T.C.

ISTANBUL AYDIN UNIVERSITY

GRADUATE INSTITUTE OF SOCIAL SCIENCES

DEPARTMENT OF BUSINESS ADMINISTRATION

MODERN WAREHOUSE MANAGEMENT IN THE MANUFACTURING AND SERVICE INDUSTRY - A CASE STUDY OF THE TURKISH AUTOMOTIVE INDUSTRY

MBA Thesis

OKWUDILI DARLINGTON UDEH

SUPERVISOR

ASSIST. PROF. DR. ILKAY KARADUMAN

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1)Tez Danışmanı: Yrd. Doç. Dr. İlkay KARADUMAN	.....
2) Jüri Üyesi : Prof. Dr. Akın MARŞAP	.....
3) Jüri Üyesi : Yrd. Doç. Dr. Tevfik Ercüment İSTEMİ	.....

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ABREVIATIONS

- WMS – Warehouse Management System
- OEM – Original Equipment Manufacturer
- 3PLs – Third Party Logistics
- JIT – Just in Time
- 2PLs – Two Party Logistics
- ABC – Selective Inventory Control System
- VED – Vital Essential and Desirable
- FSN – Fast Slow and Non
- VCA – Value Chain Analysis
- GDP – Gross Domestic Product
- PPP – Purchasing Power Parity
- RF – Radio Frequency
- MRP – Material Requirement Planning
- ERP – Enterprises Resource Planning
- DRP – Distribution Requirement Planning
- TMS – Transport Management System
- ITS – Intelligent Transport System
- SCPS – Supply Chain Planning System
- MES – Manufacturing Execution System
- TPS -- Toyota Production Systems
- MC – Mass Customization
- BTF – Built-To-Forecast
- BTO – Built-To-Order
- ATO – Assemble-To-Order
- CTO – Configure-To-Order
- JIS – Just in Sequence
- VMI – Vendor Managed Inventory
- ALB – Assembly Line Balancing
- TQM – Total Quality Management
- R&D – Research and Development
- SCM – Supply Chain Management
- ACM – Automotive Components Manufacturer
- TSM – Turkish Stock Exchange
- ROI – Return on Investment
- OSD –Automotive Manufacturers Association

- TAYSAD – Automotive Supply Industry
- MARTEK – Motor Vehicle Technical Committee
- OTAM – Automotive Technology and Research and Development Center
- UTAYSIB – Union of Uludag Auto Parts & Components Exporters Association
- KPIs – Key Performance Indicators
- AGM – Annual General Meeting
- LCV – Light Commercial Vehicle
- RTLS – Real Time Locator System
- PMS – Performance Management System
- IP – Internet Protocol
- VSM – Value Stream Mapping
- WCPP – World Class Production Program
- PSA – Potential Supplier Assessment
- ISO – International Standard Organization
- PA – Process Audit

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INTRODUCTION

This presentation shows how automotive warehousing operations has improved from what it used to be, with high storage area and small assembly floor reserved for shipment to the opposite. The research reveals the processes of inbound, outbound and how it can be improved using lean concepts, techniques and technology. The fast through-put and shorter lead time has been a major target of warehouse operators with a rapid response minded leadership. This has made the Turkish auto industry warehousing supply chain a success amid struggling and fragile economy/region.

The general operation in a conventional warehouse can be defined in two basic flows, the inbound (receiving and storing of materials) and outbound (retrieval and dispatching). The former is about all the activities needed to do when parts arrive at the warehouse and the latter cover all the process performed when parts are ready to be shipped to the customers on specific order fulfillments. Modern Warehouse Management Systems (WMS) covers all the technological applications both software and hardware integrated into the management of inventories as materials, sub-assemblies, components spare parts are coordinated through inbound and outbound flows in most efficient and effective way in the production of automobiles. This work covers all the infrastructural facilities built into Turkish automotive warehousing systems to support the automotive production line and supply chain in different production approaches available to the industry in most effective and competitive way. Most strategic approaches in used today in warehouses across all sectors of the economy originates from auto industry, in today's Turkey warehousing managements has embraced the same systems and techniques with Japan, America and European neighbor Germany .

