COMPARATIVE STUDY OF DIFFERENT MANUFACTURERS WITH RESPECT TO THEIR SUPPLY CHAIN MANAGEMENT

A Thesis

by

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ABSTRACT

Comparative Study of Different Manufacturers with Respect to Their Supply Chain Management

May 2021

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Supply Chain Management is the networking and supervision of business practices across the various organizational structures that form the supply chain. It is presumed that different manufacturing industries have individualized ways of measuring their supply chain key performance indicators, and these KPIs differ based on the types of industries, the product and services they offer, supply chain structure and supply chain challenges. The areas of interest in data collection are how their key performance indicators are evaluated, their supply chain operation processes, strategies and how the key variables influence the supply chain performance. By comparative analysis, the results indicated similarities between the supply chain management processes, strategies and KPIs evaluation method between the furniture manufacturing industry and automotive engine industry. Employing various tables, charts, and ordinary least square regression model, with the aid of IBM Statistical Package for Social Sciences (SPSS), this research shows that the two key variables, Lead time and Inventory level affect the supply chain system's performance.

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CHAPTER I. INTRODUCTION

Background of the Study

Supply Chain is the distribution of products and services from raw materials sourced from local and international suppliers to finished products for the end users. The chain is formed between three entities, which are the Suppliers, Manufacturers, and Customers. The supply chain department is a key department in the manufacturing industries because it involves networking with other departments like manufacturing, quality, transportation, logistics and warehousing, the supply chain is dependent on other departments in the manufacturing industry because they work hand in hand to function properly. It is presumed that different manufacturing industries have their various way of measuring their supply chain key performance indicators, and these KPIs differ based on the types of industries, the product and services they offer, supply chain structure and supply chain challenges. Lead time and Inventory level are examples of key variables that affect the supply chain system performance and would therefore be evaluated in this research. In this research, a survey was used to compare the supply chain management processes of the furniture and automotive engine manufacturing industry, evaluate how both industries measure their supply chain performance using KPIs and identify key variables affecting their supply chain. The information gathered in the survey was used to determine the supply chain key performance indicators, and the key variable affecting the overall performance. The results of this study was used to identify supply chain management KPIs and key variables involved in the overall supply chain process of both manufacturing industry.

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Statement of the Problem

It is understood that the supply chain is one of the vital departments of a manufacturing industry. The supply chain helps in the area of purchasing, logistics, demand planning and forecasting. Many Industries are unclear about what processes to be considered when trying to maintain a supply chain system. Manufacturing industries find it difficult to measure their system's performance and this issue results to a lot of supply chain distress, not having a strategic system would affect the supply chain system, many companies are faced with not using the right technologies for supply chain practices and the overall process would be affected. They start up with strategies that cannot be sustained over the long run. This study explained the effect of the supply chain management in various types of manufacturing industry taking furniture and automotive engine manufacturing industry as the case study. This thesis focused more on how different types of manufacturing industries perform their daily supply chain processes and how they evaluate their key performance indicators taking into consideration key variables that affect the supply chain.

Purpose of the Study

The purpose of this study compared supply chain processes of the furniture and automotive engine manufacturing industry and evaluated how KPIs are measured in both industries. The specific objectives are:

- To compare the supply chain management processes of both industries;
- To evaluate and compare how KPIs are measured in both industries;
- To determine the key variable in supply chain that affects both industries; and assessing and evaluating the KPIs and key variables would help identify the problems facing the supply chain system performance.

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Significance of the Study

This study would be beneficial to individual workers and organization because it would create more awareness of how to maintain a healthy supply chain system and how to identify key variables that affect the system. Manufacturing industries that are yet to realize the use of KPIs to measure their supply chain performance would be able to identify the importance of measuring the system's supply chain performance and identify negative impact of not implementing this process in the day to day activities of the manufacturing process.

Justification of Study

The furniture and automotive engine manufacturing were chosen for analysis in this study because these two industries are making waves in the manufacturing industries according to 2019 United States manufacturing facts; the furniture, and automotive engine manufacturing company made the top 10 United States manufacturing sectors, in millions of dollars in 2017. It is thus safe to conclude that the automotive engine and furniture manufacturing would serve as a good basis for analysis. It is necessary to compare the supply chain management system of both manufacturing industries, how they evaluate their system's performance and key variables affecting their supply chain system and make recommendations.

Research Questions

The essence of this study will attempt to respond to the following primary questions. Research Questions will include:

1. Are there significant differences in the SCM operations of the two types of manufacturing industries?
2. Are there significant differences in the KPIs of a furniture manufacturing industry and an automotive engine manufacturing industry?

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3. Does Lead time have a significant impact on the SCM performance?

4. Does Inventory level influence have a significant impact on SCM performance?

Based on the above research questions the following hypothesis are formulated:

Ho_1: Lead time has no significant impact on SCM performance

Ho_2: Inventory level has no significant impact on SCM performance

Ha_1: There are significant differences in the supply chain management between the furniture manufacturing industry and automotive engine manufacturing industry.

Ha_2: There are significant differences in the KPIs evaluation of both industries.

Research Design

This study would be carried out using quantitative method for the data collection, analysis and interpretation to answer the research question. Excel was used to create visualization of data through survey issued to two hundred supply chain specialist at both manufacturing industries. Upon conduct of study, response data obtained from participants during the survey was collated, analyzed and interpreted to answer the research questions. Collections of data was conducted on participant's involvement using a survey that will be administered to supply chain specialist to acquire their response to how KPIs are measured in the various manufacturing industries. A scorecard was used to tabulate the data obtained from the survey and track important metrics. Excel was used to interpret acquired survey data. The integration of statistical tools such as charts, graphs, and tables was used to provide proper representation of interpreted data. One square regression analysis was used to analyze the two key variables that affect the overall supply chain performance.

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Assumptions and Limitations of Study

This study is subject to several limitations, this study was based on data from two manufacturing company in the United States. This research work limited on the data obtained from a closed ended questionnaire survey from two hundred supply chain specialist. The concern of this study was how key performance indicators are evaluated and how the two selected key variables affect the overall supply chain, the study is limited because of the use of an accessible sample areas which relatively reduces the generalization in every finding. This study pattern cannot accurately measure the impact and relationship between the studied key variable. It could be possible that other variables influence the supply chain. It is also possible that the participants gave an overstated response or an unclear response, which is regular with self -reported studies.

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Definition of Terms

Cash to Cash Cycle Time: This cycle time shows the duration between when a manufacturing industry pays for stocks purchase from suppliers, and the duration it receives cash from its customers for the purchase of a product.

Customer Order Cycle Time: This cycle time shows the duration from when a customer order is received and when the ordered product is delivered to the customers.

Freight Bill Accuracy: The Bill accuracy is important to customers' satisfaction and profitability, tracking the freight bill accuracy monitors trend and improves the overall shipping accuracy.

Inventory Turnover: This KPI metrics shows the number of times inventory is sold or used in a duration of a year.

Key Performance Indicator (KPIs): These are metrics defined by marking out a precise specification that are used in evaluating and explaining the supply chain performance.

Ontime Delivery (OTD): OTD is the most important metric in supply chain management because it shows an industry ability to meet customers demand as it relates to a specific delivery time requested by the customer.

Order Fill Rate: It is also called demand satisfaction rate; it shows the rate of an inventory ability to satisfy demand.

Supply Chain Cycle Time: It is the total time taken to fulfill a customer's order if all inventory level is at zero.

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ABBREVIATIONS

AHFA: American Home Furnishing Alliance

CRM: Customer Relationship Management

CSM: Customer Service Management

DM: Demand Management

IaaS: Infrastructure as a Service

KPIs: Key Performance Indicators

KPP: Key Performance Parameter

MEMA: Motor and Equipment Manufacturers Association

MTA: Make to Assemble

MTO: Make to Order

MTS: Make to Stock

NAICS: North American Industry Classification System

OEM: Original Equipment Manufacturer

OTD: On-time Delivery

PaaS: Platform as a Service

SaaS: Software as a Service

SCPM: Supply Chain Performance Management

SCM: Supply Chain Management

SME : Small and Medium Enterprise

TQM: Total Quality Management

USMCA: United States-Mexico-Canada Agreement

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CHAPTER II. LITERATURE REVIEW

Introduction

The objective of this chapter is to review related literature on manufacturing industries with respect to their supply chain management. This thesis focuses more on two different types of manufacturing industry, how they carry out their day to day supply chain activities and evaluate their key performance indicators taking into consideration key variables that affect the supply chain. Chapter two seeks to connect the thesis research questions, and the findings obtained from articles, books and journal articles. The aim of this chapter is to have an educated approach about the subjective discussion and examine its significance on treatise.

Definition of Supply Chain Management

(Croxton et al., 2001) defined SCM as the management of the business practices across the various business structures that form the supply chain. (Morash et al., 1996) also defined Supply Chain as the networking of business processes from the initial stage of sourcing raw materials from the local and international suppliers to the manufacturing of products and services until the manufactured product is received by the end users. The global supply chain forum in (Croxton et al., 2001) identified and described eight key business processes in a supply chain process that needs to be followed in order to operate and maintain a good supply chain system that would result in minimizing cost, improving cost and operational speed. These eight processes cut across major sections in the organization; market, finance, operation, quality, sales, purchasing, all activities involved lies within this department, but includes combined functioning of all other cross functional department to work together with the supply chain.

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Key Processes in Supply Chain

Each of these eight processes play a key role in the overall supply chain activities. Eight key processes are:

- **Customer Relationship Management**: The customers are the main target here; the management identifies ways of maintaining a good manufacturer to customer's relationship that can be maintained over the long run. The opinions of the customer must be taken into consideration. Customers would be categorized into the key segment according to identified criteria.
- **Customer Service Management**: This is the voice of the organization where customers can reach out directly to a representative of the company to get information of products and services they make, feasibility of products and shipping details. When the team has developed a good customer relationship management, the next step is to get a representative that would stand as the company's spokesperson.
- **Demand Management**: This process involves managing the customers need. It involves predicting demand using the past data trend, purchasing raw material, production and the distribution of products. The customers requirements need to tally with the demand management process, which must be with the firm ability to produce.
- **Order Fulfillment**: Order fulfillment involves the combination of the manufacturing, logistics, marketing plan, the main objective of an efficient supply chain is to satisfy customers need. Here, it show processes from when an order is received from the customer, to the processing and sorting stage down to the packaging and final delivery stage of the product.

