeconomics conditions decline government officials frequently choose to support entrepreneurs creativity (Hussasin & Azaz, 2018). In metropolitan areas, artisans and guilds played an important role in demand forecasting and inventory control. Demand forecasting was an informal method based on community contacts and long-term commercial ties, as opposed to the systematic and data-driven approaches used today. This historical context demonstrates how demand forecasting evolved from a profession based on empirical knowledge and local interactions to a sophisticated discipline powered by advanced analytics and worldwide data integration.

4.2 Industrial Revolution

The Industrial Revolution represents a progressive moment of development in the history of demand forecasting in logistics. The period lasted from the late 18th to the early 19th century and saw the transition from traditional economies to industrialized and urbanized cultures. Hussasin & Azaz (2018) claims that the industrial economy experienced a transformation and significant structural changes occurred which made innovation responsible of establishing enterprises their own research and development. The introduction of mechanized production and factory expansion resulted in considerable increases in manufacturing capacity, demanding increasingly sophisticated approaches to supply and demand management. Mass production forced business to enhance their inventory management and forecasting techniques to make sure that commodities were produced and supplied in sync with market demands. During the Industrial Revolution, developments of transportation infrastructure, such as railroads and steamships, had a huge impact on logistics and demand forecasts of the particular areas (Borucka, 2023). These advances cut transportation time and expenses, allowing commodities to be moved more efficiently across longer distances with ease. The enhanced speed and reliability of transportation enabled more consistent and timely delivery of commodities, needing more coordination and planning. Companies began to collect and analyse sales data in a more systematic manner, creating the framework for modern demand forecasting techniques. This period saw the development of fundamental statistical methodologies and record-keeping processes aimed at forecasting future demand based on past sales trends.

The advent of large-scale retailing and the establishment of department stores during the Industrial Revolution emphasized the importance of accurate demand forecasting. Ton & Raman (2010) explains that to match consumer expectations, these new retail formats required businesses to handle a wide assortment of products while maintaining ideal inventory levels. As the more complex of supply chains and the expansion of consumer markets increased which resulted in the creation of more structured and formalized forecasting

methods. Companies began using early kinds of market research, such as surveys and consumer feedback, to better understand and forecast demand. The Industrial Revolution was a transformative time that dramatically increased the methodology and relevance of demand forecasting in logistics, paving the way for future advancements in the twentieth century.

4.3 The Mid and Late 20th Century

The forecasting methods were getting standardized in the middle of the 20th century. There has been increase in the use of techniques like exponential smoothing and moving trends. These techniques made it possible for companies to forecast more methodically using the past data. Demand forecasting underwent a transformation with the introduction of computers in the late 20th century (Borucka, 2023). Later the businesses could handle more datasets more efficiently and effectively with complicated data. Enterprise resource planning (ERP) systems were also integrated with other corporate activities were also introduced during this era.

According to Hussasin & Azaz (2018) the adoption of the manufacturing technology revolution led to organisational success and economic growth, which in return created new product categories. Demand forecasting in logistics improved significantly, because of technology developments and changing corporate practices. More advanced forecasting methods were required after World War II due to the rapid expansion of global trade and the rise of consumerism. The development of computers has transformed data processing capabilities, allowing businesses to analyse larger datasets more accurately and quickly comparing to the past eras. Early computer-based systems were enabled for the forecasting of demand using statistical approaches and models, with manual methods. The development of management information systems (MIS) and the introduction of enterprise resource planning (ERP) systems in the late half of the century considerably helped business to combine and analyse data from various parts of their operations.

The late twentieth century was the times for the rise of just-in-time (JIT) inventory systems, which were heavily influenced by Japanese manufacturing processes. JIT stressed the importance of precise demand forecasts in reducing inventory levels and carrying costs. This strategy necessitated strong collaboration with suppliers as well as real-time data on consumer demand to ensure that materials and products were accessible when they were needed (Ton & Raman, 2010). The deployment of JIT systems demonstrated the need of precise demand forecasting in improving operational efficiency and maintaining lean supply chains. The internationalization of supply networks created new challenges and opportunities for demand forecasting. The rise of multinational organizations and the expansion of worldwide marketplaces requires enterprises to consider a greater range of elements in their projections, including geopolitical events, currency changes, and cross-border. By the end of the twentieth century, demand forecasting had become a vital strategic function in logistics, aided by modern technology and incorporated into broader supply chain management processes.

