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Warehouse Layout Optimization and Material Handling Improvement for MSMEs: A Case Study of Toko Kharisma Batam

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ABSTRACT

This study focuses on improving warehouse management for Toko Kharisma, a Micro, Small, and Medium Enterprise (MSME) located in Batam City, which sells various school supplies. The initial assessment revealed inefficiencies in warehouse utilization, including disorganized storage, lack of material handling equipment, and manual processes that hinder operational efficiency. To address these issues, the proposed solutions include transitioning from folding storage to box storage, optimizing warehouse layout, implementing a systematic labeling system, and introducing material handling tools such as hand trolleys. Space requirements were calculated based on inventory volume and throughput to ensure effective design. The implementation plan also includes considerations for safety, accessibility, and workflow optimization. The expected outcomes of these improvements are enhanced inventory control, faster picking processes, reduced errors, and improved productivity. By adopting these strategies, Toko Kharisma can achieve better space utilization, operational efficiency, and sustainable business growth in a competitive retail environment.

Keywords:

warehouse, optimization, operational, efficiency

Introduction

In today's competitive business environment, effective warehouse management plays a crucial role in ensuring smooth operations, particularly for small and medium-sized enterprises (SMEs) that operate with limited resources. Warehousing is not simply a storage area but a critical component of the supply chain that influences efficiency, service quality, and customer satisfaction. Poor warehouse management can result in various operational problems, including delays in order fulfillment, inventory inaccuracies, increased costs, and diminished customer trust. Therefore, an optimized warehouse layout combined with appropriate material handling systems is essential for achieving operational excellence.

Toko Kharisma, a Micro, Small, and Medium Enterprise (MSME) located in Batam City, Indonesia, specializes in selling school supplies, including uniforms for elementary to high school students. The store experiences significant fluctuations in demand, especially during the back-to-school season when sales volumes peak. To meet this seasonal demand, the store procures and stores large quantities of inventory in advance. This approach creates pressure on warehouse operations, highlighting the need for efficient storage and handling systems. However, an assessment of Toko Kharisma's warehouse operations revealed multiple inefficiencies. The warehouse measures approximately five meters by three meters, yet its utilization is far from optimal. Products are stored haphazardly without clear categorization or labeling, making the picking process time-consuming and error-prone. Furthermore,

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the store relies entirely on manual handling processes without any material handling equipment, such as hand trolleys or conveyors, which slows down workflows and increases the physical burden on employees, creating ergonomic risks and potential safety hazards.

The storage method currently used, folding storage, is another major source of inefficiency. This method involves stacking goods in piles or using simple shelving without consideration of accessibility or logical categorization. While cost-effective initially, this approach severely hampers retrieval speed and complicates inventory control. Employees often struggle to locate specific products during high-demand periods, leading to delays, customer dissatisfaction, and lost sales opportunities.

Several key issues emerge from these observations. First, space utilization within the warehouse is inefficient, with poor vertical and horizontal organization leading to clutter and wasted capacity. Second, the absence of material handling tools results in slower workflows, increased labor effort, and safety risks. Third, the lack of systematic storage and labeling hinders efficient inventory management and prolongs the picking process. Finally, the use of an inappropriate storage method further limits accessibility and operational efficiency. These challenges collectively reduce productivity, increase operational costs, and undermine customer satisfaction. Addressing these problems requires a comprehensive improvement strategy that focuses on optimizing warehouse layout, adopting appropriate material handling tools, and implementing systematic inventory organization.

The purpose of this study is to design an improved warehouse system for Toko Kharisma that enhances operational efficiency and supports sustainable business growth. The objectives include developing an optimized warehouse layout that maximizes space utilization, recommending suitable material handling tools to reduce manual effort, introducing an effective storage method by transitioning from folding storage to box storage, and implementing a systematic labeling system to streamline product identification and retrieval. Achieving these objectives will result in improved inventory control, reduced processing time, and enhanced productivity, enabling Toko Kharisma to deliver better customer service and maintain competitiveness in the retail market.

The significance of this study extends beyond Toko Kharisma to other SMEs facing similar warehousing challenges. Many small businesses in Indonesia operate under financial and space constraints, often overlooking the importance of warehouse management in their operational strategy. This research demonstrates that even with limited investment, significant improvements can be realized through careful planning and low-cost solutions, such as layout redesign, labeling systems, and basic material handling tools. Effective warehouse management not only enhances operational efficiency but also reduces costs, improves inventory accuracy, and strengthens customer satisfaction, all of which contribute to long-term business sustainability.