This thesis focuses on analyzing the current and future role of Warehouse management in automotive production and supply chain. It will further, explore the

automotive WMS's journey in the revival of the industry in Turkey and how it contributed in making the industry to compete with her European counterpart and position the sector among emerging economies of the 21st century. WMS and automotive supply chain in Turkish automotive industry case study will explain the importance of benchmark of what is best obtainable in making a system efficient and effective in times of revival. Its effects on automotive industry franchising and industrialization in boosting automotive education, knowledge and infrastructural development to meet with developed economies requirement.

CHAPTER ONE
WAREHOUSE IN AUTOMOTIVE INDUSTRY

The automotive industry is the world's largest single manufacturing activity with thousands different spare parts inventory at the complex warehousing facilities with hi-technological infrastructures and full or partial automation. The automotive industry warehousing is strategically positioned to act according to the Supply chain approach employed in different seasons for different reasons. The strategic change in the industry is rapidly changing so, is its warehousing approach changing very rapidly. The complex warehousing operation in automotive industry is integrated with WMS facilities to coordinate production planning schedules and timelines.

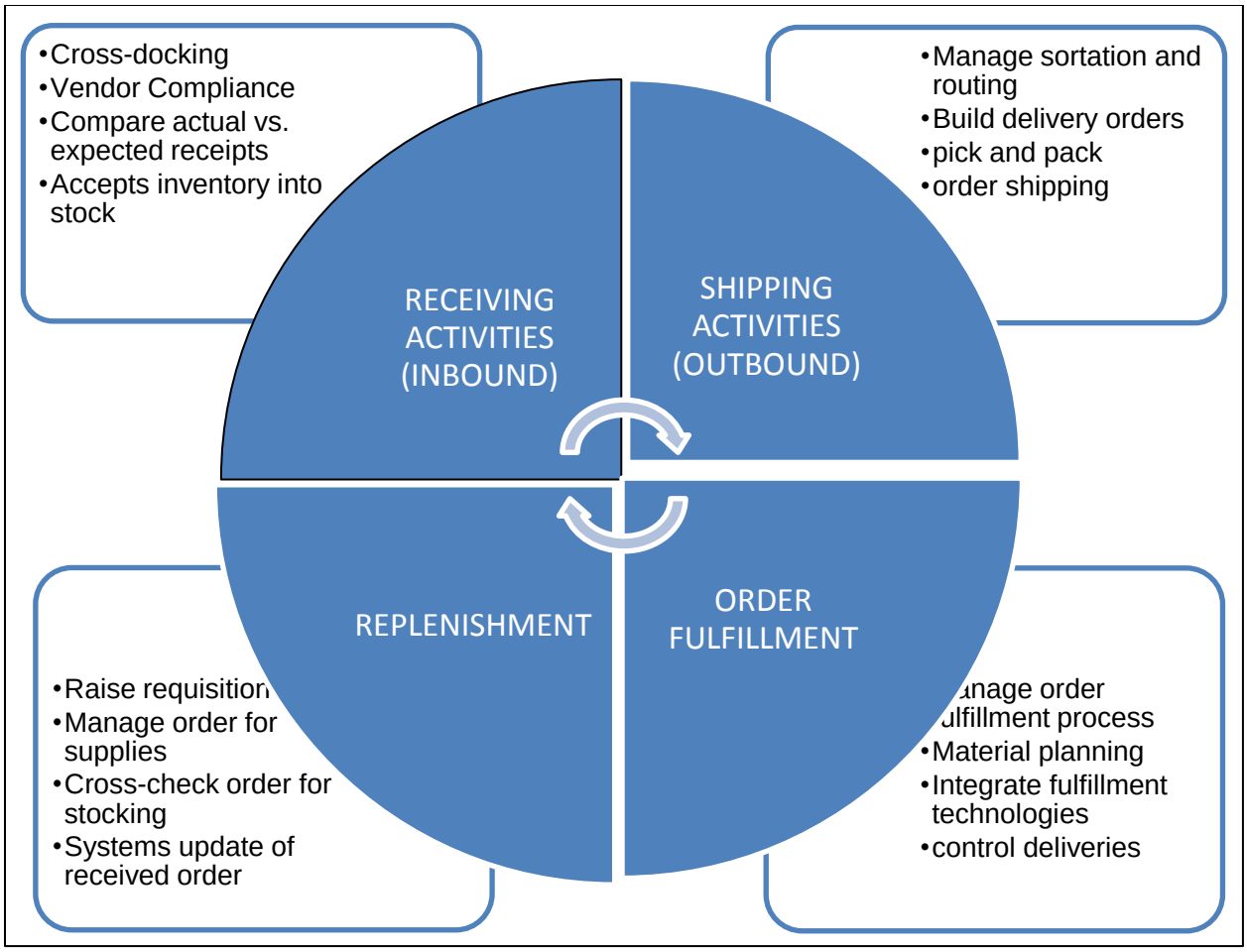
The process and procedure of operations is still the same, when compared with traditional warehousing activities from: receiving, storing, issuing and recording in an automated computer system integrated with other systems within and outside the warehousing environments. Maintaining inventory stock levels using OEM applications provided by individual automotive vendors through an automated computer system within the WMSs. The warehousing operation is the main point of spare parts order and distribution amongst other network in the integrated production systems. The central and support warehousing approaches is adopted by many automotive manufacturers in that, warehouses are divided according to location and production capacities in other to maximize the use of floor space. This makes free flow of inbounds which refers to receiving and storage while, outbound flows on interrupted through the pick, pack and shipping operations either to support warehouse or to production line. The movements or flow of inventory to manufacturing from the central or support warehouses approach is the main point in the lean principles of waste reduction or elimination. Central warehouses are built on a larger facility to accommodate more number of employees and large inventories at a time, with inbound flowing through different docks into larger floor space while support warehouses are built into the production facilities and proximity to production plant to increase through-put and reduce lead-times.