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- **Manufacturing Flow Management**: It deals with knowing the right facilities that is required to fulfil the customer's needs, this includes knowing the company's capability, limitations, and compliance. It studies the supply chain cycle duration and lead time, tells whether a customer's order can be met immediately the order is received taking note of industrial and technical feasibility.
- **Procurement**: (Novak & Stephen, 1991) defined procurement as the process involved in purchasing of goods and services and all activities involved in the process. When sourcing for raw materials from local suppliers or international suppliers, the organization must have a very cordial relationship with their suppliers, this is defined as a good supplier relationship management. This relationship would ensure that all contract with the suppliers meets the needs of the business.
- **Product Development & Commercialization**: This process is beneficial to the company's growth and development in the long run. It deals with bringing in new products into the market and the customer and supplier need to be carried along during this process. The needs of the customer must be taken into consideration during a new product introduction, this means the customer relationship management team works hand in hand with the product development and commercialization team to provide a groundwork of how the new product would affect and be recognized by the customer.
- **Returns Management**: This involves the management of a return product which is caused by a production error or for other reasons. This process plays a key role in the supply chain process because it helps the company identifies where the product needs to be improved on to reduce frequent product returns. The order fulfillment team is involved in this process, returns needs to be treated immediately, so the product does not lose its worth.

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Supply Chain Hierarchy

This shows the ranking of the supply chain management organization. This helps in the allocation of duties at various levels with the organization. The hierarchical structure is divided into the three level; Top, Middle and Operational level.

1. **The Top Level**: This level involves personnel that makes decision for the longer duration and future plan of the organization. They are involved in making decisions pertaining to materials management; selection of suppliers, sourcing of raw materials, order management, inventory management and logistics. Most of the personnel that falls in the top level of the supply chain structures are managers and analysts.
2. **The Middle Level**: Personnel in this level make decisions relating to forecasting using historical data and future demand trends. The staff in this level are Planner; supply chain planners and demand planners. They deal with activities related to planning of production.
3. **Operational Level**: Activities in this level include the implementation of supply chain tactics at the shop floor level, these activities are carried out on a daily basis. Job profile in the operational level are executives of all department in the manufacturing company; production, materials planning, warehouse, logistics and transportation.

The supply chain hierarchy below (Figure 1) shows the flowchart of the processes that are within the top level, middle level and operational level of the supply chain hierarchy where allocations of duties of the various level in the system can be found.

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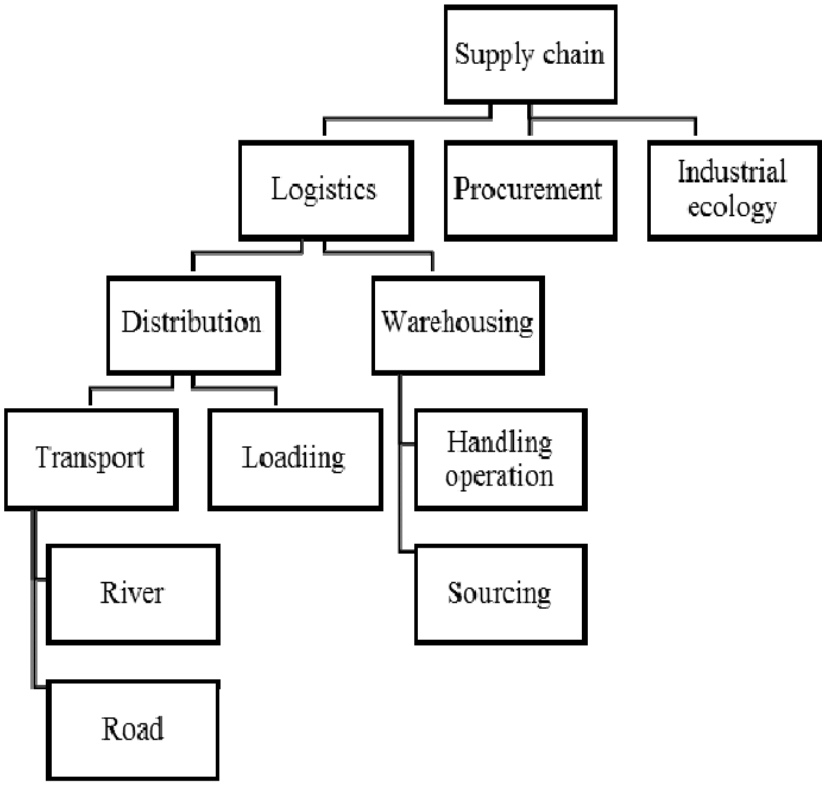

Figure 1. Supply Chain Hierarchy (Adapted from "Developing an optimization model for reducing the transportation costs of river vessels", by Adnan & Das, 2017).

Supply Chain Process Cycle

Supply chain process cycle shows the cyclic pattern of how the supply chain process is carried out. It consists of four series of cycles that are at interface between two stages of a supply chain. The four cycles are Procurement cycle, Manufacturing cycle, Replenishment cycle and Customer cycle. The highest size of order is found in the procurement cycle while the highest number of orders occur in the customer order cycle. Not all supply chain processes consist of four process cycle, some industries' pattern ends at the third cycle because they sell their products only to dealerships and distributors.

- **The Procurement cycle**: The stages in this cycle are between the suppliers and manufacturers. Activities within this cycle are for the purpose of sourcing for raw

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materials, purchasing of materials from local and international suppliers by the manufacturers.

- **Manufacturing cycle**: The manufacturers and the distributors are the stages in this cycle. This cycle involves the scheduling of production, the production process and shipping of manufactured products to the distributors who take over the process to the next cycle. The manufacturers ship the finished goods and services to the distributors who receive the process and move to the replenishment cycle.
- **Replenishment cycle**: The distributors and the retailers are at an interface in this cycle. This cycle involves the receiving orders from the retailers and order fulfillment. Most large manufacturing industries deal directly with the dealerships or distributors, and the replenishment cycle is the end of the supply chain process cycle for some manufacturing companies that do not deal directly with retailers.
- **Customer cycle**: This cycle involves the retailers and customers, activities in this cycle includes customer order entry, fulfillment of orders and the receiving of ordered products by customers. Retailers are the closest channel to the customers or end users, they replenish products.

Supply chain process cycle below (Figure 2) illustrates the process initiation from the procurement cycle through the customer order cycle. Stages between the four cycles and interface in the supply chain process involves the five supply chain participants.

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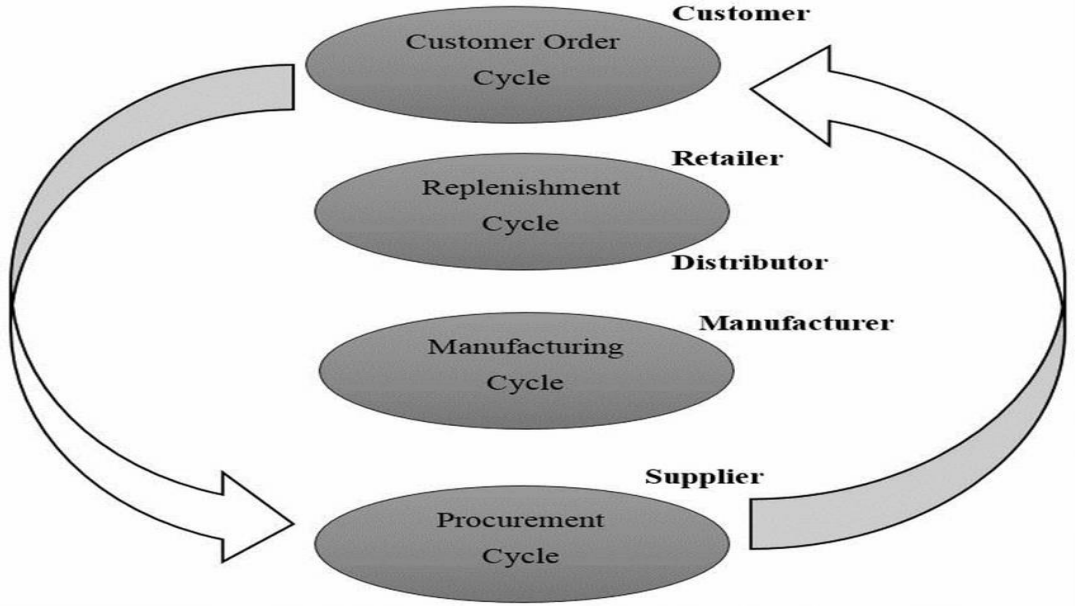

Figure 2. Supply Chain Process Cycle (Adapted from "Supply value creation in a supply chain", by Vijayan et al., 2016).

Supply Chain Strategy

This shows how the supply chain would operate to achieve the goals of the business and organization strategy. In (Porter, 1996), most business patterns are directed at bettering operation effectiveness and strategy. Porter differentiated between operational effectiveness and operational strategy; companies must have full understanding of which strategy suits them before choosing, which process to perform. He mentioned that the introduction of tools like TQM and benchmarking has replaced the position of strategy. Improving the productivity, speed and quality of a business involves choosing an uncommon strategy that is profitable to the business that are complicated to compete and imitate. Companies should work on improving their supply chain strategies into one that cannot be imitated by other companies, the contact company should be able to take on a new business operating methods and make a new demand driven plan by introducing new technology digital tools that can help the business make a proactive rather than a reactive decision in their supply chain. (Vijayan et al., 2016) mentioned the importance of strategic value creation in supply

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chain, organization making the right decisions relating to sourcing and purchasing of raw materials, production, logistics and transportation with the objective of reducing cost and affirming compliance. These tools would enable the supply chain planning team to make fast actions and look for a quick solution based on the insight drawn from the data, this would help the team match their expected demand. These tools can help lower inventory need and increase operation efficiency by building a dynamic and more accurate supply network.

One of the trending technologies is the introduction of cloud to supply chain, software as a service (SaaS) is one of the type of cloud software that is used in the supply chain line , this software is evolving rapidly and manufacturing industries are beginning to move their data and applications to cloud, and this has increased in forecasting ability and planning precision. Every supply chain should have a business goal, and this cannot be achieved without the support of other departments in the manufacturing system, the supply chain is dependent on other department in the manufacturing industry, departments like operations, finance, sales and quality. It is advisable for the supply chain of an organization to work with the cross functional teams, this would result to a significant operational efficiency and flexibility. By involving the functional team in the supply chain planning activities would help the team make tactical forecasting and budgeting from the planning stage to the execution stage.

Manufacturing Industries

Manufacturing industry is one that converts raw materials using parts and components to finished products. According to the US Bureau of labor statistics, the manufacturing sectors consists of various subsector where the furniture manufacturing companies fall under the furniture and other related products manufacturing subsector (NAICS 337), and the automotive engine manufacturing companies fall within the machinery manufacturing industries (NAICS 333) under

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engine, turbine, and power transmission equipment manufacturing (NAICS 3336). According to 2019, United States manufacturing facts, the manufacturing sectors account for 11.39% of the total output of the US economy and as 8.57% employment rate of workforce. The Covid-19 pandemic has affected a lot of manufacturing companies by putting a lot of stress on them, these companies are faced with struggling with customers demand while ensuring their workers are safe. This industry has the highest employer of labor of 85% of the United States. There are three types of manufacturing production.

