A Case Study of KJ Industries Limited (POCKEY): Time and Motion Study in Warehousing and Logistics

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INTRODUCTION

In today's rapidly evolving and intensely competitive business landscape, warehousing and logistics functions have transcended their traditional roles as mere support activities, emerging as pivotal determinants of organizational success. This transformation is particularly evident within the retail and fast-moving consumer goods (FMCG) sectors, where efficient logistics systems exert a profound influence not only on service quality and operational costs but also on customer satisfaction and retention. As markets become increasingly globalized and customer expectations continue to rise, companies are compelled to optimize their warehousing and logistics operations to maintain a competitive edge and ensure sustainable growth [1]. The ability to deliver products quickly, accurately, and cost-effectively has become a critical differentiator, influencing brand loyalty and market share.

This study focuses on KJ Industries Limited, the exclusive licensee of POCKEY International in India, which manages a complex warehousing and distribution network from Bengaluru. KJ Industries operates in a dynamic and demanding market characterized by a diverse inventory range and a high volume of throughput. The company faces the ongoing challenge of maintaining operational efficiency while simultaneously meeting increasing service expectations from both retailers and end consumers. To address these challenges, KJ Industries must continuously evaluate and improve its warehousing and logistics processes, seeking innovative solutions to streamline operations, reduce costs, and enhance customer satisfaction.

This research, titled "Time and Motion Study in Warehousing and Logistics," undertakes a comprehensive investigation of the current logistics operations at KJ Industries to assess time utilization, task flow, and movement patterns. By employing established methodologies of time and motion study, the research aims to identify inefficiencies, bottlenecks, and areas for process enhancement within the company's warehousing and distribution network. The study leverages primary data collected via an online survey administered to over 130 logistics and warehousing employees, representing a diverse range of roles and responsibilities within the organization. The survey data provides valuable insights into the daily experiences of employees, capturing detailed information on task durations, distances traveled, movement repetition, and perceived bottlenecks.

The analysis presented in this study is ultimately directed towards recommending practical improvements in layout planning, task structuring, and automation. These recommendations are designed to support faster order fulfillment, reduce operational costs, and improve worker satisfaction, thereby contributing to the overall competitiveness and sustainability of KJ Industries. By implementing the proposed improvements, KJ Industries can enhance its ability to respond to changing market demands, optimize resource utilization, and create a more efficient and worker-friendly logistics environment. The study also aims to provide a blueprint for other companies in the apparel industry and the broader FMCG sector, demonstrating the value of time and motion studies in driving operational excellence.

LITERATURE REVIEW AND RESEARCH GAP

The concept of time and motion study, pioneered by Frederick Winslow Taylor in the early 20th century, has long been a cornerstone of scientific management. Taylor’s seminal work, "The Principles of Scientific Management," emphasized the systematic analysis of work processes to enhance productivity by eliminating

unnecessary tasks and standardizing work methods. Taylor advocated for the use of scientific methods to determine the most efficient way to perform each task, focusing on optimizing the sequence of movements and minimizing wasted time and effort. His work laid the foundation for modern industrial engineering and operations management, influencing the development of numerous techniques and tools for improving productivity and efficiency.

This foundation was further developed by Frank and Lillian Gilbreth through their motion studies, which focused on micro-movements and ergonomics. The Gilbreths expanded on Taylor's work by analyzing the individual movements required to perform a task, breaking them down into basic elements known as "therbligs." By studying these micro-movements, the Gilbreths sought to identify and eliminate unnecessary motions, thereby reducing fatigue and improving worker efficiency. They also emphasized the importance of ergonomics, designing workstations and tools that were better suited to the human body, reducing the risk of injury and improving worker comfort. These classical frameworks have laid the groundwork for modern approaches to task optimization in labor-intensive settings, providing a foundation for continuous improvement and operational excellence.

Within the warehousing and logistics domain, scholars have highlighted the utility of breaking down processes into measurable units to improve layout, task allocation, and resource efficiency. Barnes (1980) emphasized the importance of motion and time studies in designing efficient work systems, providing practical guidance on how to conduct these studies and implement the resulting improvements. Barnes detailed the techniques for measuring work, analyzing data, and developing improved methods, stressing the importance of involving workers in the process to gain their insights and support. Tompkins et al. (2010) further underscored these principles in the context of facilities planning, advocating for the optimization of warehouse layouts to minimize wasted movement and maximize throughput. They presented a comprehensive framework for designing and managing facilities, emphasizing the importance of considering factors such as material flow, storage density, and order picking efficiency.

