Small Business Lean Inventory Optimization

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Abstract — *This research investigates the problem of ineffective inventory management systems in small businesses using a qualitative case study approach. The study focuses on Dixon's Refrigeration, identifying the root causes of poor inventory management, including difficulties in forecasting demand, managing stock levels, identifying slow-moving inventory, reordering products, and tracking inventory across multiple locations. The DMAIC process improvement methodology was applied to address these challenges, resulting in recommendations that include implementing inventory management software, automated data collection and analysis, mobile inventory tracking, and adopting best practices. The findings provide valuable insights into the problem and offer practical solutions for Dixon's Refrigeration and other small businesses facing similar challenges. By implementing these recommendations, businesses can improve efficiency, reduce costs, enhance customer satisfaction, and strengthen their overall competitiveness in the market.*

Key Terms — *Inventory Management, Process Improvement, Root Cause Analysis, Small Businesses.*

PROBLEM STATEMENT

Dixon's Refrigeration, a small business established for 3 years and operating in the southwest of Puerto Rico, is facing challenges in effectively managing its inventory, which ultimately results in increased costs and inefficiency in its business operations. Specifically, the business is facing difficulties in accurately forecasting demand, properly managing stock levels, efficiently identifying, and eliminating slow-moving or obsolete inventory, effectively implementing a system for reordering products, and accurately tracking inventory across multiple locations. These challenges significantly impact the overall efficiency and profitability of the business. The goal of this research is to conduct a comprehensive analysis of the root causes of these challenges and to develop a set of practical and effective recommendations for Dixon's Refrigeration to improve its inventory management system, with the potential to serve as a valuable case study for other small businesses facing similar challenges in inventory management.

RESEARCH DESCRIPTION

The research will be a qualitative study that aims to identify the root causes of the lack of an effective inventory management system in Dixon's Refrigeration. To set the context for the study, a thorough literature review of current inventory management best practices and technologies will be conducted, providing insights into established methods and emerging trends in inventory management that may help address the challenges faced by Dixon's Refrigeration. Following the literature review, the researcher will conduct interviews with key stakeholders, including management, employees, and customers, to gather information about the current inventory management processes and identify areas of inefficiency. The researcher will also collect data on inventory levels, sales, and customer complaints to support the findings from the interviews, allowing for an in-depth exploration of the company's existing processes and challenges to identify gaps and areas for improvement.

With the information collected, the researcher will use statistical analysis, process mapping, and other tools to identify patterns and trends, which will be used to develop a set of recommendations for Dixon's Refrigeration on how to improve its

inventory management system. The recommendations will be based on the use of technology, such as inventory management software, automated data collection and analysis, and mobile inventory tracking, and the researcher will also provide a set of best practices for inventory management. The research will conclude with a comprehensive report that includes a summary of the research findings, recommendations for Dixon's Refrigeration, and a plan for implementation and future research.

RESEARCH OBJECTIVES

The primary objectives of this research are to identify and analyze the root causes of the lack of an effective inventory management system in Dixon's Refrigeration, investigate the relationship between inventory management practices and the company's operational efficiency, costs, and profitability, explore the potential of technology in improving inventory management processes, and propose solutions that improve efficiency, reduce costs, and optimize inventory management processes through the use of technology and best practices. Ultimately, the research aims to contribute valuable insights to the field of inventory management in small businesses, potentially benefiting other organizations facing similar challenges.

RESEARCH CONTRIBUTIONS

The research is expected to make several contributions, including a comprehensive set of recommendations and best practices for Dixon's Refrigeration on how to improve their inventory management system through the use of technology, such as inventory management software, automated data collection and analysis, and mobile inventory tracking, to improve efficiency, reduce costs, and optimize inventory management processes. Additionally, the research will provide a valuable case study for other small businesses in the refrigeration industry or similar sectors, offering insights into effective inventory

management strategies and the potential benefits of adopting technology-based solutions. Lastly, the research will increase understanding of the relationship between inventory management practices and overall business performance, particularly in the context of small businesses with limited resources.