- **Make to Stock (MTS)**: This type of manufacturing base their production on the past demand forecast trend, they make use of past data sales to forecast demand consumption, but has a major drawback because making predictions using past data might lead to a tilting inaccurate forecast.
- **Make to Order (MTO)**: This type operates with no inventory because products are manufactured based on request or order by the customer but this results to a longer lead time because the orders are customized by the customers, and this process results to a longer production wait time.
- **Make to Assemble (MTA)**: This type of production combines the Make to Stock and Make to Order manufacturing type, it involves the receiving of orders from the customer and manufacturing the product. This process is faster when the manufacturer has the parts and component needed for production. The drawback of the make to assemble type of manufacturing production is the manufacturer would be left with excess stock if the customer does not request for a product.

The manufacturing process flow chart below (Figure 3) begins from the conversions of raw material to the inhouse production process which might require an external production process

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with the addition of parts and component to the final assembly process until the finished product is ready for shipping.

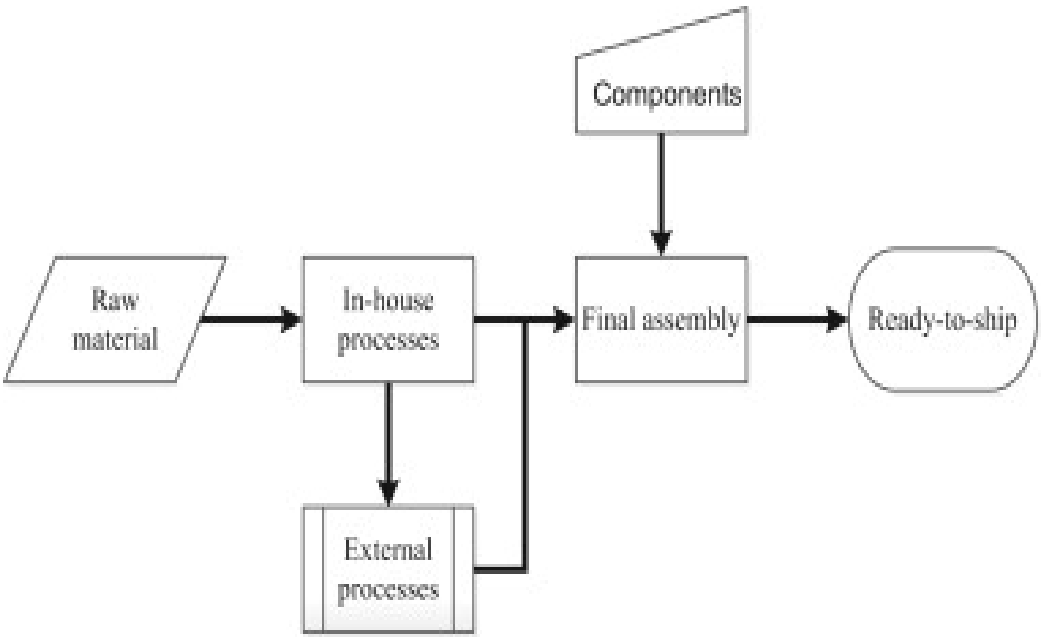

Figure 3. Manufacturing Process Flowchart (Adapted from "A hierarchical approach for evaluating energy trade-offs in supply chains", by Jain et al., 2013).

Supply Chain Management in Furniture Manufacturing Industries

The value chain of the furniture industry in the US offers impressive insights into the unique challenges being faced by various companies. While the US furniture industry is growing rapidly, the level of competition amongst big organizations and SMEs is widening. With the introduction of newer technology, one big avenue seems to have been opened for people to specialize in various aspects of the furniture industry's supply chain.

A cursory look at the set-up of the supply chain with the US furniture industry reveals persistent improvement based on four talking points;

1- Some organizations deal with furniture company through arm's length transactions

2- There are organizations with huge multinational reach, which buy furniture from suppliers and later upgrade the furniture to meet the specific taste of customers.

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3- There are also furniture manufacturing companies that import furniture from foreign countries

4- The latter are the companies with subsidiaries outside the US.

US companies that understand the dynamics of supply chain management try their best to differentiate themselves from the existing markets. Through a combination of strategies, suppliers and technology, companies involved can flourish, even during the seasonal low sales.

However, there seems to be a tough time for US furniture brands as customers develop new attitudes towards the delivery of furniture, sourcing and other supply chain decisions. The creativity and resourcefulness of the major players in the US furniture supply chain process have decreased, with many coming together to form a furniture delivery logistics company to tackle the problems of furniture supply chain in the US. With the emergence of e-commerce, consumers now expect faster delivery as David Purvis, VP of AHFA said; the furniture industry has been amazoned to death.

The economic recession also had its impact on the US furniture industry, resulting in the need for supply chain to accommodate the volatility. US furniture supply chain managers continue to improvise on their specialties. The speed cycle times of long-haul carriers are becoming faster as they implement strategies like two-driver teams and second shift unloading, to ensure an increased shipment. Some other furniture supply chain have simply moved to less-than truckload (LTL) carriers that are faster and relatively less expensive to maintain. Ray Kuntz, CEO of Watkins & Shepard Trucking affirmed, the furniture supply chain has become sophisticated over the past years, with delivery logistics companies making use of bar codes to track and identify the handler of every furniture.

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Figure 4 illustrates the supply chain flowchart processes in a furniture industry which shows the various step by step processes from when the raw materials is sourced , processed into finished products and delivered to the final end users.

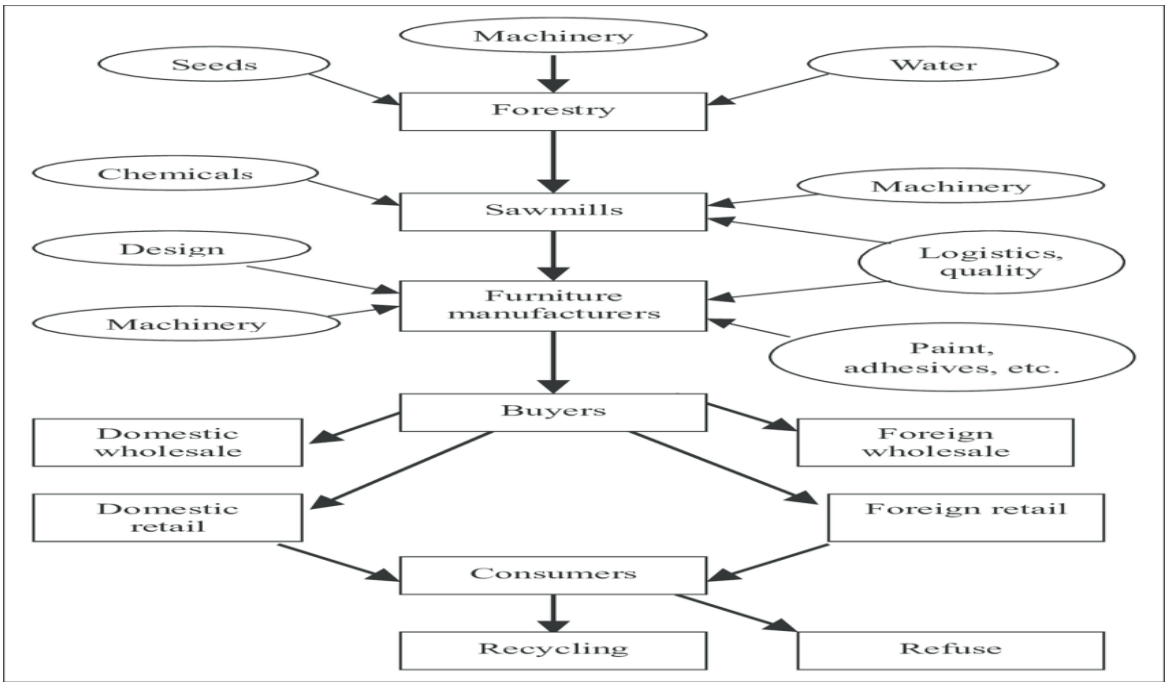

Figure 4. Supply chain in Furniture manufacturing industry **(**Adapted from "The delivery dilemma: A unique challenge for the furniture Industry", by Blue Acorn iCi ,2018).

Supply Chain Management in Automotive Engine Manufacturing Industries

The complexity of automobile engines has necessitated a rapid improvement of the supply chain in the US automotive engine industry. Bearing in mind that an average automobile engine is comprised of more than a hundred different parts, with many of the automobile engine part suppliers maintaining complex supply chain networks to assess raw material as well as ensure their products get to the final consumers. In the past, a significant number of automobile engine manufacturers in the US have experienced production stoppages due to lack of adequate supplies. To mitigate against such factors, several automobile engines companies have resorted to just-in-time manufacturing to discourage wastage and unnecessary stocking up.

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With automobile becoming more intricate, the automotive supply chain in the US has become quite innovative, with suppliers keeping up with the increasing technology of automobiles. Car manufacturers like Ford deal with more than a thousand suppliers, hence the solution for continued relevance in the automobile supply chain business is to innovate or establish partnerships with technological companies.

Also, the collaborative efforts of automotive engine manufacturers and OEMs or tier 1 engine parts suppliers have led to improved product/service delivery for automobile users. Rather than wait endlessly for automobile engine parts from automakers, car owners have shifted their focus to these OEMs, with the foreknowledge that such company will always deliver quality engine parts that are on par with what is obtainable from the original automakers.

Another import of this collaborative effort is that consumers also have access to high-quality engine parts at relatively cheaper prices. Before this millennium, GM, Ford and Chrysler, accounting for up to 90% of automobiles in the USA produced most of their replacement parts in-house. However, this has changed drastically, with up to 70% of replacement parts now handled by independent engine parts producers, thus acting as effective supply chain intermediaries between automakers and automobile consumers.

With these, one can conclude that automotive engine supply chain businesses in the US have become beneficial to automakers and car owners. This has led to increased efficiency in the distribution of engine products as well as reduced cost of replacing engine parts. However, one inherent flaw is that lower-tier engine parts producers are not finding it easy to keep up with the equipment and workforce to effectively compete with the tier 1 engine producers as the two tiers operates with suspicion, rather than collaboration. However, one chooses to look at it, (Lauren, 2019) the future of automobile engine parts rests on the effectiveness of the automobile supply

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chain businesses, with USMCA predicting a big investment boost for the automobile industry over the next five years.

In Figure 5, the supply chain flow distribution of a vehicle part model shows the process flow chart of vehicle parts distribution from local and international raw materials or components supplier stage through the final end user stage which involves other process flow activities within this stages.