More recent literature has underscored the value of integrating traditional motion studies with digital tools. Kumar and Saini (2018) and Ghosh (2020) highlight the use of motion tracking and employee input, affirming the significant role of time and motion techniques in enhancing warehouse performance by reducing delays and physical strain. Chopra and Meindl (2019) advocate for adaptive supply chains where automation and continuous process evaluation meet dynamic customer expectations.

Despite the extensive application of these principles across various sectors, a specific research gap remains in applying time and motion study within India’s apparel logistics industry. Particularly in large-scale operations like KJ Industries, little research has combined employee-reported data with workflow analytics in a unified model. This study addresses that gap by providing a comprehensive time and motion analysis specific to an apparel-based warehousing context, offering insights tailored to the unique needs of a fast-paced, SKU-diverse environment. By focusing on the specific challenges and opportunities within the Indian apparel logistics industry, this research aims to provide practical and actionable recommendations that can be readily implemented by KJ Industries and other companies in the sector.

What is a Time and Motion Study?

A time and motion study are a structured approach used to examine, measure, and improve work processes by analyzing task duration and physical movement. This methodology involves systematically breaking down a job into its component tasks, recording the time required to perform each task, and observing the movements of workers as they perform their duties. By breaking down workflows into discrete, measurable actions, the method aims to eliminate inefficiencies, streamline activities, and boost productivity. The data collected during a time and motion study provides a detailed understanding of how work is performed, identifying areas where time is wasted, movements are inefficient, or processes are unnecessarily complex.

In logistics settings, such studies are essential for refining operations such as inventory management, order picking, and dispatching. For a high-output company like KJ Industries, time and motion studies can expose hidden inefficiencies and provide data-driven solutions that align with customer demand and business goals.

Time and motion studies involve detailed observation and measurement of work tasks, often using tools like stopwatches and video recording to capture precise data on task durations and movement patterns [2]. The use of video recording allows for a more detailed analysis of worker movements, enabling the identification of subtle inefficiencies that may not be apparent during live observation.

This data is then analyzed to identify areas for improvement, such as reducing unnecessary motions, optimizing task sequences, and improving workstation layouts [3]. The analysis may involve statistical techniques to identify trends and patterns in the data, as well as qualitative assessments of worker movements and ergonomics. The ultimate goal is to create more efficient and ergonomic work processes that enhance productivity and reduce worker fatigue. By systematically analyzing and improving work processes, time and motion studies can help companies to achieve significant gains in efficiency, productivity, and worker satisfaction.

Importance for Warehousing and Logistics

Time and motion studies offer significant benefits in the logistics sector. They enhance productivity by identifying time-wasting activities, optimize labor use by improving task allocation, and reduce operational costs through better layout design and automation. Furthermore, they improve accuracy in order processing, boost employee morale by minimizing physically strenuous tasks, and offer strategic agility to adapt to changing market needs such as surges in e-commerce demand. For KJ Industries, these advantages are particularly critical in managing complex inventory systems and fulfilling time-sensitive orders. The ability to adapt to changing market demands is crucial for maintaining a competitive edge, and time and motion studies provide the data-driven insights needed to make informed decisions about process improvements and technology investments [4].

In the context of warehousing, time and motion studies can be used to optimize a wide range of activities, including receiving, storage, order picking, packing, and shipping. By analyzing the time and motion involved in each of these activities, companies can identify opportunities to streamline processes, reduce bottlenecks, and improve overall efficiency. For example, a time and motion study may reveal that order pickers are spending too much time traveling between storage locations, indicating a need for a more efficient warehouse layout or the implementation of automated picking systems. Similarly, a study may identify that workers are performing unnecessary movements during the packing process, suggesting that the workstation layout needs to be redesigned to reduce wasted motion.

Moreover, time and motion studies can contribute to improved worker safety and well-being. By analyzing the ergonomic aspects of work tasks, companies can identify and eliminate hazardous movements, reduce physical strain, and create a more comfortable and safe working environment. This can lead to reduced rates of injury and absenteeism, as well as improved employee morale and job satisfaction. The implementation of ergonomic improvements can also result in increased productivity, as workers are able to perform their tasks more efficiently and with less fatigue.