Previous studies have highlighted the importance of warehouse optimization in improving supply chain performance. Research suggests that systematic planning and layout optimization are essential for eliminating operational bottlenecks and improving efficiency. Scholars have also emphasized the benefits of structured storage systems, material handling tools, and clear labeling in reducing errors and improving speed in warehouse operations. This study builds upon these insights by applying practical, low-cost solutions in the context of a real-world MSME in Batam City, demonstrating their applicability and effectiveness in small-scale business environments.

The findings of this study aim to provide actionable recommendations for Toko Kharisma while offering valuable insights for other small businesses seeking to improve their warehouse operations. By implementing the proposed improvements, businesses can achieve better utilization of available space, streamline workflows, and create safer and more organized storage environments. These enhancements ultimately enable businesses to provide faster, more reliable service to customers, thereby increasing satisfaction and reinforcing their competitive advantage in an increasingly dynamic market environment.

Method

This study employed a practical and descriptive approach to analyze the existing warehouse conditions at Toko Kharisma and develop an improvement plan based on logistical principles and space optimization strategies. The research process began with field observations and measurements of the warehouse space, which has a total area of approximately 5 meters by 3 meters. These measurements were necessary to understand the current utilization of space and to identify constraints that affect efficiency. In addition to physical measurements, interviews were conducted with the store owner to gather information about inventory management practices, product categories, purchasing patterns, and seasonal demand fluctuations, particularly during the back-to-school period when sales are at their peak.

After collecting preliminary data, the next step was to identify and classify the main operational problems within the warehouse. These problems included inefficient space utilization, lack of material handling equipment, disorganized storage systems, and the absence of systematic labeling. To quantify these issues, the research team assessed product flow, storage density, and accessibility within the current layout. The team then calculated space requirements for storage based on the dimensions and quantities of packaging boxes. This calculation allowed the researchers to determine the number of racks, packaging units, and material handling tools needed to accommodate the inventory effectively while maximizing available space.

Following this analysis, several improvement strategies were proposed. The first strategy involved transitioning from folding storage to box storage, a method that allows for better stacking and categorization of products. This approach also supports easier inventory control and retrieval during peak demand periods. The second strategy was redesigning the warehouse layout using 2D and 3D modeling tools. These design models were based on principles of throughput analysis and rectilinear distance calculations to ensure an efficient flow of goods and minimal travel time during picking operations. Products with higher throughput values were positioned in easily accessible areas to reduce handling time and improve operational efficiency.

In addition to layout optimization, the implementation of a systematic labeling system was proposed. Labels would provide detailed information on product categories, sizes, and other attributes, enabling faster identification and reducing errors during picking and restocking processes. To further enhance efficiency, the introduction of material handling equipment, specifically a hand trolley, was recommended. This tool would reduce manual lifting and carrying, minimize physical strain on workers, and accelerate the movement of goods within the warehouse.

Finally, a cost analysis was performed to estimate the investment required for implementing these improvements. The analysis included the costs of racks, hand trolleys, safety equipment, and warehouse layout adjustments. The total estimated cost was IDR 91,285,000, which was deemed reasonable considering the expected improvements in efficiency, safety, and service quality. The methodology adopted in this study emphasizes practicality and cost-effectiveness, ensuring that the proposed solutions can be realistically implemented by small businesses such as Toko Kharisma without imposing excessive financial burdens.

Results and Discussion

The findings of this study reveal several critical observations regarding the existing warehouse conditions at Toko Kharisma and the improvements proposed through layout redesign, storage method optimization, and the introduction of material handling systems. Initially, the assessment of the warehouse demonstrated severe inefficiencies that hindered operational effectiveness. The existing storage method relied heavily on folding storage, which involved stacking products without structured organization or categorization. This practice not only consumed excessive space but also created significant challenges during the picking process, particularly during the back-to-school season

when product demand surged. Employees reported difficulties in locating products quickly, leading to increased retrieval time and frequent delays in order fulfillment.