4.4 The 21st Century

Technology breakthrough occurred in this period with the emergence of machine learning and A.I and the use of these technologies with large datasets could be analysed more carefully. The producing of demand projections that were more precise and dynamic. Big data analytics integration also made it possible for companies to take into account a wider variety of demand-influencing variables.

Demand forecasting has improved a lot in the twenty-first century, resulting to rapid technological improvements and the analysis of large data. The combination of artificial intelligence (AI) and machine learning (ML) has transformed forecasting approaches, allowing the prediction models to be capable of processing and analysing large datasets with unparalleled precision. Systems that are autonomous and self-regulating may give birth to a number of problems and crises at the national, international and industrial levels (Hussasin

& Azaz, 2018). These forecasting system uses real-time data from a variety of sources, including social media, economic indicators, and Internet of Things devices, to provide detailed insights into consumer behaviour and market trends to forecast the demand that can come. Cloud computing has simplified the storing and processing of massive amounts of data, making advanced forecasting tools available to enterprises of all sizes with low cost included. The growth of e-commerce and retailing has highlighted the necessity of accurate demand forecasting in managing more complex and dynamic supply chains in the business scenarios.

4.5 Technological Advancements of Demand Forecasting

Technological improvements have transformed demand forecasting in logistics, dramatically improving accuracy and efficiency of demand forecasting in a business scenario. Bharadiya (2023) mentions that the integration of data analytics has been a game changer, allowing businesses to process and analyse massive amounts of data from many sources such as supply chain process and customer's trends. Logistics organizations create more accurate and exact demand projections by combining data from sales records, market trends, customer feedback, and even weather patterns if needed. This method helps in uncovering previously invisible patterns and connections which was not possible before technological era, resulting in more informed judgments about inventory management, procurement, and distribution during the business operations. Big data analytics allows businesses to do scenario analysis and stress tests, preparing them for various demand swings and potential disruptions.

Artificial intelligence (AI) and machine learning (ML) have advanced the capabilities of demand forecasting in logistics. Artificial Intelligence and data analytics have changed these fields bringing up new ways to make precise predictions and in return improving safety stock levels (Seyedan, 2023). Machine learning algorithms can discover complicated patterns and trends that traditional statistical approaches may miss, resulting in more accurate projections. AI-powered tools also improve demand sensing, which entails real-time data

analysis to detect market demand trends immediately. The real-time capacity enables logistics managers to make rapid adjustments to their operations, ensuring that they can adapt quickly to changes while maintaining service standards in a business. AI and machine learning can optimize forecasting operations by automating data gathering and analysis, lowering the time and labour is necessary for these jobs, and freeing human resources to focus on strategic planning and decision-making rather than focusing on the monotonous and repetitive jobs.

The emergence of the Internet of Things (IoT) has also greatly helped the technological advancement of demand forecasting in logistics. IoT devices enable real-time tracking and monitoring of items, resulting in more accurate and timely data collection on inventory levels, shipment status, and supply chain conditions during the business operations (Sallam, Mohamed, & Wagdy, 2023). This data is collected into advanced forecasting models, which provide a more detailed predictions of the supply chain and improve the accuracy of demand estimates in business. IoT technology also improves coordination and communication throughout the supply chain, resulting in more synchronized and efficient processes of supply chain. Logistics organizations improve their market response and inventory management strategies by using real-time visibility and improved data accuracy. Logistics businesses are using technologies for better prediction of market shifts and enhancing their supply chain operations and maintain high levels of customer satisfaction in an increasingly complex and dynamic market environment with the help of advancing technologies.

5 Present and future scenario of demand forecasting

The thesis explores the importance of demand forecasting in the business and to provide insights into effective strategies and techniques for improving the forecasting accuracy on the business operations.

5.1 Current Scenario of demand forecasting

Today's business and supply chain management environment, demand forecasting has changed hugely comparing to the ancient times. The invention of customer data analytics, artificial intelligence (AI), and machine learning (ML) is being studied and developed to transform traditional forecasting models into more dynamic and accurate tools for the business operations (Bharadiya, 2023). These technologies allow business to examine volumes of data from a variety of sources, such as historical sales data, industry trends, and even social media insights that they achieve. The analysis enables more precise and detailed demand forecasts, which are critical for making educated decisions in a continuously changing market for any business in any sector. Logistics organizations are better prepared to predict demand variations, optimize inventory levels, and streamline their supply chain as per their needs.