The insights gained from time and motion studies can also inform strategic decisions related to technology investments. By quantifying the benefits of automation and other advanced technologies, companies can make more informed decisions about which technologies to adopt and how to implement them effectively. For example, a time and motion study may demonstrate that the implementation of automated guided vehicles (AGVs) would significantly reduce travel time and labor costs, providing a strong business case for investing in this technology. Similarly, a study may reveal that the implementation of a warehouse management system (WMS) would improve inventory accuracy and order fulfillment rates, justifying the investment in this software.

METHODOLOGY

The research followed a systematic approach, leveraging SurveyMonkey to gather data from 130 employees across key logistics roles including inventory handlers, pickers, and dispatchers. The use of an online survey platform allowed for efficient data collection from a geographically dispersed workforce, ensuring that a

representative sample of employees was included in the study. The methodology comprised five key steps: survey design and distribution; workflow analysis to identify repetitive actions and delays; motion tracking to observe ergonomic challenges and travel patterns; identification of inefficiencies; and development of targeted recommendations.

The survey captured data on task durations, distances traveled, movement repetition, and perceived bottlenecks, forming the basis for subsequent workflow evaluation and improvement proposals. The survey instrument was carefully designed to elicit detailed and accurate information about the daily activities of employees, including the time spent on various tasks, the distances traveled within the warehouse, the frequency of repetitive movements, and the perceived causes of delays and inefficiencies. The survey also included questions about worker perceptions of ergonomic comfort and safety, providing valuable insights into the potential for improvements in these areas.

The use of SurveyMonkey allowed for efficient data collection from a large number of employees, providing a comprehensive view of the warehousing and logistics operations at KJ Industries. The data collected was then analyzed using statistical methods to identify trends and patterns, which informed the development of targeted recommendations for improvement [5]. The statistical analysis included descriptive statistics to summarize the key characteristics of the data, as well as inferential statistics to test hypotheses and identify significant relationships between variables. The results of the statistical analysis were then used to create visualizations, such as pie charts, heat maps, and bar charts, to communicate the findings in a clear and accessible manner.

In addition to the survey data, the research also involved direct observation of work processes within the warehouse. This involved spending time on the warehouse floor, observing workers as they performed their tasks, and documenting the movements and interactions involved. The direct observation provided valuable context for the survey data, helping to validate the findings and identify additional areas for improvement. The combination of survey data and direct observation provided a rich and comprehensive understanding of the warehousing and logistics operations at KJ Industries, enabling the development of targeted and effective recommendations for improvement.

FINDINGS

The analysis revealed that order picking was the most time-consuming activity, accounting for 30% of total task time, followed by inventory management (25%), transport coordination (20%), and packing (15%). Miscellaneous duties, including administrative work and breaks, occupied the remaining 10%. A pie chart visualization underscored the importance of streamlining order picking and inventory tasks. Additionally, a heat map of employee movement identified congestion between storage and dispatch zones, indicating poor warehouse layout. A bar chart summarizing inefficiency feedback showed that 34% of employees faced repetitive motions, while 26% reported long travel distances. Process bottlenecks (20%) and ergonomic discomfort (12%) also emerged as significant issues. Finally, a comparative workflow diagram highlighted a redesigned model with shorter paths, fewer task hand-offs, and a more ergonomic flow, which collectively promise improved efficiency and reduced worker fatigue. These insights laid the foundation for the actionable recommendations discussed in the subsequent chapter.

The analysis of the survey responses from 130 employees at KJ Industries Limited revealed several key insights into the warehousing and logistics operations. A detailed breakdown of time spent on various tasks indicated that order picking consumed the largest portion of employees' time (30%), followed by inventory management (25%), transportation coordination (20%), and packing (15%), while miscellaneous activities such as administrative duties and breaks accounted for the remaining 10%. This distribution was visually represented through a pie chart, which highlighted the need to focus optimization efforts on order picking and inventory processes, where time consumption was highest. This aligns with findings from other studies that have identified order picking as a major source of inefficiency in warehouse operations [6]. Market trends, including globalization and customer expectations, necessitate efficient order picking systems [6]. The high time consumption in inventory management also suggests potential for improvement through better inventory control systems and processes [7]. Inventory record inaccuracy can lead to inefficiencies and financial losses, highlighting the importance of accurate inventory management [7].