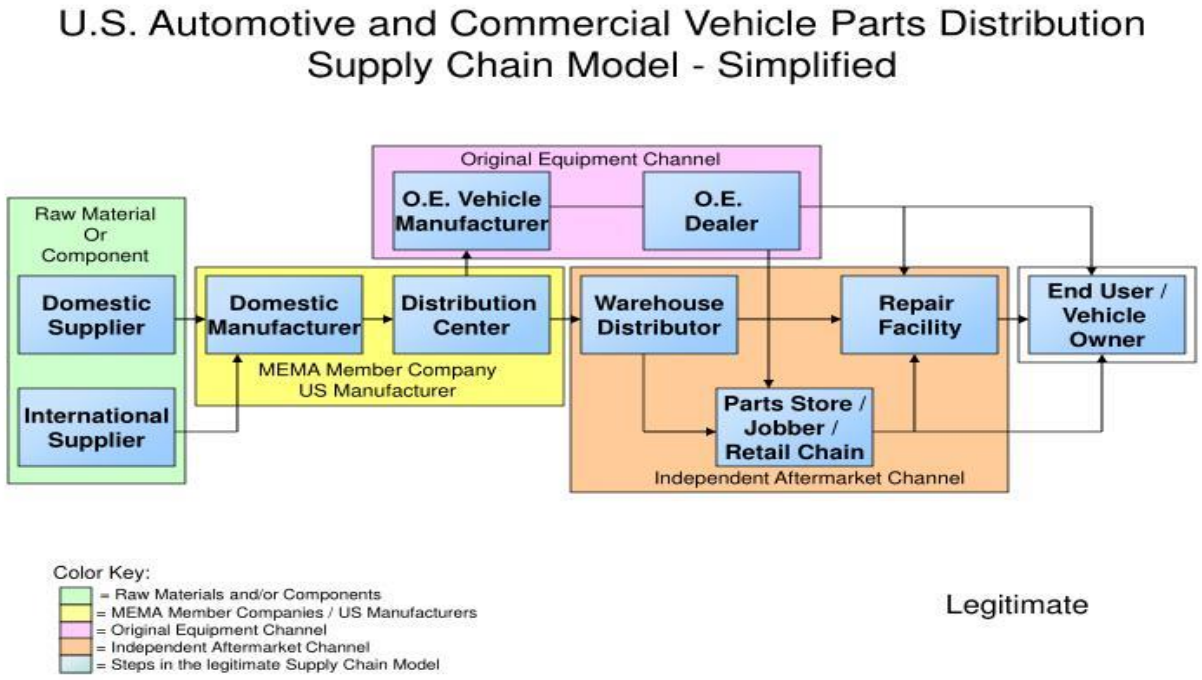

Figure 5. Counterfeit and Gray Market Flow Chart (Adapted from "The US motor vehicle industry", by Billa & Brent, 2010).

Supply Chain Key Performance Indicator

Supply chain key performance indicators help measure the financial health of the organization. They give unveil helpful acumen about the supply chain operations and enables the organization to make smarter decisions faster. According to (Hald & Mouritsen, 2018), the evaluation of the SCM performance is important in the operations of the overall SCM process

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because it helps to achieve an efficient and effective supply chain management system. There is a total of seventeen KPIs used to determine the company's supply chain performance, they help to identify the supply chain process, measure performance and carry our root case analysis on how the process can be improved. The supply chain is affected by multiple KPIs because these KPIs influence and evaluate the performance of the process. Specifically, "supply chain cycle time", "customers order cycle time", "freight bill accuracy", "cash to cash cycle time", "inventory days' supply" and "ontime delivery" are all found to be important key performance indicators influencing the supply chain performance.

Importance of Key Performance Indicators in Supply Chain

- It tracks the performance of the supply chain process.
- It pinpoints area where the supply chain needs to improve on.
- It identifies area of the supply chain process is not performing up to expectation and how they can be improved.

Hierarchy of Key Performance Indicators

The KPIs hierarchy is illustrated by a pyramid that is divided into three segments called Tiers. The three tiers are also known as the Main KPIs, Basic KPIs and the Key performance parameter, each tier consist of different KPIs embedded in it. Apex tier is called Assess also known as the main KPIs tier, this segment gives the top decision makers assess to evaluate the general state of the supply chain. The second tier is called Diagnosis also known as the basic KPIs tier, this segment shows the supply chain performance of the system and how the performance can be measured, the basic KPIs put the organization cash flow into more consideration. The bottom tier is called Correct also known as the Key Performance Parameter, it consists of two rows of KPIs

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that are involved in correction, it helps to pinpoint and implement issues related to the Assess and Diagnosis tiers.

The hierarchy of key performance indicator below (Figure 6) shows the three key performance indicators tier levels , provide basic informations on the system operations and how the systems performance can be evaluated and maintained.

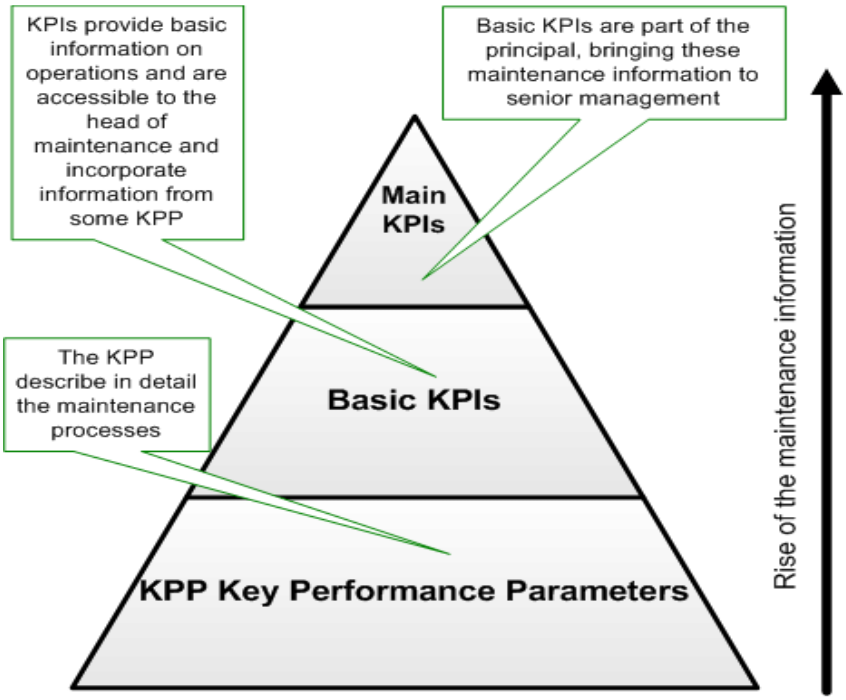

Figure 6. Hierarchy of Key Performance Indicators (Adapted from "Maintenance metrics: A hierarchical model of balanced scorecard", by Galar et al., 2011).

Key Variables affecting the Supply Chain

For this study, two key variables would be analyzed, they are Lead time and Inventory level. These variables would be studied on how they affect the supply chain performance.

- **Lead time**: This is defined as the number of days between when an order is placed and when it is available for use. It tells us when to place orders for new sets of products, this process is known as Inventory Replenishment. The lead time variable is independent

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on the system's supply chain performance; the lead time is a key variable in supply chain management because it gives a clear guideline in ordering materials and replacing stocks.

- **Inventory level**: Inventory is a relevant focus in supply chain; they are raw materials or finished product kept in a place in the organization mostly called the warehouse that is meant for raw materials or resale of finished products. An inventory keeping, monitoring, and tracking of stock goods of inventory from manufacturers to the warehouse, and from the warehouse to the final point of sale to dealers/wholesalers or directly to our end users. The inventory management holds a crucial role in the supply chain because it involves a good cordial relationship between customers and vendors. Having a collaborative relationship would have a great impact on the supply chain because most of the relationship in supply chain evolves from activity that are involved in managing relationship based on sourcing, purchasing and transportation of inventory.
- **Effect of Lead time on SCM performance**: The lead time has a influence on the supply chain because it affects safety stock and the customers opinion about the organization's customer capability. The longer the lead time, the more unpredictable delivery, and this results to shortage of actual stocks needed. It is important to have a shorter lead time because longer lead time leads to excess inventory hold which would also affect demand alongside other departments like sourcing, logistics and warehousing.
- **Effect of Inventory level on SCM performance**: Inventory is a key variable in SCM because it affects every department in the industry. Ranging from warehousing, operations, manufacturing and logistics. The inventory level is a major determining factor, low inventory affects safety stock allocation, excess inventory level leads to stock sitting in the

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inventory and loss of revenue. It is more appropriate and advisable to have the right amount of inventory and a proper forecasting system would help achieve that.

Other common variables that can affect the performance of a supply chain system are:

- **Delivery Performance**: This variable is defined as the rate at which goods and services manufactured by an organization satisfy the customer expectation. (Handfield & Pannesi, 1992) defined delivery performance as a variable in supply chain because it shows the current ability of a company to deliver goods and services on time by using available resources at no additional cost. (Peng & Lu , 2017) highlighted the two significant measure of delivery performance; delivery reliability and delivery speed. Delivery reliability is the ability of a manufacturing industry to deliver products on or before a specified date while delivery speed is the amount of days a supplier takes to fulfill products ordered by a customer and this is usually evaluated by the average fulfillment lead time. This variable is measured by KPIs, ontime delivery from suppliers, getting the right quantity ordered from the supplier can help improve the delivery performance, planning a production schedule would help production be on track, a proper inventory management and keeping track of logistics will help to confirm the numbers of time the logistics were right.
- **Customers Satisfaction**: This variable is the connection between the customer and the manufacturer. Whether customer that source directly from the manufacturer or customers that orders products from retailers, companies can find a way to improve their customers satisfaction by delivering ordered products on or before the promised date and time. The supply chain should have a good track of the record of their inventory to avoid stock outage when delivery is expected to be made .

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Supply Chain Challenges and Opportunities

Supply chain systems are multifaceted, with several stakeholders and operators. With the continued improvement in technology, the supply chain is becoming more efficient by the day. However, it should be noted that investing in the wrong technology may hinder productivity and profitability.

One major challenge of supply chain systems is how to properly identify and eliminate the excess and obsolescent inventories. The reason for this problem stems from the fact that an accurate forecast cannot be made about the product that consumers will demand. Using the rule of thumb to determine the inventory to stock often leads to overstocking of items that may on the long run become obsolete. An effective supply chain system can only be achievable through accurate demand forecast by predicting and ensuring that the downstream supply chain systems run smoother. Overcoming the downstream effects because of delays caused by one or more suppliers remains a problem as it leads to the unnecessary cost incurred. Accounting for unforeseeable delays along the supply chain remains a challenging task for several manufacturing businesses.