1.1. THE ROLE OF WAREHOUSING AND STORES

A warehouse is simply defined as a facility in the supply chain of an organization used for material planning, receiving and storing of inventories that are needed for further production of goods and services, the same definition applies to stores with significant different in design, operational capacity and capability. The Warehouse function is a package of services that enables the smooth running of the other operating functions in any organization as raw materials and spares needed in other section are holding in stock.[1] Each plays a significant role of serving the purpose of its institution by holding stocks and releasing when needed to increase value.

It also provide valued added processes and shorten response time in delivery of materials as when due. Automotive industry warehousing is the place that coordinates with research and development department for product improvement and value engineering operations for customize services to gain competitive advantage. These warehousing is classified by the role it plays at a particular location or supports center, as different warehouses exist in the industry to fulfill different manufacturing needs or other production approach like: built-to-order, built to stock etc. All these Warehousing management types in automotive industry supply chain functions as the process of storing inventory in a secured place in orderly and systematic manner and a system of retrieval when it is need for use. Therefore, Warehousing is a systematic process with a physical approach, which implies that, an physical material are kept, coordinated with WMS in real time and supply to production as and when needed.

[1]Rita Makumbijuly 6, 2013 Introduction to Warehousing Principles and Practices



Sources: supplychain247.com/article

Figure 1.1 Role of Warehousing

1.1.1 Warehousing and Aftermarket Approach

Aftermarket approach of automotive warehousing management is strictly on just-in-time procedure as spares are supplied at the right place, in the right quantity and quality, at the right time to solve the operational needs. Support warehousing coordinate speedy deliveries based on JIT to meet market demand for overall profitability of the supply chain. Global aftermarket champions operate optimized networks of warehouses

in the different regions and location as the case maybe and use benchmarks to transfer best experiences among warehouses to meet critical demand in most efficient.[2]

Aftermarket is generally a more profitable as it increases customer loyalty, dependability and it increases goodwill that helps in brand management. OEMs and ACMs are often more protective to this operation as it has a strong impact on consumer royalty of the brand. A good aftermarket programs boost consumer confidence and sustains the products life cycle in the market place. It uses the best supply chain techniques in this dispensation of lean synchronization to maintain supplies across different locations in their global network. In recent time aftermarket operation has become the engine room of marketing in highly competitive auto industry. Companies now employ supply chain experts to manage this part of their business as the importance cannot be over emphasized.