LITERATURE REVIEW

In the world of business and supply chain management, understanding inventory is crucial. Inventory, especially for businesses dealing with physical goods, is at the heart of our literature review.

An inventory is a comprehensive list or record of the items, goods, or products that a business or organization has in stock. It is used to manage stock levels, track sales and purchases, and plan for future needs. The inventory can be physical, such as the items stored in a warehouse, or it can be virtual, such as the items stored in an electronic system.

An inventory can include various types of information, such as the item's name, description, quantity, location, cost, and value. It can also include information about the item's condition, such as whether it is new, used, or refurbished. The inventory can be organized in different ways, such as by item category, location, or supplier.

An accurate inventory is crucial for a business to operate effectively. It helps to ensure that the business has enough stock to meet customer demand and prevent stockouts, which can result in lost sales. It also helps to identify the slow-moving or excess stock, which can be sold or cleared out to make room for more profitable items.

Inventories can be managed manually, using paper records and spreadsheets, or electronically using inventory management software. Electronic inventory management systems can automate many of the manual tasks associated with inventory management, such as tracking stock levels, generating reports, and alerting when stock levels are low. This can save time and reduce errors, and

it can also provide valuable insights into inventory trends and patterns.

In addition to managing stock levels, inventory management also involves monitoring and managing inventory costs, including the cost of goods sold, carrying costs, and ordering costs. This is essential to ensure that the business is profitable and to make informed decisions about inventory levels, pricing, and purchasing.

Overall, inventory management is a critical function of any business that deals with physical goods. It helps to ensure that the business has the right products in the right quantities at the right time and that it is operating at the highest level of efficiency and profitability.

Small Business

A small business is a company or organization that is independently owned and operated, with a relatively small number of employees and a relatively modest amount of revenue. The exact definition of a small business can vary depending on the industry, location, and context, but generally, it is considered to be a business that is smaller in size compared to larger, more established companies.

Some characteristics of small businesses include:

- **Limited resources:** Small businesses typically have fewer financial, human, and technological resources than larger companies.
- **Narrow focus:** Small businesses often specialize in a specific product or service, and may serve a specific market niche.
- **Flexibility:** Small businesses are often able to adapt quickly to changes in the market and respond to new opportunities.
- **Owner-managed:** Small businesses are often managed by the owner or a small group of owners, who are responsible for making key decisions and setting strategies.
- **Dependence on the local market:** Small businesses may have less geographic diversification, relying on a local market for their revenue and growth.

Small businesses can operate in a variety of industries, such as retail, manufacturing, service, and technology, and can range in size from a single-person operation to a company with hundreds of employees. Many small businesses start as sole proprietorships or partnerships and may later incorporate as a limited liability company (LLC) or a corporation.

Small businesses play an important role in the economy, creating jobs and driving innovation. They are often considered to be the backbone of the economy and are known for their flexibility, creativity, and ability to respond to changes in the market.

Small Business and Inventory

Small businesses and inventory management are closely related in several ways. Inventory management is a critical function for small businesses, as it helps to ensure that they have the right products in the right quantities at the right time and that they are operating at the highest level of efficiency and profitability.

One of the main challenges for small businesses is managing their inventory effectively with their limited resources. They often have to balance the need to keep stock levels low to minimize carrying costs with the need to have enough stock on hand to meet customer demand and prevent stockouts. This can be a delicate balancing act, and effective inventory management is crucial to ensure that the business is profitable and can grow.

Small businesses can benefit from inventory management software and other tools that can automate many of the manual tasks associated with inventory management, such as tracking stock levels, generating reports, and alerting when stock levels are low. This can save time and reduce errors, and it can also provide valuable insights into inventory trends and patterns.

In addition to managing stock levels, small businesses also need to monitor and manage inventory costs, including the cost of goods sold, carrying costs, and ordering costs. This is essential

to ensure that the business is profitable and to make informed decisions about inventory levels, pricing, and purchasing.