Also, we should understand that manufacturing supply chain involves many moving parts with each having unique challenges; solutions to these challenges need to be interoperable to give a room for optimization that will ensure effective supply chain performance. Some manufacturer finds it tasking to align supply capacity to consumers' demands while meeting corporate objectives. The lack of proper integrated business planning gives room for potential pitfalls and failure.

Many manufacturing businesses focus too much on single-source supply chain on the backdrop of maintaining prolonged partnerships. However, this may not be too good as the

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manufacturing companies may face serious problems if the suppliers face shortages due to production interruptions. The complexities of supply chain systems have made single-sourcing riskier and may lead to a loss of sales when there is a disruption in supply. Hence, manufacturing companies need to shift focus to risk strategies that will minimize supply chain challenges. Lastly, the COVID-19 pandemic has also brought unprecedented supply chain challenges. Supply chain systems' strategies that are cost-driven have led to widespread disruptions, with the lack of digitalization leading to information being hidden in silos.

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CHAPTER III. METHODOLOGY

Introduction

The objective of this paper was to compare the supply chain process carried out in a furniture manufacturing industry and automotive engine industry. Chapter three provided the approach in methodology in terms of sampling procedures, data collection methods, and analytical approaches to data. The similiarities and differences in supply chain methods of the two manufacturing industries and survey data would help to evaluate the differences in their KPIs performance. Data were collected through a survey from supply chain specialists at the furniture and automotive engine manufacturing industry. The areas of interest in data collection are the key variables affecting the supply chain; inventory control and lead time. Both descriptive and inferential data analysis methods were used to analyze and interpret the data. IBM SPSS statistics processor was used to carry out ordinary least square regression analysis. Statistical tools such as tables, graphs, and charts was used to present the data. The analyzed data determined the result and recommendations were made.

Research Questions

1. Are there significant differences in the SCM of the two types of manufacturing industries?
2. Are there a significant differences in the KPIs of a furniture manufacturing industry and automotive engine manufacturing industry?
3. Does Lead time have a significant impact on supply chain performance.
4. Does Inventory level have a significant impact on supply chain performance.

Based on the research questions the following hypothesis are formulated:

Ho_1: Lead time has no significant impact on supply chain performance.

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Ho_2: Inventory level has no significant impact on supply chain performance.

Ha_1: There are significant differences in the supply chain management between the furniture manufacturing industry and automotive engine manufacturing industry.

Ha_2: There are significant differences in the KPIs evaluation in both industries.

Research Design

Survey research design was used in this study. Primary data was utilized in this study, which was collected using a close-ended questionnaire with questions consisting of five parts; Part A to Part E. The data collected was used for the data analysis and hypothesis testing.

Target Populations

The targeted population for this study consists of part time and full time supply chain specialists from different departments within the supply chain with over three months work experience in their respective area of specialization. These employees were chosen because they are supply chain specialists, and their area of specialization was in line with the purpose of this study, this helped to evaluate their understanding about supply chain management activities in their various industries so as to look into how supply chain KPIs are measured for both types of manufacturing industries and how key variables influence their supply chain system performance.

Sampling Techniques

In this study, sample selection was carried out in two manufacturing industries: the type of the manufacturing industries and the choice of participants from the both manufacturing industry. Thus with the use of a simple random sampling techniques, furniture manufacturing and automotive engine manufacturing industry were selected and one hundred (100) respondents were selected from automotive engine manufacturing industry and one hundred (100) respondents were selected from furniture manufacturing industry making a total of two hundred (200) participants.

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Table 1 shows the sample size distribution of the furniture manufacturing industry and automotive engine manufacturing industry.

Table 1. Sample size distribution of the Manufacturing Industries

	Type of Manufacturing Industry	**Sample Size**
1	Automotive Engine Manufacturing	100
2	Furniture Manufacturing	100
	Total	**200**

Methods of Data Collection

Survey method was used for the method of data collection for this study, a closed-ended questionnaire comprising of four sections that contained questions from Part A to E was used to obtain data from the participants. A total of two hundred (200) questionnaires was distributed to the participants who are supply chain specialist in both manufacturing industries. The questionnaire has five (5) parts labelled A to E: demographic data, supply chain operation self - assessment, strategies in supply chain management ,questions relating to areas in the manufacturing industry where KPIs are evaluated , which of the KPIs are utilized and how the selected two key variables affect each other and the supply chain process.

- The demographic data includes the job title, age, gender, type of employment, length of employments, department in supply chain and number of working hours per day and per week.
- Part A: The supply chain operation self- assessment section consists of questions relating to the operations of the supply chain department. These questions are pertaining

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the day to day running of the supply chain, how the organizations supply chain department carry out their daily activities, technologies used, interactions with suppliers and customer. This section gave a basic understanding of the industries supply chain process cycle.

- Part B: This section consists of questions regarding the business strategy of the industry, this section played a vital role in the research because it gave answers to the research question of if there was a significant difference in the supply chain management of both industries. Questions relating to production, customer relationship management, continuous improvement and planning can be found in Part B of the questionnaire.
- Part C: The second section consists of a list of KPIs and options to choose from if these KPIs are used for evaluating the supply chain system of these manufacturing industries. Participants chose which of these KPIs are used for evaluating the system performance. This section gave answers to the research question of the significant difference between the two industries supply chain management and how their KPIs are evaluated.
- Part D: The third section of the questionnaire also expanded on what areas in the supply chain were these KPIs evaluated. Departments were listed in this sections and participants were given the right to add other department that was not listed in the table, they are required to choose where these KPIs are implemented in their various industries. This gave more understanding on what department used KPIs for evaluations.
- Part E: The last section was centered at the two selected key variable that affect the supply chain performance. Questions regarding the two selected variable; Inventory level and Lead time are listed in Part E. The participants were given the opportunity to choose if key the variables influence their system's performance and select the factors affecting this

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key variable. Part E gave answers to the research question of the impact of inventory level on supply chain performance and the impact of lead time on supply chain performance.

Method of Data Analysis

After collection, data has been transferred into the system for statistical analysis. Using Microsoft Excel, the data collected was analyzed using both descriptive and inferential statistical method. Frequency tables and charts was used in the analysis of the data collected for the descriptive statistics. The ordinary least square linear regression model (IBM SPSS Statistics Processor) was the inferential statistics used to determine if the key variable have an impact on the supply chain performance and if there is a significant difference in the supply chain strategies and KPIs evaluation of both manufacturing industries, which aided the hypotheses testing analysis results.

Ethical Consideration

The following ethical considerations was made in this study:

- Permission was taken from supply chain leaders of both manufacturing industries who chose to be anonymous to ensure company's privacy .
- No employee was compelled to participate in the survey, all participants were expected to volunteer for this study in their own free will.
- Confidentiality was maintained during the data collection process and all participants remained anonymous during the duration of the research and afterwards. Every participant was given a code to avoid any information that may disclose the participant's identity.
- Each participant was briefed of their right to take part in the survey, such as voluntary participation and the right to confidentiality. Informed consent was obtained from all participants.

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The aim of the survey was explained to all participants and they had the right to refuse the submission of the survey if they decided to change their mind.

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CHAPTER IV. RESULTS AND DISCUSSION

Introduction

This chapter four presents the analysis and interpretation of data collected through the copies of questionnaires distributed to supply chain specialist, employees of selected furniture manufacturing company and automotive engine manufacturing company within the United States, testing of the four research hypotheses formulated in chapter one. A total of two hundred (200) copies of questionnaire were distributed and all copies were returned completed. Using Microsoft Excel Software, the data collected were presented and analyzed using a frequency table, bar chart, and ordinary least square linear regression method (IBM SPSS Statistics Processor). The results obtained from the analyses formed the basis of hypotheses testing and thus, provides a framework for discussions and recommendations.

Data Presentation, Analysis and Discussion

Table 2 displays the distribution by job title of the two hundred respondents, 54% of the respondents in the furniture manufacturing industries are Supply Chain Specialist while 46% are other job titles within the supply chain department while 52% of the respondents in the automotive engine manufacturing industries are Supply Chain Specialist while 48% are other job titles within the supply chain department. This indicates that there are more Supply Chain Specialist working in the both manufacturing industries.

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Table 2. Distribution of Respondent by Job Title

Job Titles	Furniture Industry	Automotive Engine Industry
Supply Chain Planner	20	16
Demand Analyst	7	8
Supply Chain Specialist	54	52
Logistics Specialist	5	9
Inventory Manager	8	10
Procurement Officer	6	5

Source. Field survey, 2021.

Table 3 shows that most respondents (69%) are males, while females only account for 31% of the respondents. This suggests that there are 2 males for every 1 female working in both manufacturing industries.

Table 3. Distribution of Respondent by Gender

Gender	Manufacturing Industry		Valid Percent	Cumulative Percent
	Automotive Engine	Furniture		
Male	76	62	69.0	69.0
Female	24	38	31.0	100
Total	**100**	**100**	**100.0**	

Source. Field survey, 2021.

Table 4 shows the age distribution of the respondents in both manufacturing industries, 24.5% are between ages 21 – 30 years, 47.5% are between ages 31 – 40 years, 24% are between age 41 and 50 years, while the rest (4%) are between age 51 and 60 years. This indicates that most of the employees of both manufacturing industries are middle age adults within the ages 31 – 40 years.

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Table 4. Total Distribution of Respondent by Age

Age Range	Manufacturing Industry		Percent	
	Automotive Engine	Furniture	Valid	Cumulative
21 – 30yrs	24	25	24.5	24.5
31 – 40yrs	44	51	47.5	72.0
41 – 50yrs	27	21	24.0	96.0
51 – 60yrs	5	3	4.0	100.0
Total	**100**	**100**	**100.0**	

Source. Field survey, 2021.

Table 5 verifies that (100%) of respondents for both industries are full time workers, while (0%) of the respondents are part time. This shows that there are no part time workers for both manufacturing industries.

Table 5. Distribution of Respondent by Type of Employment.

Type of Employment	Manufacturing Industry		Valid Percent	Cumulative Percent
	Automotive Engine	Furniture		
Full Time	100	100	100.0	100.0
Part Time	0	0	0.0	100.0
Total	**100**	**100**	**100.0**	

Source. Field survey, 2021

Table 6 shows that 5% of the respondents have been working for 3 – 6 months at their respective industries , 15% for 7 - 12 months, 13% for more than 1yr and the remaining 67% have

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been working for more than 2 – 5yrs. This denotes that majority of the respondents (67%) have been working at their respective manufacturing industry for over 2 - 5yrs but not less than 1yr.