Real-time data is becoming increasingly important in demand forecasting, reflecting current developments in logistics and supply chain management in business. The introduction of Internet of Things (IoT) devices and smart tracking systems enables real-time visibility into supply chain activity, it allows logistics managers to dynamically change their projections based on the most recent data (Sallam, Mohamed & Wagdt, 2023). The real-time data integration helps to minimize the risks associated with unexpected fluctuations in demand, such as those created by economic fluctuations, natural catastrophes, or other disturbances. Communication across the supply chain increases, with businesses sharing data and insights to improve overall forecasting accuracy for making business decisions. The collaborative strategy improves individual firm performance and strengthens the overall resilience and efficiency of the

supply chain network. The current state of demand forecasting in logistics is characterized by technological advancements and a greater emphasis on real-time data driven decision making for the business.

5.2 Challenges of demand forecasting

Despite technological advances, demand forecasting in logistics has some serious concerns. One key challenge in demand forecasting is data quality and availability of the information that occurs in the business operation. Accurate forecasting requires accurate, timely data from multiple sources; yet, data dispersed in various places, and outdated information can impair reliability. Integrating external data, such as market trends and uncertain client behaviour, complicates the forecasting process. Demand forecasting creates a number of difficulties for businesses, such as managing demand variations, reducing operational uncertainty and improving the complex procedures involved (Ge et al., 2019).

Another challenge in forecasting demand in a fluctuating market. External factors like as economic swings, geopolitical instability, and natural disasters can produce unexpected shifts in demand patterns that typical forecasting models struggle to predict and prepare. The rising globalization of supply chains complicates matters, as do cross-border legislation and trade policies that influence demand. This necessitates complex models that can respond to quickly changing situations. Vlckova & Patak (2012) explains that Integrating demand forecasting into the whole logistics strategy presents additional obstacles. Effective forecasting necessitates coordination among several areas like as sales, marketing, finance, and operations. Miscommunication between these parties might cause differences in demand predictions and resource allocation which might severely affect the business operations.

5.3 Future Trends of demand forecasting

Several significant themes are shaping the future of demand forecasting in logistics, powered mostly by technological improvements and changing global market demands. Demand forecasting future is expected to be defined by its increased precision, predictive insights and real-time flexibility(White, 2023). One notable trend is the increased use of artificial intelligence (AI) and machine learning (ML) to improve predicting accuracy in decision making of business and the possibility of how much the AI and ML will develop in the upcoming future. AI and machine learning will help logistics organizations to handle and analyse complicated datasets of customers more effectively, revealing hidden patterns and trends that can help them make better decisions for the business operations. The technologies will enable more dynamic and real-time forecasting, allowing businesses to react quickly to market shifts and disruptions.

Another key trend that is estimated to bloom in the future is an increased emphasis on real-time data and predictive analytics. With the development of Internet of Things (IoT) devices and smart tracking systems, logistics operations are becoming more trackable and trustworthy. This interconnection generates a lot of real-time data that can be used to make more accurate and timely demand estimates. White (2023), in his article mentions that companies are able to adjust their strategy in real time to unexpected interruptions or unexpected spikes in demand by combining real-time data feeds with predictive models. Predictive analytics tools will use the real-time data to deliver real time insights, allowing businesses to better predict demand variations and improve their supply chain operations.

The future of demand forecasting in logistics is expected also to place a focus on sustainability and ethical factor such as environmental concerns and regulatory demands mount (Esan, Ajayi, & Olawale, 2024). This approach could include forecasting demand for environmentally friendly items, optimizing logistical routes to reduce carbon footprints, and managing inventories to

minimize waste during transportation. Ethical factors like fair work practices and responsible sourcing will become more relevant in the coming days. Business in the future, must ensure that their forecasting and supply chain strategies reflect these ideals, balancing economic efficiency with social and environmental responsibility.

6 Current state of Demand Forecasting in SCM

The current state of demand forecasting has evolved significantly with advancements in technology and data analytics which was not present before. In past, the logistics was less of a data and more of a manual work and predictions but today it is more about the data along with consideration of the factors. This system will grow and be more accurate in the future. In the ever-changing market demand forecasting has always played an essential part in assisting businesses and remaining adaptable.