Furthermore, a heat map analysis of employee movement within the warehouse illustrated congested travel routes, particularly between the storage and dispatch areas. These high-traffic zones, shown in red, suggested inefficient layout planning and indicated a potential for reconfiguring the warehouse design to reduce walking distances and travel time. This finding is consistent with the principles of lean warehousing, which emphasize minimizing unnecessary movement and optimizing material flow [8]. Person-based design can guide factory settings, and a holistic model can be useful in space and layout factors [8]. Reconfiguring the warehouse layout to reduce travel distances can significantly improve efficiency and reduce worker fatigue [9]. Walking speed and distance traveled significantly impact human energy expenditure, which affects throughput [9].

When evaluating operational inefficiencies based on employee feedback, a bar chart revealed that 34% of respondents frequently encountered repetitive movements, while 26% cited long travel distances between workstations. Idle time due to process bottlenecks (20%) and physical strain or ergonomic discomfort (12%) were also commonly reported, with the remaining 8% falling into other miscellaneous concerns. These findings underscore the importance of both layout and task redesign to improve operational performance. The high percentage of employees reporting repetitive movements suggests a need for automation or job rotation strategies to reduce physical strain and improve worker well-being [10]. Upper-limb exoskeletons can reduce muscle fatigue and energy expenditure, which is relevant for tasks involving handling and sorting [10]. Addressing process bottlenecks and ergonomic discomfort can also lead to significant improvements in productivity and employee morale [11]. Smart tools can correlate with workers' performance and well-being, opening avenues for individualized resource management [11].

Finally, a comparative workflow diagram illustrated the contrast between the current and proposed processes. The optimized workflow showed reduced hand-offs, minimized travel paths, and better sequencing of tasks, which could collectively lead to faster task completion and decreased worker fatigue. These visual and data-driven findings formed the foundation for the recommendations outlined in the following chapter, with a strong emphasis on process automation, ergonomic improvements, and warehouse reorganization to enhance overall efficiency. Implementing the proposed workflow changes can lead to significant improvements in efficiency and worker satisfaction [12]. Automated vehicles are increasingly entering logistics operations, and understanding stakeholder perspectives is crucial for successful automation [12].

RECOMMENDATIONS

Based on the findings of the time and motion study conducted at KJ Industries Limited, several targeted recommendations can be made to enhance efficiency, reduce operational costs, and improve worker well-being within the warehousing and logistics framework. These recommendations are grounded in the data collected from employee surveys, direct observations of work processes, and a review of relevant literature on warehousing and logistics best practices. By implementing these recommendations, KJ Industries can create a more agile, efficient, and worker-friendly logistics environment, positioning the company for continued success in the dynamic and competitive apparel market.

First, optimizing the warehouse layout is essential—particularly in addressing the congestion identified between the storage and dispatch zones. Reconfiguring the flow of materials and workstations to minimize travel distance can significantly reduce wasted motion and time. This can be achieved through techniques such as ABC analysis to prioritize high-demand items and locate them closer to the dispatch area [5]. ABC analysis involves categorizing inventory items based on their value and usage frequency, with "A" items representing the highest value and most frequently used items, "B" items representing moderate value and usage, and "C" items representing the lowest value and least frequently used items. By placing "A" items closer to the dispatch area, order pickers can reduce the distance they need to travel, thereby saving time and improving efficiency.

Implementing a well-designed layout can reduce travel time, minimize congestion, and improve overall efficiency [13]. Genetic algorithms can minimize the distance traveled by pickers, optimizing routes and operational efficiency [13]. In addition to ABC analysis, other layout optimization techniques include cross-docking, which involves transferring goods directly from receiving to shipping without placing them in storage, and zone picking, which involves assigning workers to specific zones within the warehouse and

having them pick all of the items for an order within their assigned zone. These techniques can further reduce travel time and improve order picking efficiency.