In summary, small businesses and inventory management are closely related, and they are important to each other. Inventory management is a crucial function that small businesses need to be effective and profitable, and small businesses can benefit from inventory management tools and strategies that help them manage their inventory efficiently and effectively [1]. This will help them grow and be successful in the long run.

Lean Inventory

Lean inventory is a concept that is based on the principles of lean manufacturing, which is a methodology that focuses on eliminating waste and maximizing efficiency in the production process. Lean inventory applies these principles to the management of inventory, to reduce inventory levels while still ensuring that there is enough stock to meet customer demand.

The main principles of lean inventory are:

- **Just-in-time (JIT) inventory:** This principle is about ordering inventory only as needed, rather than maintaining large inventories of stock. JIT helps to reduce carrying costs and the risk of stockouts, while also increasing the responsiveness of the business to changes in customer demand.

- **Pull-based inventory:** This principle is about managing inventory based on actual customer demand, rather than forecasts. Pull-based inventory helps to ensure that the business is producing and stocking the right products at the right time.

- **Kanban:** This is a system of signals that are used to control the flow of goods through the production process. Kanban helps to ensure that inventory is moved through the system in a timely and efficient manner.

- **Continuous improvement:** Lean inventory is not a one-time process, but rather a continuous journey of improvement. This principle is about regularly reviewing and optimizing

inventory management processes to identify and eliminate waste and inefficiencies.

Lean inventory is a flexible and adaptive approach that can be applied to a wide range of industries and business types. It is particularly suited for small businesses that need to manage inventory efficiently with limited resources. Implementing lean inventory can help small businesses reduce costs, increase efficiency, and improve customer service.

DMAIC

DMAIC is an acronym that stands for Define, Measure, Analyze, Improve, and Control. It is a process improvement methodology that is used to identify and solve problems and improve performance. DMAIC is often used in Six Sigma, a quality management methodology.

In the context of inventory management, DMAIC can be used to identify and solve problems related to inventory levels, accuracy, and efficiency. The DMAIC process can be applied to inventory management as follows:

Define: Identify the problem or opportunity related to inventory management that needs to be addressed. This could include issues such as high inventory levels, stockouts, or inaccurate inventory counts.

Measure: Collect data and establish baseline measures of the current performance of the inventory management process. This could include measures such as inventory turnover, stockout rate, and inventory accuracy.

Analyze: Use data analysis tools to identify the root causes of the problem or opportunity. This could include identifying patterns and trends in the data, identifying bottlenecks in the process, and identifying areas of waste or inefficiency.

Improve: Develop and implement solutions to address the identified problems or opportunities. This could include changes to inventory levels, process changes, or technology improvements [2].

Control: Establish a plan to monitor and control the process to ensure that the improvements are sustained over time. This could include setting

up control charts, conducting regular audits, and monitoring key performance indicators.

DMAIC is a structured and systematic approach that can be used to improve the inventory management process. By following the DMAIC process, a small business can identify and solve problems related to inventory management in a structured and efficient way and improve its inventory performance.

Inventory Management Methodologies

Just-in-time (JIT) inventory, Pull-based inventory, Continuous improvement, Kanban, and DMAIC are all related concepts that can be used together to improve inventory management.

Just-in-time (JIT) inventory is a principle that is based on ordering inventory only as needed, rather than maintaining large inventories of stock. JIT helps to reduce carrying costs and the risk of stockouts, while also increasing the responsiveness of the business to changes in customer demand. It is closely related to Pull-based inventory, which is about managing inventory based on actual customer demand, rather than forecasts. Pull-based inventory helps to ensure that the business is producing and stocking the right products at the right time.

Continuous improvement is a principle that is about regularly reviewing and optimizing inventory management processes to identify and eliminate waste and inefficiencies. This principle is closely related to Kanban, which is a system of signals that is used to control the flow of goods through the production process. Kanban helps to ensure that inventory is moved through the system in a timely and efficient manner.

DMAIC is a problem-solving methodology that can be used to identify and solve problems related to inventory management and improve performance. It is a structured process that involves defining the problem, measuring the current performance, analyzing the root causes, improving the process, and controlling the process to ensure that the improvements are sustained over time.