1.1.2 Inbound Warehousing and Outsourcing

Inbound warehousing is the process of taking inventory into the warehouse floor/shelf. The inbound warehousing is an integral element and the process of receipt, inspection and storing of material inventory. It's the basic activity of a warehousing operation for a manufacturing firm, involving the processes and documentation of raw materials for use in production or other departments. Inbound process refers to all warehouse procedures for managing the receipt, placement and availability of items entering the warehouse. Outsourcing this important function of the warehouse operation can be generating cost reductions in the general cost or through reduction of work force in downsizing.

For organizations to really focus on their core competency in the management of complex warehousing in automotive, there is need to outsourcing parts of the supply chain to highly technical supply chain expert company. The bottlenecks and dynamics

[2]http://www.capgemini.com/resource-file access/resource/pdf/tl_The_Aftermarket_in_the_Automotive_Industry.pdf

involved in the management of Supply chain and the follow-up, expediting actions in procurement and supplier management. There is a mutual corporation between the outsourcing company and chartered company's internal operational activities and the occurrence of disruptions in the firm's inbound logistics flow from subcontractor's activities.[3] In outsourcing inbound or warehousing activities to a professional 3PLs with a lot of expertise and experience, they can bring excellence to all the warehouses of the chartered company causing them to focus on their core competence.

1.1.3 Cycle Time Management Within the SCM

This concept in SCM highlights the importance of time management in business, since time has become a key success measure in business today. The saying that 'Time is money' is very true in manufacturing and service industries. In today's marketing management a products success or failure often depends on time to market, or how quickly a new products hit the market before others in the same industry does. The stiff competition in today's auto industry and intellectual property theft of design and concept copy makes sense in utilizing time efficiency. Cycle time is as its name implies, the time it takes for a task, job or order to completes its full circle or cycle. That is the time period required to complete one cycle of an operation from start to finish.

In production, cycle time refers to total time required to complete production of a product or production cycle time is the time when an order is place for a specific material and released to the production floor until completion and delivery to the customer. In order fulfillment, order processing cycle time is used in the warehouse operation to determine the total time required to process an order. Order processing time actually starts when a call is made for the requisition of a particular material through initial order placing and ends when the order is sent to production scheduling, this cycle time includes all the paper-work related to the fulfillment of that order. The concept of cycle time has become very important as a measurement tool in the SCM

[3]Göran Svensson, (2001) "The Impact of Outsourcing on Inbound Logistics Flows", International Journal of Logistics Management, The, Vol. 12 Iss: 1, pp.21 - 35

concepts like; JIT operation management, ERP coordination and management. It has been proved that cycle time improvement in supply chain tools have been linked to reduction in operational cost, reduced inventories, strengthening lean application and final result of increased capacity.

1.1.4 Warehousing Location and Design

A key decision that automotive industries must make is the location and design of their multiple warehouses. The importance of warehouse location and design cannot be over-emphasizing as it contributes immensely, to the success of automotive manufacturer, assembly plant, automotive supplier or 3PLs outfits. The importance location and design of a warehouse facility has increased in recent times to become value adding centers, meeting customer satisfaction and corporate profitability. This projected information should be in place to support other warehousing activities and other activities such as process flows, material handling equipment, special handling requirements and work force to consolidate the warehousing structure.