Second, the company should consider implementing partial automation for high-frequency tasks such as order picking and inventory updates. Technologies like barcode scanners, mobile picking devices, and conveyor systems can streamline repetitive processes and reduce human error. Automated systems can significantly improve throughput, reduce labor costs, and enhance accuracy in order fulfillment [14]. Highly automated warehouses equipped with technologies like robotics and automated storage and retrieval systems (ASRS) can boost throughput and enhance operational flexibility [14]. The implementation of barcode scanners and mobile picking devices can enable real-time tracking of inventory and orders, reducing the risk of errors and improving order accuracy. Conveyor systems can automate the movement of goods between different areas of the warehouse, reducing the need for manual handling and improving efficiency.

The use of automated guided vehicles (AGVs) can also help to reduce travel distances and improve material flow within the warehouse [15]. AGVs are driverless vehicles that can transport goods between different locations within the warehouse, following pre-programmed routes or responding to real-time instructions from a warehouse management system (WMS). AGVs can operate 24/7, reducing the need for manual labor and improving overall efficiency. The critical success factors for AGV application depend on increasing technological advancements [15].

Third, a job rotation strategy should be introduced to combat physical strain caused by repetitive tasks. This would involve alternating employee roles throughout the day, helping to balance physical exertion and improve engagement. Job rotation can reduce the risk of musculoskeletal disorders, improve employee morale, and increase overall productivity [16]. Ergonomics evaluation using motion capture technology is growing to eliminate risks associated with health workers [16]. Providing employees with varied tasks can also enhance their skills and knowledge, making them more valuable to the organization [17]. Eye-tracking technology can help identify patterns in worker-system interaction, enhancing performance and well-being [17].

Furthermore, employee training programs should be updated to incorporate ergonomic practices and workflow awareness, ensuring that staff are equipped to work efficiently and safely. Training programs should focus on proper lifting techniques, workstation setup, and the importance of taking breaks to reduce physical strain [18]. Automating production process data acquisition can improve ergonomic assessment [18]. Educating employees about the rationale behind process changes and involving them in the design of new workflows can also increase buy-in and improve the success of implementation efforts [8]. A person-centered design that respects people is useful and can lead to factors in a firm’s competitiveness [8].

Additionally, real-time tracking systems and performance dashboards can provide supervisors with actionable insights into daily workflow bottlenecks and labor allocation, allowing for timely interventions. Real-time data can help to identify and address bottlenecks, optimize resource allocation, and improve overall efficiency [19]. Strategic operations management practices can improve overall performance by addressing challenges and improving efficiency [19]. Performance dashboards can also be used to track key performance indicators (KPIs) and monitor progress towards improvement goals [20]. Data strategy implementation enhances operational efficiency and helps gain a competitive edge [20].

Incorporating employee feedback into the design of process changes is also recommended, as those directly involved in logistics operations often offer practical suggestions for improvement. Employee involvement can lead to more effective and sustainable solutions, as it ensures that the changes are aligned with the needs and capabilities of the workforce [12]. Understanding the diverse perspectives of logistics stakeholders is required for successful automation [12]. Gathering feedback through surveys, focus groups, and one-on-one interviews can provide valuable insights and help to identify potential challenges and opportunities [21]. Practitioner's insights stress the importance of employment and real data analysis methods [21].

Finally, regular time and motion audits should be institutionalized to continuously evaluate operational effectiveness and respond proactively to evolving demands in the FMCG and retail landscape. Regular audits can help to identify areas for further improvement and ensure that the warehousing and logistics operations

remain aligned with the changing needs of the business [22]. WMS implementation needs continuous assessment to see whether or not it meets business needs and to plan for future enhancements [22]. These audits should involve a combination of data analysis, observation, and employee feedback to provide a comprehensive assessment of operational performance [5]. Data analytics can enhance operational efficiency by transforming inventory management and supply chain operations [5].

These strategic interventions, grounded in data and employee experience, can help KJ Industries build a more agile, efficient, and worker-friendly logistics environment. By implementing these recommendations, KJ Industries can improve its competitive position, reduce operational costs, and enhance employee satisfaction [1]. Globalization, e-commerce growth, and technological advancements intensify international business in transport and logistics services [1].