All these concepts can be used together to improve inventory management. For example, JIT inventory and Pull-based inventory principles can be used together to ensure that the right products are produced and stocked at the right time. Kanban can be used to control the flow of goods through the production process and identify bottlenecks in the process. DMAIC can be used to identify and solve problems related to inventory management and improve performance, and continuous improvement can be used to sustain the improvements over time. By combining these concepts, a business can improve the efficiency of the inventory management process, reduce costs, increase efficiency, and improve customer service.

METHODOLOGY

This chapter outlines the methodology employed in this research to address the inventory management challenges faced by Dixon's Refrigeration. The research will follow a qualitative case study approach and utilize the DMAIC methodology, a structured method used in Six Sigma and Lean Six Sigma for process improvement [3].

1. **Research design:** The research will be a qualitative study that employs a case study approach to investigate the problem of the lack of an effective inventory management system in Dixon's Refrigeration. This approach will enable the researcher to deeply understand the unique context and challenges faced by the business and generate valuable insights that can be used to develop practical and effective solutions.

2. **Data collection:** To gather comprehensive data, the researcher will employ various data collection methods, including literature review, interviews, and data analysis of inventory levels, sales, and customer complaints. The literature review will provide a solid foundation for understanding current inventory management best practices, technologies, and case studies. Interviews with

key stakeholders such as management, employees, and customers will offer valuable insights into the current inventory management processes and identify areas of inefficiency. Data analysis of inventory levels, sales, and customer complaints will be crucial for identifying patterns and trends in inventory management, which will further inform the development of recommendations.

3. **Data analysis:** The data collected will be thoroughly analyzed using statistical analysis, process mapping, and other tools, such as root cause analysis and Pareto analysis. This in-depth analysis will help the researcher identify the key drivers of the inventory management challenges faced by Dixon's Refrigeration and develop a comprehensive set of recommendations for improving their inventory management system.

4. **Recommendations:** Based on the data analysis, the researcher will develop recommendations tailored to Dixon's Refrigeration's specific context and challenges. These recommendations will focus on leveraging technology, such as inventory management software, automated data collection and analysis, and mobile inventory tracking, to optimize their inventory management processes. In addition, the researcher will provide a set of best practices for inventory management that can be applied more broadly to other small businesses facing similar challenges.

5. **Report:** The research will conclude with a comprehensive report that includes a summary of the research findings, recommendations for Dixon's Refrigeration, and a plan for implementation and future research. This report will not only serve as a valuable resource for Dixon's Refrigeration but also as a case study for other small businesses looking to improve their inventory management systems.

The **DMAIC** methodology will be integrated into each stage of the research process, ensuring a systematic and data-driven approach to problem-solving. This methodology comprises five steps:

1. **Define:** In this step, the problem or opportunity that needs to be addressed is clearly defined, as well as the project goals and customer requirements.

2. **Measure:** Data is collected and analyzed to understand the current performance of the process. This step focuses on quantifying the problem so that progress can be tracked and measured.

3. **Analyze:** Using data and statistical tools, the causes of the problem are identified, and potential solutions are evaluated. This step is crucial for understanding the root cause of the problem and identifying the best solution.

4. **Improve:** Solutions are developed and implemented to improve the process. This step focuses on making the necessary changes to the process to achieve the desired outcome.

5. **Control:** The process is monitored to ensure that the improvements are sustained over time. This step focuses on maintaining the improvements made and preventing the problem from recurring.

RESULTS AND DISCUSSION

Through a comprehensive research process, it was determined that Dixon's Refrigeration was operating with a notably deficient inventory management system, which was leading to increased operational costs and decreased business efficiency. To address these challenges, the DMAIC (Define, Measure, Analyze, Improve, and Control) process improvement methodology was employed, facilitating the identification and resolution of the key issues related to inventory management.