6.1 Advanced Technology

Technological advancements in demand forecasting have changed the traditional ways of logistics, introducing unparalleled levels of accuracy and efficiency in the business data tracking and prediction. The use of advanced technologies has been transformative, allowing businesses to handle and analyse massive volumes of data with amazing precision. The technologies enable the creation of complicated prediction models capable of continuously learning and improving in response to fresh data inputs like Open AI (Bharadiya, 2023). Logistics organizations can use AI and ML to understand the difficult patterns and correlations in data, which leads to more accurate demand estimates during the business operations. The improved forecasting capabilities helps organizations to optimize inventory levels, eliminate waste, and increase overall supply chain efficiency during the business operations. The data analytics plays an important role by involving varied data sources such as past

sales data market trends, and social media data, providing a brief view of the factors influencing demand in the business.

The tech advancement has uplifted business in demand forecasting. This data processing ability provides more dynamic and flexible forecasting algorithms that can react to changing situations instantly so business can act fast to improve their business. The concept of cloud computing provides scalable and adaptable data storage and processing options, allowing businesses to handle massive amounts of data and execute complicated analysis without investing heavily in physical infrastructure like traditional methods. Hussain & Aziz (2018) states that although the new technology has a lot of dangers as it penetrates the market far more quickly and has a greater influence than the current technology. Logistics firms may better anticipate demand swings, streamline operations, and provide excellent customer service, giving them a competitive advantage in an increasingly data-driven market

6.2 Real time data and IoT

The use of real-time data and the Internet of Things (IoT) is significantly changing the current status of demand forecasting in supply chain management. Real-time data gives businesses immediate insights into sales trends, inventory levels, and market circumstances, allowing them to make real time quick changes to their supply chains (Sallam, Mohamed, & Wagdy, 2023). This quick action is important for sustaining good service standards and responsiveness, especially in today's fast-paced market climate where quickness is one of the ways for business growth. Companies with access to real-time data can analyse in customer data of the demand as they occur, allowing them to quickly adjust production schedules, reallocate inventory, and optimize distribution routes that boosts up. This process decreases the possibility of stockouts or overstocks, which will then improve operational efficiency and consumer happiness in the business.

The Internet of Things (IoT) is critical for collecting and transmitting real-time data throughout the supply chain. This real-time access into the supply chain allows for more exact demand forecasts by giving accurate and timely data on inventory levels, product movement, and environmental conditions that may impact product quality. The use of smart grids has already gained popularity in developed countries, enabling real-time atmospheric condition prediction as well as tracking of general operational efficiency as an issue for power generation. This is in contrast to technologies of the first and second industrial eras, when there were no wireless sensors or Internet of things based technologies (Armstrong & Green, 2011). The technological integration allows more dynamic and flexible supply chain management, allowing businesses to respond quickly to problems, optimize resource use, and maintain a competitive advantage in the marketplace against the competitors.

6.3 Predictive Analytics

Predictive analysis has developed as an essential part of modern demand forecasting in supply chain management, utilizing advanced statistical approaches and algorithms to predict future demand more accurately and reliably. Kumar (2018) shares that unlike traditional forecasting methods, which rely on historical data and intuition, predictive analytics uses large data to identify patterns and connections to predict the demand in business. Predictive analytics algorithms can provide more detailed and adaptable forecasts by examining historical sales data, market trends, economic indicators, and even external elements like as weather patterns and social media sentiments of the business.

One of the most common advantages of predictive analysis in demand forecasting is its capacity to estimate demand of a business through analysing the data in a business operation. This skill allows businesses to customize their inventory and production plans to fit specific demand patterns and consumer preferences, hence improving resource allocation and lowering inventory holding costs. Predictive analytics enables scenario planning and sensitivity

analysis, allowing business to examine the possible impact of various market scenarios and make informed decisions proactively (Kumar, 2018). This proactive strategy not only improves operational efficiency, but it also strengthens the supply chain by decreasing risks and uncertainties that business might face in the supply chain management. Predictive analytics' role in demand forecasting is projected to grow increasingly as technology and data science progress in the future.