Table 6. Distribution of Respondent by Length of Employment

Length of Employment	Manufacturing Industries		Valid Percent	Cumulative Percent
	Furniture	Automotive Engine		
3 – 6months	7	3	5.0	5.0
7 – 12months	20	10	15.0	20.0
>1yr	12	14	13.0	33.0
2 – 5yrs	29	35	32.0	65.0
>5yrs	32	38	35.0	100.0
Total	**100**	**100**	**100.0**	

Source. Field survey, 2021

Table 7 shows that 96.5% of the respondents work between 1 and 5 days a week, while the rest 3.5% work for more than 5 days a week. This shows that most of the respondent in the manufacturing industries take up to two days off each week

Table 7. No of Workday per Week.

Workday per week	Manufacturing Industry		Valid Percent	Cumulative Percent
	Automotive Engine	Furniture		
1 – 5days	95	98	96.5	96.5
>5days	5	2	3.5	100.0
Total	**100**	**100**	**100.0**	

Source. Field survey, 2021.

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Table 8 shows that 0% of the respondents work less than 20hours a week, 96.5% work between 21 and 40 hours, while only 3.5% work for more than 40 hours a week. This shows that majority of the manufacturing industries workers work between 21 - 40 hours a week.

Table 8. Hours Worked per Week.

Working Hours per hours	Manufacturing Industry		Valid Percent	Cumulative Percent
	Automotive Engine	Furniture		
<=20hrs	0	0	0.0	0.0
21-40hrs	95	98	96.5	96.5
>40hrs	5	2	3.5	100.0
Total	**100**	**100**		

Source. Field survey, 2021.

Table 9 identifies the area of comparison of the two manufacturing industries, these areas give an overview of their supply chain operations. After comparing the SCM operations some similarities were identified like the use of the Material Resource Planning (MRP) software, their organizations using a mapped-out activities plan, maintaining a transactional business process that include suppliers and customers relationship and most importantly, evaluating their supply chain performance using KPIs in a six months' time horizon.

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Table 9. Supply Chain Operations in Furniture Industry and Automotive Engine Industry.

Area of Comparison	**Furniture Industry**	**Automotive Engine Industry**
Organization Operation Method	Cross functional business operations that include interaction with suppliers and customers	Organization carries out business processes to include suppliers and customers
Organization Activities Plan	Mapped out plan usage	Mapped out plan usage
Technology Use	Use of SAP ERP and MRP software	Use of Oracle ERP and MRP software
Customer's Relationship	Have a Transactional and On-going relationship with suppliers	Have a Transactional, collaborative and On-going relationship with customers and suppliers
Company Customer Focus	Customer focused organization	Customer focused organization
Supply Chain Performance Evaluation Method	Uses Key Performance Indicators (KPIs)	Uses Key Performance Indicator (KPIs)
Evaluation Time Range	6 months	6 months
Inventory Management	Actively manage inventory	Manage inventory to increase on – time delivery and maintain good safety stock.
Interactive Website Usage	Yes	Yes

Source. Field survey, 2021.

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Table 10 shows the strategies used in supply chain for both manufacturing industries; the results obtained from the respondents, both manufacturing industries are operating under the same supply chain strategies with similarities in their strategies operations.

Table 10. Strategies in Supply Chain Management.

Business Strategy in SCM	**Furniture Industry**		**Automotive Engine Industry**	
	Unimportant	**Important**	**Unimportant**	**Important**
Common introduction of benchmarking & performance metrics	5	95	3	97
Use of underlining procedure to receive customer's feedback, who are engaged in product development	2	98	6	94
Cross functional team meeting to discuss production information on regular basis	0	100	0	100
Use of leading technologies to increase efficiency of the supply chain process e.g. demand forecasting and supply planning	0	100	0	100
Application of "5s", "Just in Time" lean tools for continuous improvement & competitiveness	0	100	0	100

Source. Field survey, 2021.

Table 11 shows that the frequently used key performance indicators in both industries are Supply Chain Cycle time, On-Time Delivery, Freight Bill Accuracy, Customers Order Cycle and Inventory Days' Supply. Other KPIs were also implemented in evaluating the system's supply chain cycle but only few respondents recorded the usage of Cash to Cash cycle time and Return on Investments, this indicates that the two KPIs are not prominent in evaluating the performance of the system.

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Table 11. KPIs evaluated in Supply chain processes.

Key Performance Indicators	Furniture Industry			Automotive Engine Industry		
	Disagree	Agree	Agree Strongly	Disagree	Agree	Agree Strongly
Supply Chain Cycle Time	0	0	100	0	0	100
Cash to Cash Cycle Time	0	52	48	0	36	64
On – Time Delivery	0	0	100	0	0	100
Inventory Turnover	0	21	79	0	0	100
Freight Bill Accuracy	0	3	97	0	0	100
Customer Order Cycle	0	2	98	0	0	100
Fill Rate	0	17	83	0	4	96
Inventory Days' Supply	0	8	92	0	11	89
Gross Margin	13	82	5	3	16	81
Return on Investment	12	37	51	8	72	20

Source. Field Survey, 2021.

In Figure 7, "supply chain cycle time", "on-time delivery", "customers order cycle" key performance indicators reflect 100% usage in the furniture and automotive engine manufacturing industries. Other key performance indicators illustrated in Figure 7 are also utilized in both manufacturing industries to measure the supply chain systems performance.

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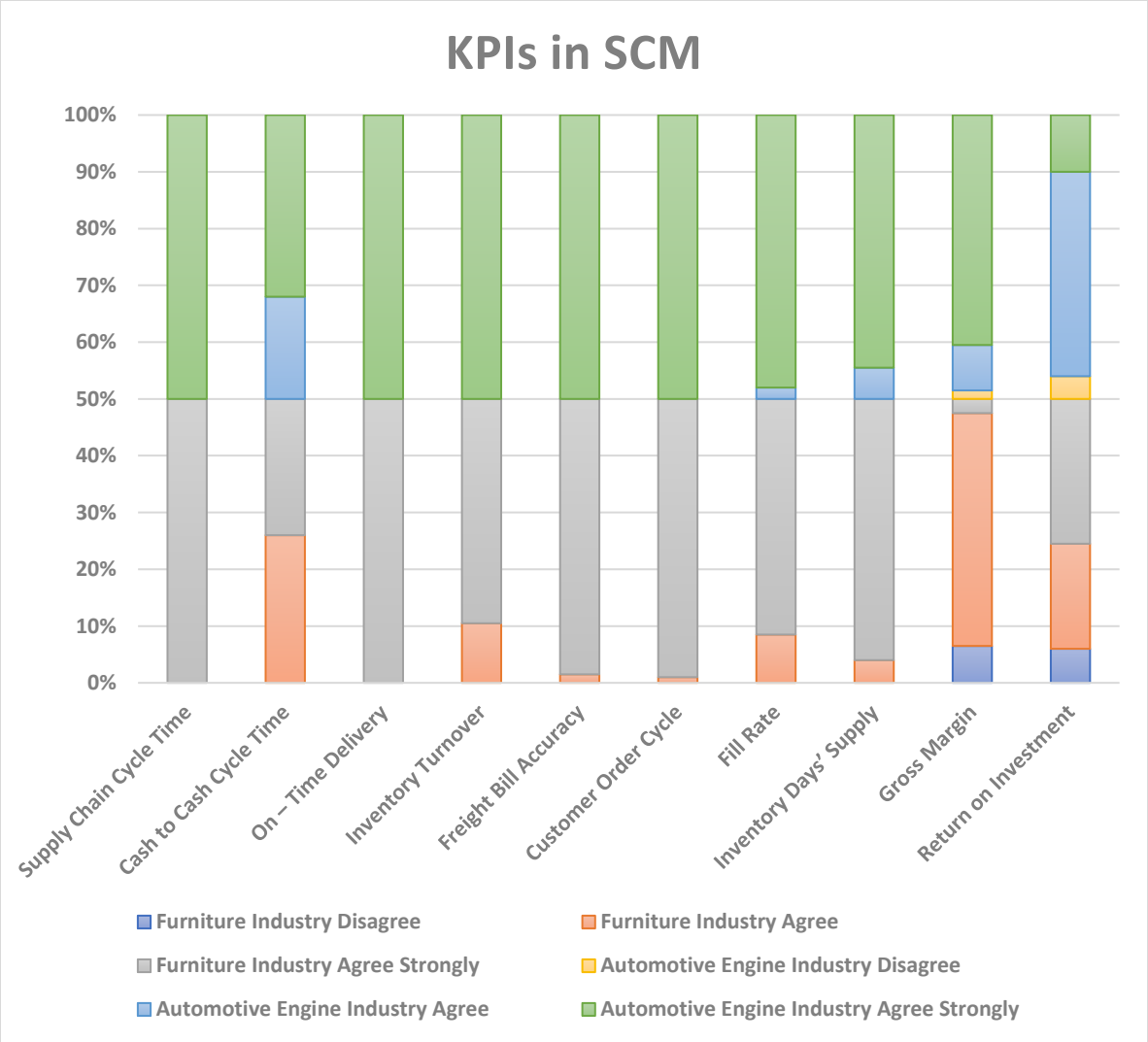

Figure 7. KPIs in SCM

Table 12 shows that the most common areas where KPIs are implemented in the department within the supply chain are inventory management (100%), suppliers management (100%), manufacturing /production (100%) and demand planning & forecasting (100%). Three areas like order management, purchasing management and warehousing also implement the usage of KPIs to evaluate their industry's supply chain performance. Only few respondents indicated the use of KPIs in transportation and logistics.

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Table 12. In what areas of your industry are KPIs implemented.

Areas of Comparison	**Furniture Industries**		**Automotive Engine Industries**	
	Yes	**No**	**Yes**	**No**
Order Management	93	7	100	0
Inventory Management	100	0	100	0
Purchasing Management	87	13	94	6
Supplier Management	100	0	100	0
Manufacturing / Production	100	0	100	0
Warehousing	74	26	68	32
Transportation / Logistics	45	55	31	69
Demand Planning & Forecasting	100	0	100	0

Source. Field Survey, 2021

In Figure 8, both manufacturing industries implement the use of key performance indicators to evaluate the SCM system performance in the various departments within the supply chain. Departments like demand planning & forecasting, manufacturing & production, inventory management and supply chain management indicated 100% usage of KPIs in their departments. Other departments like purchasing management, order management, warehousing and transportation & logistics also applied the use of KPIs to evaluate their system's performance.