Conceptual Model

Based on the above findings the following Integrated Model for Enhancing Warehousing and Logistics Efficiency at KJ Industries is drawn :-

Strategic Area	Objective	Key Interventions	Expected Outcomes	Strategic Area
1. Layout Optimization & Process Flow	Minimize travel time and reduce congestion	- ABC analysis for item placement - Cross-docking - Zone picking - Genetic algorithms for layout design	- Reduced wasted motion and time - Faster order picking - Fewer bottlenecks	**1. Layout Optimization & Process Flow**
2. Automation & Technological Integration	Improve accuracy and throughput Reduce human error	- Barcode scanners and mobile picking devices - Conveyor systems - AGVs - WMS implementation	- Higher picking speed - Lower labor costs - Real-time inventory tracking	**2. Automation & Technological Integration**
3. Workforce Well-being & Skills	Enhance physical health and engagement	- Job rotation programs - Ergonomic training - Use of motion capture and eye-tracking - Involving workers in workflow design	- Reduced fatigue and injuries - Improved morale - Increased task proficiency	**3. Workforce Well-being & Skills**
4. Performance Monitoring & Data Use	Enable data-driven decision-making and fast intervention	- Real-time tracking systems - Performance dashboards - KPI-based monitoring - Operational data strategy implementation	- Optimized resource allocation - Continuous workflow improvements	**4. Performance Monitoring & Data Use**
5. Continuous Feedback & Improvement	Sustain long-term efficiency gns and adaptability	- Regular time and motion audits - Employee feedback loops - Continuous evaluation of automation and WMS	- Agile response to market changes - Stronger alignment with business needs	**5. Continuous Feedback & Improvement**

This model outlines a five-pillar strategy to enhance warehousing and logistics efficiency at KJ Industries. It emphasizes optimizing layout and process flow to reduce travel time and congestion. Technology integration improves accuracy and throughput, while workforce well-being initiatives boost morale and reduce physical strain. Data-driven performance management enables timely interventions through real-time tracking and KPIs. Continuous feedback and audits ensure the system evolves with business needs and employee input.

CONCLUSION

This study offers a detailed and data-driven view into the warehousing and logistics operations of KJ Industries Limited. Through a scientific analysis of time and motion components, it provides evidence-based recommendations for improving efficiency, reducing costs, and enhancing service delivery. The research has identified several key areas for improvement, including warehouse layout, order picking processes, inventory management, and worker ergonomics. By implementing the recommendations outlined in this study, KJ Industries can achieve significant gains in operational efficiency, reduce costs, and improve worker satisfaction, positioning the company for continued success in the dynamic and competitive apparel market.

As KJ Industries continues to grow in a fast-paced retail landscape, the insights from this study will serve as a valuable blueprint for operational excellence and sustained competitiveness. The company can leverage the findings of this research to inform strategic decisions related to technology investments, process improvements, and workforce development, ensuring that its warehousing and logistics operations remain aligned with the changing needs of the business. The study also highlights the importance of continuous evaluation and improvement, emphasizing the need for KJ Industries to institutionalize regular time and motion audits to identify new opportunities for optimization and maintain its competitive edge.

The findings and recommendations of this study can also be applied to other companies in the apparel industry and the broader FMCG sector, providing a framework for improving warehousing and logistics operations [19]. Strategic operations management in the FMCG industry drives efficiency, quality, and customer satisfaction [19]. The importance of adapting to changing market demands and leveraging technology to enhance efficiency and worker well-being cannot be overstated [23]. The warehouse business has undergone a revolution with the integration of advanced technology [23]. By embracing a data-driven approach to operations management and prioritizing the well-being of its workforce, KJ Industries can create a sustainable and competitive logistics environment that supports its continued growth and success.

Big Data and Blockchain

The integration of big data analytics and blockchain technology presents significant opportunities for revolutionizing logistics business models. Big data analytics enables organizations to process and analyze vast amounts of data from various sources, providing valuable insights into supply chain operations, customer behavior, and market trends [24]. Logistics business model strategies adapt to changes in big data and blockchain technology [24]. Blockchain technology, on the other hand, offers a secure and transparent platform for managing transactions and tracking goods throughout the supply chain [25]. Revolutionizing logistics business models occur through big data and blockchain [25].

By combining these two technologies, logistics companies can enhance their decision-making processes, improve operational efficiency, and build trust and transparency with their customers and partners. For example, big data analytics can be used to forecast demand, optimize routes, and predict potential disruptions in the supply chain, while blockchain technology can be used to verify the authenticity of goods, track their movement, and ensure secure payment transactions. The use of data for organizational decision-making has become an integral part of digitization and automation [24].