6.4 Supply Chain Visibility

Supply chain improvement helps business to make more accurate demand forecasting where the companies are investing in technologies that provide real time visibility allowing them to identify potential problems, disruptions and opportunities for optimization in real life operations of the business. Supply chain visibility has become an important component of demand forecasting which is affecting supply chain management as well. Technology offering real-time insights into inventory levels, manufacturing schedules, and logistical operations using advanced technologies helps business to avoid foreseeable problems (Emmanuel, Kemevor, Konadu, & Asibey, 2022). This visibility improves accuracy by allowing firms to follow and analyse data throughout the supply chain, allowing for proactive changes to inventory and distribution plans based on current demand trends. Companies can use complete insight to grow resource allocation, reduce stockouts, and increase overall efficiency by better coordinating with supply chain partners in supply chain management. This capability improves operational ability of the business and also enables informed decision-making, resulting in increased customer satisfaction and competitive advantage in today's changing market businesses.

6.5 Continuous Improvement

It remains as the key principle in demand forecasting as companies are investing in ongoing training, refining algorithms and incorporating feedback to ensure their forecasting models evolve with changing market dynamics. The

current state of demand forecasting in the industry reflects a dynamic view where the technology, collaboration and adaptability are key drivers of success. As businesses continue to move towards new challenges and leverage technological advancements, demand forecasting will likely remain a critical focus is for optimizing supply chain operations.

Demand forecasting in supply chain management is always improving, in the need to respond for changing market dynamics and technological improvements in the forecasting technologies. Companies are focusing on improving forecasting accuracy and responsiveness to manage their supply chain. The iterative approach entails assessing previous forecasting errors, changing models based on feedback, and incorporating new data sources and technology to improve prediction skills. The use of machine learning algorithms enables organizations to learn from historical data patterns and produce more precise forecasts, responding in real time to changes in consumer behaviour, market trends, and external influences.

Continuous development in demand forecasting includes not just technology advancement but also process optimization and organizational learning (Benhamida, Kaddouri, Ourouche, & Benaichouche, 2021). Companies are investing in training programs for their employees to improve data literacy and analytical abilities, allowing them to better evaluate and apply forecasting information and utilize the information collected by the AI and ML as well. Businesses with technology improve the accuracy of their demand projections, but they also increase operational efficiency, lower inventory management costs, and ultimately improve customer happiness by ensuring products are available when and where they are needed with demand forecasting. This continuing evolution of demand forecasting methods enables businesses to handle risks and exploit opportunities in an increasingly competitive global business scenario.

7 Implementation of AI and Machine Learning

In logistics and supply chain management, the application of artificial intelligence (AI) and machine learning (ML) to demand forecasting is a significant development. Through processing huge amounts of data and spotting complex trends that conventional statistical approaches would overlook, AI and ML technologies improve forecasting accuracy (Bharadiya, 2023). To produce more accurate demand forecasts, these technologies can examine industry trends, social media signals, historical sales data, and other relevant variables. AI and ML models get better over time by continuously learning from new data inputs and evolving to accommodate shifts in consumer behaviour and market dynamics.

The success of supply chain and demand forecasting of organizations depends on information sharing, collaboration, and integration. Amin (2024) in his paper explains that business and supply chain participants operate in a dynamic environment every day. He mentions that just-in-time and cost-efficiency must be balanced against conflicting objectives including durability, actual financial hazards, risk and vulnerability minimising and process stability. He also mentions that companies are implementing the best data analytics features (such as data science, predictive analytics, and big data) in response to supply chain collaboration in an effort to enhance operations and, eventually, efficiency.

The capacity to analyse data in real-time and provide dynamic forecasts is one of the main advantages of employing AI and ML in demand forecasting. Conventional techniques for demand forecasting frequently depend on static models that are difficult to adjust to abrupt shifts in the market. On the other hand, real-time data processing capabilities of AI and ML algorithms enable organizations to promptly adapt to fluctuations in market demand (Demirkan, Bess, Spohrer, Rayes, Allen & Moghadam, 2015).