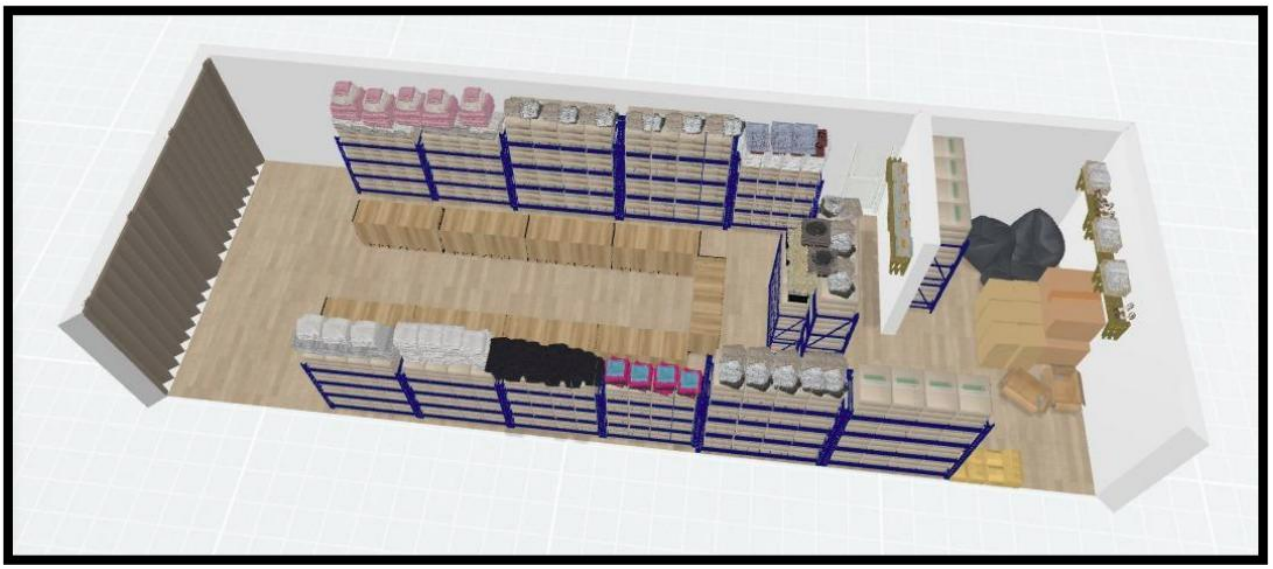

Figure 1. Existing Warehouse Layout

The absence of a systematic labeling system further exacerbated these challenges. Without proper labeling, workers relied on memory and visual inspection to identify products, which was inefficient and prone to errors. Misplacement of items was common, and instances of stockouts occurred despite adequate inventory, simply because items were not easily accessible. The lack of proper inventory control measures undermined the store's ability to maintain accurate stock levels, resulting in both overstocking and understocking scenarios. In addition, manual handling of goods without material handling equipment increased physical strain on workers, posed safety risks, and slowed down operational processes.

The implementation of improvement strategies began with calculating the space requirements necessary to accommodate the inventory more effectively. By transitioning from folding storage to box storage, the warehouse was able to achieve better stacking capabilities and improved organization of goods. Box storage allows products to be grouped by category, size, and type, which significantly enhances accessibility and simplifies inventory checks. The calculations indicated the number of racks and packaging units required to store the current inventory while leaving sufficient aisle space for movement. This transition not only improved the density of storage but also minimized clutter, allowing for a more streamlined flow of materials within the warehouse.

The redesign of the warehouse layout was another critical aspect of the improvement process. Using principles of throughput analysis and rectilinear distance, a new layout was developed that positioned high-turnover products in easily accessible areas, reducing travel time during picking operations. Products that were in high demand during the back-to-school season were placed near the front or along primary aisles, while slower-moving items were stored in less accessible locations. This approach ensures that the most frequently picked items are retrieved with minimal effort, reducing operational time and labor costs. The new layout design also incorporated wider aisles to facilitate movement and accommodate material handling equipment, improving both efficiency and safety.

Figure 2. Warehouse Layout Improvement

The introduction of a labeling system played a vital role in improving operational efficiency. Each rack and box was labeled with clear and concise information, including product type, size, and stock-keeping unit (SKU) codes. This system not only reduced the time required to locate items but also minimized errors in picking and restocking. By standardizing the labeling process, employees were able to work more systematically, which improved overall workflow and productivity. The labeling system also supports future implementation of inventory management software, should the business decide to adopt digital solutions in the future.

Material handling improvements were another significant outcome of this study. The purchase of a hand trolley provided a simple yet effective solution to reduce manual lifting and carrying, which had previously slowed operations and exposed workers to ergonomic risks. The use of the trolley allowed for the simultaneous movement of multiple items, reducing the number of trips required and improving overall efficiency. While the addition of more advanced equipment such as conveyors or automated systems was not feasible due to budget constraints and the limited size of the warehouse, the introduction of a basic hand trolley represents a cost-effective enhancement with immediate benefits.