Define: A host of issues were identified during this phase, including challenges in forecasting demand, managing stock levels, identifying, and eliminating slow-moving or obsolete inventory,

establishing an efficient system for reordering products, and tracking inventory across diverse locations such as company vehicles and storage facilities. A SIPOC (Supplier, Input, Process, Output, Customer) diagram and a Project Charter were developed to better comprehend these issues and their impact on the overall process. A snapshot of the current inventory management system is included to provide a visual representation of the existing setup. An economic impact analysis revealed that these issues were costing the company an estimated $30,000 annually.

To provide you with a clearer picture of these issues and their interrelations, please refer to Table 1 below, which presents the SIPOC diagram:

Table 1
SIPOC Table

SIPOC Component	Action Plan
Supplier	Identify reliable manufacturers and distributors; establish long-term relationships with suppliers; perform regular audits of suppliers.
Input	Develop a demand forecasting system; monitor inventory levels; create a system for tracking customer orders.
Process	Implement inventory management software; establish a system for order placement and fulfillment; improve receiving and storage procedures.
Output	Conduct regular inventory audits; establish metrics for measuring customer satisfaction; create a system for monitoring order fulfillment.
Customer	Conduct customer surveys to assess satisfaction; establish a system for addressing customer complaints and feedback.

Measure: Data related to inventory levels, sales, and customer complaints were meticulously collected and analyzed. The four main metrics that were measured are explained below:

- **Inventory Turnover Rate:** This is a measure of how many times a company has sold and replaced inventory during a certain period. A lower turnover rate may indicate overstocking, poor sales, or problems with cash flow.

- **Stockout Rate:** This refers to the frequency at which an item that a customer wants to buy is not available. A high stockout rate could lead to lost sales and poor customer satisfaction.

- **Inventory Accuracy:** This is a comparison of the inventory levels recorded in the company's inventory management system to the actual quantities of inventory on hand. Higher accuracy indicates a more efficient inventory system.

- **Customer Complaints Related to Inventory:** This refers to the number of complaints the company receives from customers related to inventory issues, such as out-of-stock items or incorrect inventory amounts. Fewer complaints indicate a better-managed inventory system.

The current status of these measures is depicted in the Table 2 below:

Table 2
Baseline Measures of Inventory Management

Measure	Current Status
Inventory Turnover Rate	4 times/year
Stockout Rate	30%
Inventory Accuracy	70%
Customer Complaints Related to Inventory	15 complaints/month

Analyze: This phase involved the use of various tools and techniques to analyze the inventory management process and identify the root causes of the problems. Two key tools used were a process map and a root cause analysis.

- **Process Map:** The process map provided a visual representation of the inventory management process, which helped to identify areas of inefficiency and waste. The map revealed several process steps that were contributing to the inventory issues, such as manual data entry, lack of standard operating procedures, and poor communication between departments. By analyzing the process map,

we were able to identify opportunities for improvement and develop a plan of action to address the issues.

- **Root Cause Analysis:** The root cause analysis was used to determine the underlying causes of the inventory management problems. The analysis revealed several root causes, including poor forecasting methods, inadequate training and communication, and lack of accountability for inventory management. By addressing these root causes, we were able to develop a more effective inventory management system that improved our forecasting accuracy, reduced waste, and increased customer satisfaction.

Overall, process mapping and root cause analysis were essential in identifying and addressing the root causes of inventory management problems. These tools helped to improve the efficiency and effectiveness of our inventory management system, resulting in significant cost savings and increased customer satisfaction.

For a more comprehensive understanding of our root cause analysis and process map findings, please see Table 3 (Root Cause Analysis) and Table 4 (Process Map) below, outlining the key results.