Intelligent Logistics

Intelligent logistics systems leverage advanced technologies such as the Internet of Things (IoT), artificial intelligence (AI), and machine learning (ML) to optimize logistics operations and improve decision-making [26]. Intelligent automation optimizes supply chain processes and enhances operational

efficiency [26]. The IoT enables the collection of real-time data from various sources, such as sensors, vehicles, and warehouses, providing a comprehensive view of the logistics network. AI and ML algorithms can then be used to analyze this data, identify patterns and trends, and make predictions that can inform operational decisions.

For example, AI-powered systems can be used to optimize warehouse layouts, predict equipment failures, and automate tasks such as order picking and packing. ML algorithms can also be used to improve demand forecasting, optimize transportation routes, and personalize customer service. The integration of these technologies can lead to significant improvements in efficiency, cost savings, and customer satisfaction. Intelligent automation drives strategic decision-making and achieves agility and responsiveness in competitive markets [26].

Smart Logistics Systems

Smart logistics systems integrate various technologies, including the Internet of Things, information communication technology, and artificial intelligence, to enable more efficient and responsive logistics operations [27]. Smart logistics is a promising solution for handling increasing complexity and volume operations [27]. These systems can monitor and manage the flow of goods, information, and resources throughout the supply chain, providing real-time visibility and control. Smart logistics systems can also automate many of the manual tasks involved in logistics operations, such as data entry, order processing, and shipment tracking.

The use of smart sensors and wearable technology can further enhance the efficiency and safety of logistics operations [11]. Smart sensors can be used to monitor environmental conditions, such as temperature and humidity, ensuring the quality and safety of goods in transit. Wearable technology can be used to track worker movements and physiological data, providing insights into worker fatigue and stress levels, and enabling the implementation of ergonomic improvements. Operations research mainly concerns the application of underlying technologies, business logic, and optimization problems [27].

Logistics Tracking Systems

Logistics tracking systems are essential for providing real-time visibility into the location and status of goods throughout the supply chain. These systems typically use a combination of technologies, such as GPS, RFID, and barcode scanning, to track the movement of goods from origin to destination. Logistics tracking systems can also provide valuable information about the condition of goods, such as temperature, humidity, and shock levels, ensuring that they are handled properly during transit.

The use of computer algorithms can enhance the intelligence and efficiency of logistics tracking systems [28]. A sophisticated tracking system can be created by utilizing computer technology [28]. For example, algorithms can be used to detect integrity in goods packaging and identify behavior posture using three-dimensional acceleration sensors [28]. These algorithms can analyze data from sensors and tracking devices to identify potential problems, such as damaged goods, delays, or security breaches, and alert stakeholders in real-time. The primary focus is on developing an intelligent inventory decision support system [28].

Agile Supply Chains

Agile supply chains are designed to be flexible and responsive to changing market demands and customer expectations [29]. Global quick response (GQR) strives to combine cost and scale efficiencies with quick and accurate response to market requirements [29]. These supply chains are characterized by close collaboration between suppliers, manufacturers, distributors, and retailers, enabling them to quickly adapt to changing conditions. Agile supply chains also leverage technology to improve visibility, communication, and decision-making.

The use of data analytics, cloud computing, and mobile technologies can enable companies to respond quickly to changing market demands and customer expectations. Agile supply chains also emphasize the importance of

continuous improvement, with companies constantly seeking ways to streamline processes, reduce costs, and improve customer service. GQR is based on lead time compression, effective information management, dynamic planning, and strong logistics [29].

Last-Mile Delivery

Last-mile delivery refers to the final leg of the supply chain, from the distribution center to the customer's doorstep. This is often the most expensive and time-consuming part of the supply chain, accounting for a significant portion of total logistics costs. Optimizing last-mile delivery operations is therefore critical for improving overall supply chain efficiency and customer satisfaction [30]. Optimizing last-mile delivery operations is pivotal for sustaining customer satisfaction and operational efficiency [30].

The use of predictive analytics, technology integration, and sustainable practices can significantly improve last-mile delivery operations. Predictive analytics can be used to forecast delivery needs and driver performance, allowing for pre-emptive adjustments that enhance reliability and efficiency. Technology integration, such as route optimization algorithms and real-time tracking systems, can drastically reduce delivery times and operational costs. Sustainable practices, such as the use of electric vehicles and alternative delivery methods, can mitigate environmental impact and potentially lower delivery costs. By integrating predictive analytics, technology, and sustainable practices, companies can significantly improve their last-mile delivery operations, leading to improved service levels and operational excellence.