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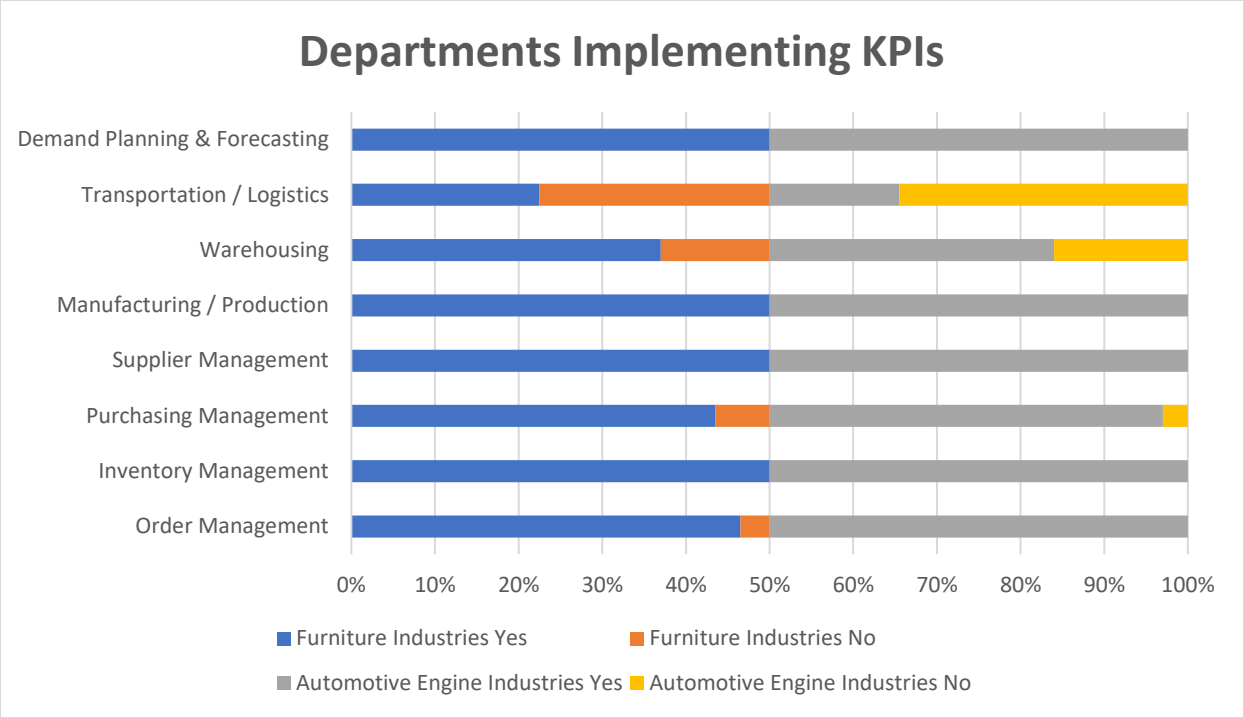

Figure 8. Departments implementing KPIs.

Effect of Key Variables on Supply Chain Performance

As shown in Table 13 which listed the various effect of key variables on the SCM performance. Lead time has a positive or negative influence on the supply chain system, effect on the customer's order, supplier's reordering time , inventory management , production schedule, impact on safety stock, order delivery time and extent of customer's satisfaction would influence the supply chain performance.

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Table 13. Effect of Lead time on Supply chain performance.

Effect of Lead time on Supply chain performance	Valid Percent	Cumulative Percent
Customer's Order	31.0	31.0
Supplier's Reordering Time	23.0	54.0
Inventory Management	18.5	72.5
Production Schedule	11.5	84.0
Impact on Safety Stocks	7.0	91.0
Order Delivery Time	5.5	96.5
Extent of Customer's Satisfaction	3.5	100

Source. Field Survey, 2021

In Table 14, the inventory level has an effect on the supply chain performance in the following areas namely forecast accuracy , excess inventory holds, supply chain decisions, product quality, revenue loss and inventory level shortage.

Table 14. Effect of Inventory level on Supply chain performance.

Effect of Inventory level on Supply chain performance	Valid Percent	Cumulative Percent
Forecast System Accuracy	29.0	29.0
Excess Inventory Holds	6.0	35.0
Supply Chain Decisions	23.0	58.0
Product Quality	6.0	64.0
Procurement Cost	13.5	77.5
Revenue Loss	5.0	82.5
Inventory Level Shortage	17.5	100

Source. Field Survey, 2021

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Key Variable Parameters

Table 15 shows the parameter of the lead time key variable, it clearly stated that the lead time (independent variable) is affected by some factors which are material supply, labor shortage, transportation factors and weather conditions.

Table 15. Lead Time Parameters.

Lead Time Parameters	Valid Percent	Cumulative Percent
Labor shortage	6.5	6.5
Materials supply	18.0	24.5
Weather conditions	32.5	57.0
Transportation factors	43.0	100.0

Source. Field Survey, 2021

Table 16 shows the independent variable (inventory level) is also affected by factors like planning frequency, supply network, forecast quality and production capacities. These factors lead the variables to have either a positive or negative effect on the system's supply chain performance.

Table 16. Inventory Level Parameters.

Inventory Level Parameter	Valid Percent	Cumulative Percent
Planning frequency	41.0	41.0
Supply network	19.0	60.0
Production capacities	5.5	65.5
Forecasting quality	34.5	100.0

Source. Field Survey, 2021

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Test of Hypotheses

In Chapter One, the hypotheses for the study, were examined using comparative analysis and ordinary least square regression model (IBM SPSS Statistical Processor).

Hypothesis I: Lead time has no significant impact on Supply Chain Performance.

To determine if the lead time affects the supply chain performance, it is essential to know the relationship between the two variables, lead time (independent variable) and supply chain performance (dependent variable). The independent variable is also affected by some parameters as shown in Table 15. In addition to tables, hypothesis II was tested using the ordinary least square regression model (IBM SPSS Processor). To determine the relationship between factors affecting the lead time and effect of lead time on the supply chain performance , parameters affecting lead time as shown in Table 13 is regressed on effect of the lead time on supply chain performance as shown in Table 15. The result in Table 17 shows a strong relationship between the lead time and supply chain performance with a correlation coefficient (R) OF 0.955. The R^2 of 0.912 with an adjusted R^2 OF 0.869 which means 91.2% variation in dependent variable (effect of lead time on supply chain performance) is explained by the independent variable (lead time parameters). The ANOVA results in Table 18 tries to test overall goodness of fit of fitted regression model, the F-test is statistically significant with a p-value of 0.045 which is less than 0.05, as there is less than a 5% probability that the null is correct. Therefore, the null hypothesis that lead time has no significant impact on the supply chain performance is rejected; thus alternative hypothesis is accepted that lead time has significant impact on the supply chain performance.

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Table 17. Ordinary Least Square Regression Model Summary.

Descriptive Statistics

	Mean	Std. Deviation	N
Effect of Lead Time on SCM Performance	22.250	6.4356	4
Lead Time Parameters	25.000	16.0364	4

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.955[a]	.912	.869	2.3319	.912	20.849	1	2	.045

a. Predictors: (Constant), Lead Time Parameters

b. Dependent Variable: Effect of Lead Time on SCM Performance

Table 18. ANOVA Result.

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	113.374	1	113.374	20.849	.045[b]
	Residual	10.876	2	5.438		
	Total	124.250	3			

a. Dependent Variable: Effect of Lead Time on SCM Performance

b. Predictors: (Constant), Lead Time Parameters

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Hypothesis II: Inventory level has no significant impact on Supply Chain Performance.

To determine the effect of inventory level, it is essential to know the relationship between the two variables, inventory level (independent variable) and supply chain performance (dependent variable). Hypothesis 3 was tested using the ordinary least square regression model, with the aid of IBM Statistical package for Social Science (SPSS) Processor.

To determine the relationship between the inventory level and supply chain performance, parameters affecting inventory level as shown in Table 16 is regressed on the effect of inventory level on supply chain performance as shown in Table 14. The result in Table 19 indicates a strong relationship between the inventory level and supply chain performance with a correlation coefficient (R) OF 0.997. The R^2 of 0.993 with an adjusted R^2 OF 0.990 which means 99.3% variation in dependent variable (effect of inventory level on supply chain performance) is explained by the independent variable (inventory level parameters). The ANOVA results in Table 20 tries to test overall goodness of fit of fitted regression model, the F-test is statistically with a p-value of 0.003 which is less than 0.05, as there is less than a 5% probability that the null is correct. Therefore, the null hypothesis that inventory level has no significant impact on supply chain performance is rejected; thus alternative hypothesis is accepted that the inventory level has a significant impact on the supply chain performance.

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Table 19. Ordinary Least Square Regression Model Summary.

Descriptive Statistics

	Mean	Std. Deviation	N
Effect of Inventory Level on Supply Chain Performance	20.750	6.7392	4

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.997[a]	.993	.990	.6722	.993	299.542	1	2	.003

a. Predictors: (Constant), Inventory Level Parameters

b. Dependent Variable: Effect of Inventory Level on Supply Chain Performance

Table 20. ANOVA Result.

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	135.346	1	135.346	299.542	.003[b]
	Residual	.904	2	.452		
	Total	136.250	3			

a. Dependent Variable: Effect of Inventory Level on Supply Chain Performance

b. Predictors: (Constant), Inventory Level Parameters

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Hypothesis III: There are differences in supply chain management operations between the furniture manufacturing industry and automotive engine manufacturing industry.

To determine the significant differences in the SCM processes, the results as shown in Table 9 and Table 10 were used as a basis for this analysis. In Table 9, there are similarities in the supply chain operations like the application of a mapped out plan , the use of MRP software, having an ongoing and transactional relationship with suppliers , a customer focused organization with an interactive website usage using a six months' time range horizon for evaluating KPIs. Table 10 shows the strategies used in supply chain for both manufacturing industries; the data obtained from the questionnaire show that from the results obtained from the respondents, both manufacturing industries have major similarities in their strategies operations. The discussion above clearly shows that there are similarities in the SCM and strategies ; thus, the alternative hypothesis is rejected, and the null hypothesis accepted that there are no significant differences in supply chain management operations between the furniture manufacturing industry and automotive engine manufacturing industry.

Hypothesis IV: There are significant differences in the KPIs evaluation of both industries.

In determining the significant differences in the KPIs evaluation of both industries, as shown in Table 11 which listed the KPIs used to evaluate the system's supply chain process, the results as shown in Table 11 and Figure 7 was used to get a visual representation of the data, both manufacturing industries use KPIs like Supply Chain Cycle Time, On-Time Delivery, Inventory Turnover, Inventory Days' Supply , Customer's Order Cycle and Freight Bill Accuracy. The least two KPIs which are Gross Margin and Cash to Cash cycle received the lowest data input from respondents of the two manufacturing industries. In Table 12 which shows what areas in the various department where these KPIs implemented was also used as the basis for this analysis. As

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shown in Figure 8 , KPIs are implemented in both manufacturing industries, this indicates the importance of KPIs used as a way of measuring how the industry efficiently accomplish their business target. Similarities in the areas where KPIs are evaluated, areas like supplier management, manufacturing and production, inventory management ,demand planning and forecasting. Areas where slight variations where noticed in the results obtained by respondents are transportation and logistics, warehousing and purchasing management.