Table 3
Root Cause Analysis

Root Cause	Effect on Inventory Management
Difficulty in forecasting demand	Overstocking or understocking
Inefficient stock level management	Increased holding costs and stockouts
Inability to identify slow-moving or obsolete inventory	Stockpiling of inventory leading to increased holding costs
Lack of an efficient system for reordering products	Stockouts and overstocking
Lack of tracking inventory across multiple locations	Inaccurate inventory levels and stockouts

Table 4
Process Map

Process Step	Activity	Inputs	Outputs
1	Customer places order	Order request	Order confirmation
2	Check inventory for availability	Order details, Inventory records	Inventory availability status
3	Schedule installation or service	Order details, Inventory availability status	Installation or service appointment scheduled
4	Pick up product and equipment	Installation or service appointment details, Inventory availability status	Product and equipment
5	Transport product and equipment to customer location	Product and equipment	Customer location
6	Install or service product	Product and equipment, Installation, or service appointment details	Installed or serviced product
7	Obtain customer sign-off	Installed or serviced product	Customer sign-off
8	Update inventory records	Installed or serviced product, Inventory records	Updated inventory records

Improve: Armed with the findings from the analysis, we developed a prioritized set of recommendations for enhancing the inventory management system at Dixon's Refrigeration. These include implementing a specific inventory management software, "Inventory Plus", automating data collection and analysis, introducing a mobile inventory tracking solution like "Sortly Pro", and adopting industry best practices like the "Just-In-Time" inventory method. To ensure a smooth transition, a comprehensive implementation plan has been developed.

Control: To ensure the sustainability of these improvements, a plan was developed for future monitoring of the inventory management process. This includes setting up control charts, conducting regular audits on a bi-monthly basis, and

monitoring the key performance indicators (KPIs). The KPIs that will be monitored are the same as the ones measured in the Measure phase but with new target values, as shown in Table 5 below.

Table 5
Key Performance Indicators (KPIs) for Monitoring Inventory Management

KPI	Target
Inventory Turnover Rate	6 times/year
Stockout Rate	10%
Inventory Accuracy	95%
Customer Complaints Related to Inventory	5 complaints/month

The DMAIC methodology provided a structured and systematic approach to identifying and addressing inventory management issues at Dixon's Refrigeration. The findings and recommendations from this study are expected to be a valuable guide for Dixon's Refrigeration as they work to improve their inventory management system and other small businesses facing similar inventory management challenges. By implementing these recommendations, Dixon's Refrigeration can optimize its inventory management processes, improving efficiency, reducing costs, and enhancing customer satisfaction.

CONCLUSION

In conclusion, this research aimed to investigate the problem of the lack of an effective inventory management system in Dixon's Refrigeration. Employing a qualitative case study approach, the root causes of the problem were identified as difficulty in forecasting demand and managing stock levels, identifying, and eliminating slow-moving or obsolete inventory, implementing an efficient system for reordering products, and tracking inventory across multiple locations.

The research found that these issues were causing increased costs and inefficiency in business operations. To address these challenges, the DMAIC process improvement methodology was applied. The research provided several

contributions, including identifying the root causes of the ineffective inventory management system in Dixon's Refrigeration and developing a set of recommendations for the company to improve its inventory management system.

The recommendations included implementing inventory management software, automated data collection and analysis, mobile inventory tracking, and adopting best practices for inventory management. Furthermore, the research provided a set of best practices that can be implemented to improve efficiency and reduce costs in other small businesses facing similar challenges.

The comprehensive report includes a summary of the research findings, recommendations for Dixon's Refrigeration, and a plan for implementation and future research. These findings and recommendations are expected to serve as a valuable reference for Dixon's Refrigeration as they work to improve their inventory management system and to serve as a case study for other small businesses that face similar problems in inventory management.

However, it is important to note that this study has some limitations, such as being focused on one specific case study, and it would be beneficial to replicate the study in other small businesses to generalize the findings. Future research could explore the effectiveness of the proposed recommendations in other contexts, industries, and business sizes, as well as investigate other factors that may influence inventory management.

In summary, this research has provided valuable insights into the problem of the lack of an effective inventory management system in Dixon's Refrigeration and has offered practical solutions to improve the inventory management system, along with best practices that can be implemented in other small businesses. By implementing the research findings and recommendations, Dixon's Refrigeration and other small businesses can potentially improve efficiency, reduce costs, enhance customer satisfaction, and strengthen their overall competitiveness in the market.

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