The strategy is to implement AI and ML algorithms for demand forecasting can be clarified further with the following table:

Strategy	Benefits	Challenges
Implementing AI and ML	Enhanced Accuracy, Ability to analyse large data, improved forecasting.	Initial setup cost, need skilled manpower, need more careful monitoring.
Demand Sensing (Using real time data)	Improved response, reduced stockouts and excess inventory, enhanced visibility.	Dependent on accurate real time data, need to manage dynamic demand signals.
Collaborative Forecasting	More Insights, actual market conditions, improved communication.	Data privacy, diverse teams. Need effective collaboration platforms
Dynamic pricing strategies	Maximize revenue, optimize inventory turnover, responding to change.	Balancing price change, customer satisfaction.
Scenario planning	Improved risk management, better preparation, enhanced supply chain resilience.	Identifying scenarios, needs more planning.

Sustainable forecasting	Social responsibility goals, meeting customer demand	Limited past data, less cost efficient.
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Table 1 Strategy, Benefit, and challenges of the AI and machine learning

8 Real world examples

Some of the real-world examples are as:

Amazon: Amazon, one of the world's largest e-commerce and cloud computing companies, is renowned for its innovative approach to technology and customer service. It was founded in 1994 by Jeff Bezos, Amazon has transformed from an online bookstore to a global retail giant offering a vast array of products and services. Central to its success is its sophisticated demand forecasting system, which optimizes supply chain management and maintains a competitive edge.

Coca-Cola: Predictive analytics for demand shaping.

Amazon analyses vast amounts of data, such as past sales, consumer preferences, browsing habits, and external variables like the weather and economic indicators, using machine learning and artificial intelligence. With the use of these complex algorithms, Amazon is able to accurately forecast future demand by spotting patterns and trends. With this feature, the business may minimize excess inventory of less popular items while guaranteeing that hot items are always in stock. Anticipatory shipping is one cutting-edge strategy that Amazon employs. It involves pre-shipping goods to nearby distribution facilities prior to orders being placed, greatly cutting down on delivery times and raising customer happiness. By combining cutting-edge analytics and technology with demand forecasting, Amazon strengthens its competitive edge in the e-

commerce sector while improving operational efficiency, shortening delivery times, and promoting its objective of rapid and dependable service.

Coca-Cola: Coca-Cola is a global leader in the beverage industry, which relies on sophisticated demand forecasting techniques to optimize its extensive supply chain and meet customer demand effectively. With a diverse product range and a vast distribution network, accurate demand forecasting is necessary for maintaining product availability and operational efficiency in the company. By analysing vast quantities of data including past sales, market trends promotional activity, seasonal fluctuations and external factors like weather patterns and economic situations, the company uses complex data analysis, machine learning and artificial intelligence to forecast future demand.

Coca-Cola uses these sophisticated forecasting tools to match its production plans to expected demand, cutting waste and overproduction while avoiding stockouts. The business also plans inventory levels, delivery routes, and accurate demand forecasts to optimize distribution and logistics operations and save lead times and transportation costs. Accuracy and responsiveness throughout the supply chain are further improved by cooperative forecasting with retailers and suppliers.

9 Conclusion

In summary, supply chain management and logistics are made more effective and efficient through the use of demand forecasting. Businesses can improve customer satisfaction and operational efficiency by optimizing inventory levels, streamlining transportation, and cutting expenses by properly projecting future demand (RQ1). Though they are straightforward and dependable, traditional demand forecasting techniques like time series analysis and historical data review can prove insufficient when dealing with detailed and ever-changing market situations from the business perspective. Modern techniques, on the other hand, such as artificial intelligence (AI) and machine learning, offer higher accuracy and flexibility by examining massive datasets and finding patterns those conventional methods could miss. But to execute these sophisticated methods well, a sizable data infrastructure and a high level of experience are needed (RQ2).

The most recent developments in demand forecasting, such as cloud-based technologies, big data analytics, and the Internet of Things (IoT), have transformed supply chain management by providing real-time insights and enhancing decision-making procedures. Business Giants like Amazon, Unilever, etc. uses the techniques in their logistics management. By enabling companies to react quickly to shifts in the market and outside shocks, these technologies improve the overall resilience of the supply chain (RQ3). Businesses must combine demand forecasting with other essential elements of supply chain management, like inventory control, supplier relationships, and customer service, in order to fully realize the potential of this tool. An operation that is more coordinated, adaptable, and customer-centric is the result of improved collaboration throughout the supply chain, which is fostered by this integration (RQ4). Demand forecasting is therefore a strategic factor in modern logistics and supply chain success, not just a predictive tool.

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