Warehousing Policy Framework

A well-defined warehousing policy framework can serve as a business enabler, facilitating collaboration and competition among firms [31]. Warehousing policy frameworks enable firms to collaborate and compete [31]. Such a framework provides criteria for specific needs, synchronizing materials and planning capacities. However, there is no standard topology for these various industries, presenting a gap to explore requirements and procedures. A warehousing policy framework provides criterion for specific needs and helps synchronize materials [31].

A study examining the moderating role of warehousing policy frameworks on supply chain performance processing in Kenya revealed that the majority prioritized space optimization and maintenance under regulatory restrictions [31]. However, many did not automate or mechanize workflow, suggesting a need for automation and mechanization technology to improve production efficiency. The warehousing policy framework has led to the growth of proficient warehouses, facilitating firms to collaborate and compete [31].

Artificial Intelligence

Artificial intelligence (AI) is increasingly being used in warehousing to improve performance in terms of time, inventory, and cost [32]. Artificial intelligence brings warehouse performance benefits in time, inventory, and cost [32]. AI technologies such as machine learning, robotics, and the Internet of Things (IoT) are being applied to various warehousing processes, including inventory management, order picking, and logistics planning. AI can optimize inventory levels, production schedules, and procurement activities, enhancing productivity and reducing costs [33]. Neural networks in supply chain management can help optimize inventory levels and production schedules [33].

AI can also be used to detect anomalies and abnormalities in data, such as unexpected patterns, quality issues, or disruptions in operations, in order to minimize the impact on the supply chain. Furthermore, AI can analyze supplier performance, including quality, delivery times, and pricing, to assess the reliability and effectiveness of suppliers. By analyzing various data sources, such as weather conditions and political instability, AI can help mitigate risks and ensure the safety and security of the supply chain.

Multi-Warehouse Robots

The use of multi-warehouse robots is becoming increasingly important in logistics and other industries. Research on their path planning is essential to improve operational efficiency and reduce operating costs. A

two-level vehicle path planning model can integrate static and dynamic elements to improve operational efficiency and reduce operating costs [34]. The two-level vehicle model for multi-warehouse robots integrates static and dynamic elements to improve operational efficiency [34].

This model can enhance the ant colony optimization (ACO) algorithm, effectively avoiding nodes during movement. It can also adjust routing strategies in real-time, giving optimal solutions according to the situation. Simulations confirm that the proposed model outperforms other methods in terms of average running distance, number of blocked nodes, percentage of replanned paths, and time, showing great potential for optimizing operations.

Overhead Multi-Station Multi-Shuttle Systems

Overhead multi-station multi-shuttle systems are being used in various fields, including warehouses, hospitals, and airports, to improve efficiency. These systems utilize conveyors and shelf-lifting mobile robots to transform warehouses into fulfillment factories. Modern warehouses are increasingly becoming significant e-commerce hubs, with organizations using robots and conveyors to transport shelves. The aim is to analyze and organize the relationship between system families and address synchronization issues within different warehouse settings. Enhancing the layout can significantly enhance throughput performance, surpassing other well-studied decision tasks.

Motion and Time Study

Motion and time study, pioneered by Frederick Winslow Taylor and further developed by Frank and Lillian Gilbreth, has long served as a cornerstone of scientific management. This approach emphasizes the analysis of work processes to boost productivity by eliminating unnecessary tasks and streamlining activities. In logistics settings, motion and time studies are essential for refining operations such as inventory management, order picking, and dispatching. By breaking down workflows into discrete, measurable actions, the method aims to eliminate inefficiencies, streamline activities, and boost productivity. The concepts of motion and time studies can be applied to various industries to improve productivity [2].

SUMMARY

In conclusion, this comprehensive analysis underscores the critical role of time and motion studies, enhanced by technological integrations and strategic management practices, in optimizing warehousing and logistics operations. The insights from KJ Industries Limited serve as a valuable case study, demonstrating the tangible benefits of applying these principles in a real-world setting. As the logistics and FMCG sectors continue to evolve, the adoption of data-driven approaches, ergonomic improvements, and innovative technologies will be essential for maintaining competitiveness and achieving sustainable growth.

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