The discussion above clearly shows that there are similarities in the KPIs evaluation of both supply chain system ; thus, the alternative hypothesis is rejected, and the null hypothesis is accepted that there are no significant differences in the KPIs evaluation of both industries.

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CHAPTER V. CONCLUSION

Introduction

Chapter V gives a summary of the research findings, conclusion and recommendations based on the research findings. The study compared the supply chain management system used in the two manufacturing industry,furniture industry and automotive engine industry in the United States. The objectives was to show the similarities and differences in the supply chain processes and discuss how they evaluate their supply chain performance for both manufacturing industries. Supply chain is one of the most important department in the manufacturing industries because it is seen as the origin of where all production processes start, processes like sourcing for suppliers locally or internationally for raw materials to the distribution flow of these raw materials around the various departments within the industries till it gets to the end users. The objectives of a good supply chain system is to deliver quality products and services to the end user within a specified time range.

Summary

The purpose of this study was achieved by collecting data using a closed ended questionnaire. A total of two hundred (200) copies of questionnaires administered to supply chain specialist were returned completed. Data collected from the copies of questionnaires returned were analyzed using frequency table, bar chart and ordinary least square regression method in IBM SPSS Statistics Processor. The results obtained from the analyses formed the basis for the hypothesis testing and provided a structure upon which discussions and recommendations were made. This study also answered research questions ranging from how the supply chain KPI evaluated in the manufacturing industries, the similarities, differences and supply chain methods from both furniture and the automotive engine industries, how the inventory level influences the

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overall supply chain performance and how the lead time impacts the overall supply chain performance.

Four hypothesis statements were tested:

Hypothesis 1 was tested using the ordinary least square regression method in IBM SPSS Statistics Processor.

Hypothesis 2 was tested using the ordinary least square regression method in IBM SPSS Statistics Processor.

Hypothesis 3 was addressed using comparative analysis

Hypothesis 4 was addressed using comparative analysis.

Conclusion

The results obtained from the analyses and hypotheses testing show that there are similarities in the supply chain KPIs used in evaluating SCM system. The importance of using key performance indicators to evaluate the supply chain process was understood and the significance of the usage of these KPIs and how it affects the day to day running of the system was explained. Both industries know the importance of inventory level and lead time and how it affects the SCM performance. The supply chain performance is dependent on the lead time and inventory and inability to meet up designated time for delivering products and services to customers would affect the satisfaction of the customers. This study also showed a strong relationship between the SCM system of the two manufacturing industries and thus, indicated both manufacturing industries evaluate their supply chain performances using KPIs and operate under similar processes and strategies.

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Recommendation

Based on my findings, the following are recommended to ensure an efficient supply chain:

- The supply chain system should implement the use of local raw materials suppliers, this would result in a shorter lead time which is an essential factor in any supply chain process.
- Employees should be trained frequently on the importance of the supply chain system and how to continuously implement the KPIs for the twice in a year evaluation time.

Limitations of the Study

This research is aimed at comparing the supply chain system of the furniture manufacturing industry and automotive engine manufacturing industry and identify how their systems operate and evaluate their performances using Key performance indicators using two manufacturing industries as a case studies , hence, questionnaires were issued as the means of data collection. The use of questionnaires gives an assumption that the respondents who completed the questionnaire were highly knowledgeable about all the variables examined.

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REFERENCES

Adnan, T., & Das, A. (2017). Developing an optimization model for reducing the transportation costs of river vessels (Case Study: Lafarge Surma Cement Ltd.). *International Journal of Mechanical Engineering and Automation.* 4. 120-129.

Billa, C., & Brent, Y. (2010). The US motor vehicle industry: Confronting a new dynamic in the global economy, accessed from https://fas.org/sgp/crs/misc/R41154.pdf

Blue Acorn iCi, (2018). The delivery dilemma: A unique challenge for the furniture industry.

Croxton, K.L., Garcia-Dastugue, S.J., Lambert, D.M., & Rogers, D.S. (2001). The supply chain management processes. *International Journal of Logistics Management*, 12(2), 13-36.

Galar, D., Parida, A., Stenström, C., Kumar, U., Stenstrom, C., Berges, L. (2011). Maintenance metrics: A hierarchical model of balanced scorecard. *2011 IEEE International Conference on Quality and Reliability*, ICQR 2011. 67 - 74. 10.1109/ICQR.2011.6031683.

Hald, K. S., & Mouritsen, J. (2018). The evolution of performance measurement systems in a supply chain: A longitudinal case study on the role of interorganisational factors. *International Journal of Production Economics*, *205*, 256-271. https://doi.org/10.1016/j.ijpe.2018.09.021.

Handfield, R. B., Pannesi, R. T. (1992). An empirical study of delivery speed and reliability. *International Journal of Operations & Production Management* 12(2): 58-65.

Jain, S. L., Jon, E. L., & Johansson, B. (2013). A hierarchical approach for evaluating energy trade-offs in supply chains. *International Journal of Production Economics*. 10.1016/j.ijpe.2013.03.015.

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Lauren, H. (2019, December 19). Mnuchins's USMCA growth estimate might be too optimistic, CNBC. Available at https://www.cnbc.com/2019/12/19.

Morash, E. A., Droge, C. L., & Vickery, S. K. (1996). Strategic logistics capabilities for competitive advantage and firm success. *Journal of Business Logistics* 17(1): 1-22.

Novak, R. A., & Stephen W. S. (1991). "The industrial procurement process: A supply chain Perspective-" *Journal of Business Logistics* , 12(1), 145 -167.

Peng, D. X., & Lu, G. (2017). Exploring the impact of delivery performance on customer transaction volume and unit price: Evidence from an assembly manufacturing supply chain. Production and operations management, forthcoming, Available at SSRN: https://ssrn.com/abstract=2892733.

Porter, M. E. (1996). What is a strategy? Harvard business review (November-December): pp 61-78.

Vijayan, G., Mukherjee, A., Kamarulzaman, N. H., & Vaiappuri. S. K. N. (2016). Strategic value creation in a supply chain (pp. 186 -204). Available at https://doi.org/10.4018/978-1-4666-9639-6.CH011.

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APPENDIX A : Thesis Questionnaire

Demographic Data

Job Title : _____

Gender: Female ( ) Male ( )

Age: _____

Type of Employment: Full Time ( ) Part Time ( )

Length of Employment: _____

Department in Supply Chain: _____

Number of working hours per day / week: _____

Part A: Supply Chain Operation Self-Assessment

1. How does your organization operate? **Cross functional business processes** **Functional Silos** **Business processes that include suppliers and/or customers**
2. How does your organization carryout activities? **Mapped out plan** **Unplanned**
3. What technologies does your organization use? **MRP** **SAP ERP** **ORACLE ERP** **Others _____**
4. How does your organization interact with Suppliers and / or Customers? **Transactional** **Collaborative** **On-going relationship**
5. Does your organization have an interactive website that allows customers to order product, track shipments, and communicate directly to the customers? **Yes** **No**
6. Does your organization evaluate their Supply chain process using Key Performance Indicators? **Yes** **No** **Others**_____
7. Does your organization actively manage inventory with the goal of reducing inventory levels? **Yes** **No**

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8. Is your company customer focused? **Yes** **No**

9. Are Key Performance Indicators used to evaluate Supply Chain Performance? **Yes** **No**

10. How frequent is the Supply Chain Performance Evaluated? **6months** **1-2 years** **3 - 5years**

Part B: Strategies in Supply Chain Management.

Business Strategy in SCM	**Unimportant**	**Important**
Common introduction of benchmarking & performance metrics		
Use of underlining procedure to receive customer's feedback, who are engaged in product development		
Cross functional team meeting to discuss production information on regular basis		
Use of leading technologies to increase efficiency of the supply chain process e.g. demand forecasting and supply planning		
Application of "5s", "Just in Time" lean tools for continuous improvement & competitiveness		

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Part C: Which of these key performance indicators are evaluated in your industry's supply chain process?

Rating Scale: 1,2,3 – (Disagree) 4,5,6 – (Agree) 7,8,9 – (Strongly Agree - Usually Appropriate)

S/N	Key Performance Indicators	Evaluation		
		Disagree	Agree	Strongly Agree
1	Supply Chain Cycle Time			
2	Cash to Cash Cycle Time			
3	On–Time Delivery			
4	Inventory Turnover			
5	Freight Bill Accuracy			
6	Customer Order Cycle			
7	Fill Rate			
8	Inventory Days' Supply			
9	Gross Margin			
10	Return on Investment			

Part D: In what areas of your industry are KPIs implemented? Pick Yes / No

Areas	Yes	No
Order Management		
Inventory Management		
Purchasing Management		
Supplier Management		
Manufacturing/Production		
Warehousing		
Transportation/ Logistics		
Demand Planning & Forecasting		

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PART E: Variable affecting Supply Chain process

Does an effect on Lead time in these areas affect Supply Chain Performance? **Pick Yes / No**

Effect of Lead Time on Supply Chain Performance	Yes	No
Customer's Order Time		
Supplier's Reordering Time		
Inventory Management		
Production Schedule		
Impact on Safety Stocks		
Order Delivery Time		
Extent of Customer's Satisfaction		

Does an effect on Inventory level in these areas affect Supply Chain Performance? **Pick Yes/No**

Effect of Inventory on Supply Chain Performance	Yes	No
Forecast System Accuracy		
Excess Inventory Holds		
Supply Chain Decisions		
Product Quality		
Procurement Cost		
Revenue Loss		
Inventory Level Shortage		

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1. **Parameters affecting Lead time and Inventory level.**

- Which of these parameters affect lead time? **Pick Yes / No**

Parameters affecting Lead Time	**Yes**	**No**
Labor Shortage		
Materials Supply		
Weather Conditions		
Transportation Factors		

- Which of these parameters affect inventory level? **Pick Yes / No**

Parameters affecting Inventory Level	**Yes**	**No**
Planning frequency		
Supply Network		
Production Capacities		
Forecasting Quality		

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VITA

Deborah Efe Eruteya was born in Lagos, Nigeria and grew up in the southwestern part of Nigeria. She attended Ezekiel International College for her high school education. She then attended the University of Lagos, Akoka - Yaba, where she obtained her bachelor's degree in Chemical Engineering. Deborah worked in various manufacturing roles for two years before proceeding to Texas A&M University Kingsville in Fall 2019 to pursue a master's degree in Industrial Management. During her master's program, She interned as a Supply Chain – Purchasing Intern in the Summer, 2020 and she also interned as a Supply Chain Planning Co-op in Fall 2020 – Spring 2021.

This thesis was typed by the author.

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