Financial feasibility was a key consideration throughout the improvement process. The estimated cost for implementing these changes, including the purchase of racks, hand trolleys, a ladder, and safety equipment such as fire extinguishers, amounted to IDR 91,285,000. While this figure represents a significant investment for a small business, the long-term benefits in terms of improved efficiency, reduced labor costs, and enhanced customer satisfaction justify the expense. Furthermore, the implementation plan was designed to be scalable, allowing for phased adoption if necessary, to accommodate the financial limitations of the business.

The expected operational improvements resulting from these changes are substantial. By adopting a box storage system and reorganizing the warehouse layout, space utilization is maximized, and

product accessibility is improved. Employees can now retrieve products more quickly, reducing picking time and minimizing delays during peak periods. The systematic labeling system further enhances efficiency by eliminating confusion and reducing errors, while the introduction of material handling equipment improves safety and reduces physical strain on workers. Collectively, these improvements contribute to smoother workflows, higher productivity, and a more organized and professional working environment.

From a broader perspective, these enhancements also strengthen Toko Kharisma's ability to compete in an increasingly competitive retail market. Efficient warehouse operations translate into faster order fulfillment and improved customer service, both of which are critical for customer retention and business growth. By investing in warehouse optimization, the business can handle higher sales volumes without proportionately increasing labor costs, thereby improving profitability. Additionally, the structured approach to inventory management reduces the likelihood of stockouts or overstocking, which in turn lowers holding costs and minimizes losses due to unsold inventory or damaged goods.

The findings of this study also highlight important lessons for other MSMEs facing similar challenges. Many small businesses underestimate the impact of warehouse management on overall business performance, often viewing it as a secondary concern compared to sales or marketing. However, this case study demonstrates that even modest investments in warehouse optimization can yield significant operational and financial benefits. Low-cost solutions such as layout redesign, systematic labeling, and the introduction of simple material handling tools can dramatically improve efficiency and customer satisfaction without requiring substantial capital expenditure.

It is worth noting that while the improvements proposed in this study address the immediate challenges faced by Toko Kharisma, further enhancements could be explored in the future. For instance, the adoption of digital inventory management systems could provide real-time visibility into stock levels, enabling more accurate demand forecasting and reducing the risk of stock discrepancies. Similarly, the introduction of additional material handling equipment, such as shelving systems with adjustable heights or lightweight mobile racks, could further optimize space utilization and flexibility. Environmental considerations, such as energy-efficient lighting and climate control, may also be integrated into future plans to ensure product quality and sustainability.

In conclusion, the results of this study clearly demonstrate the effectiveness of practical, low-cost solutions in improving warehouse operations for small businesses. Through systematic analysis and targeted interventions, Toko Kharisma was able to overcome the limitations of its existing warehouse setup and implement improvements that enhance efficiency, safety, and service quality. These findings underscore the importance of viewing warehouse management as a strategic function rather than a purely operational task. For MSMEs operating in competitive markets, efficient warehouse operations can be a critical differentiator that drives customer satisfaction, operational resilience, and long-term business success.

Conclusion

This study has demonstrated that effective warehouse management is essential for improving operational efficiency and supporting sustainable growth, even for small businesses with limited resources. The initial analysis of Toko Kharisma revealed several critical issues, including inefficient use of space, the absence of material handling equipment, disorganized storage systems, and a lack of systematic labeling. These issues negatively affected workflow, increased operational time, and reduced overall productivity, particularly during high-demand periods such as the back-to-school

season. The implementation of improvements focused on four key strategies: transitioning from folding storage to box storage, redesigning the warehouse layout using throughput analysis and rectilinear distance principles, introducing a standardized labeling system, and adding basic material handling equipment such as a hand trolley. These changes collectively addressed the identified challenges by optimizing space utilization, reducing retrieval time, minimizing errors, and improving worker safety.

The estimated investment of IDR 91,285,000 for implementing these improvements is justified by the long-term operational and financial benefits, including increased efficiency, better inventory control, and enhanced customer satisfaction. These findings underscore the importance of viewing warehouse optimization as a strategic priority rather than an optional enhancement. For Toko Kharisma, the adoption of these improvements will not only streamline day-to-day operations but also provide a foundation for future growth and competitiveness in the retail market. The results of this study also serve as a practical guide for other MSMEs facing similar challenges, demonstrating that significant performance gains can be achieved through cost-effective and scalable solutions. Ultimately, efficient warehouse management enhances productivity, reduces costs, and strengthens the ability of small businesses to meet customer expectations in an increasingly dynamic business environment.

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