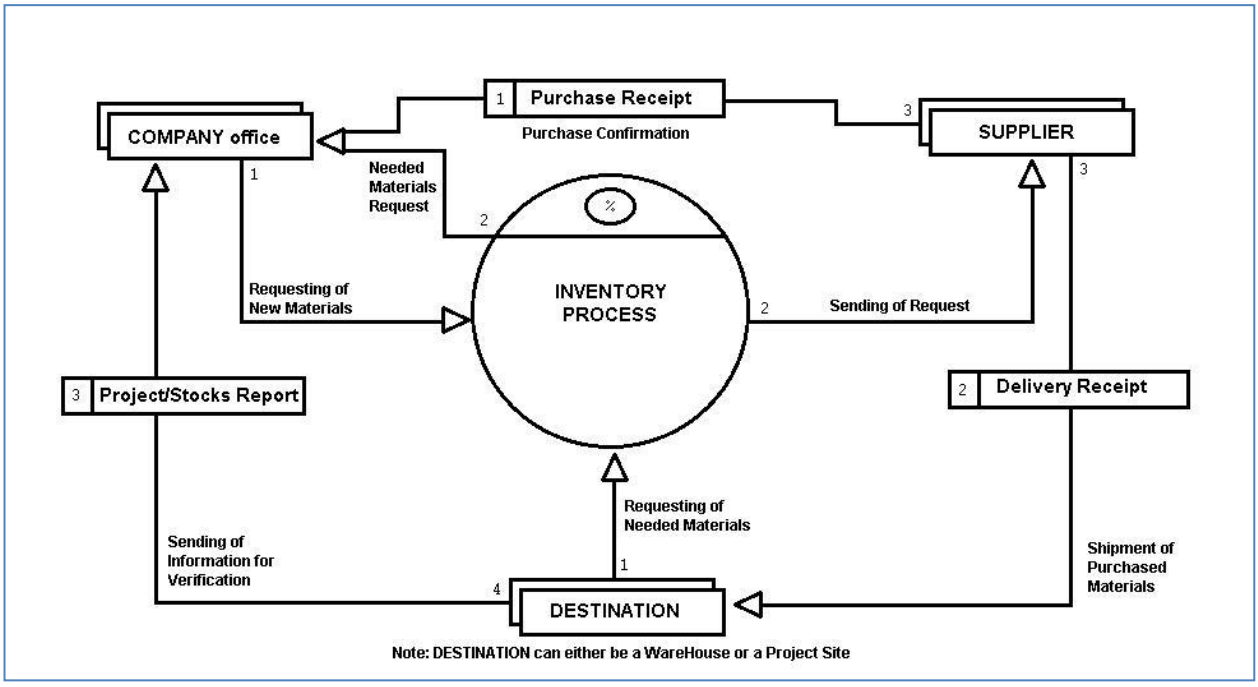
Warehouse location and design selection problem include both quantitative and qualitative factors. Localizing warehouse operations requires analyzing your current capacity and projected level of activities in which the operation will sustain when in operation, including the receiving, shipping and inventory levels. The location and design efforts are really a balance of the right amount of space, labor, and time alongside an understanding of strategy and all other business information.[4]

1.2 AUTOMOTIVE INDUSTRY WAREHOUSING

The automotive industry is traditionally the forerunner in the development of modern warehousing, SCM, production and logistics strategies due to the complex nature of the industry's production and assembly line. Warehousing in the automotive sector has been gaining tremendous importance in recent times due to the growing

[4]Thomas L. Freese 2000 http://www.freeseinc.com/images/Warehouse_Layout_and_Design.pdf

need to reduce storage and lead times for material inventory. Furthermore, the concentration of the auto manufacturing activity in a few location has led automotive manufacturers to construct warehouses in strategic places as central or support warehouses to ease fluctuations in there supply chain and increase rapid response to requirements.



Sources: FBM Constructions and Agro-Industrial Corp. Automated Inventory System

Figure 1.2: Integrated Warehousing System

This central or support warehouses are positioned to serve as the distribution and collection centers for finished and intermediate products parts from outside suppliers for the production and assembly line continuous material flow. The automotive industry warehousing management approach is based in integrated operational systems as shown in figure 1.2 above; with suppliers playing important role in the control and coordination of materials and logistical services in the making of the industry.

Logistical services like:

- Grouping of different tier 1 suppliers and modules
- Pre-assembly
- Assembly of components, modules and systems
- Line feeding
- Just-in-sequence delivery
- Processing of delivery schedule
- Just-in-time
- Quality control

1.2.1 Just in Time Approach (JIT)

The most fundamental approach in automotive warehousing strategy in lean manufacturing is the JIT approach. JIT is basically, a strategy to cut operational costs by reducing the amount of inventory held in the stock to avoid material waste. The strategy of just-in-time in automotive industry is in different classes. Developing a JIT approach and implementing the doctrine into the system requires planning and experience from supply chain experts. This is the reason why many automotive companies outsource this part of their warehouse operation to experts 2PL and 3PLs companies to ensure effectiveness of the entire process. In JIT approach there is a significant positive correlation between use of non-financial performance indicators and organizational performance in productivity measurements.[5]

Almost all the players competing in automotive industry use 2PL or 3Pls as the case maybe, for a part or full of their logistics operations due to the JIT success approach in the industry. The importance and efficiency of logistics and JIT services has the automotive logistics and supply chain evolve much faster as compared to other industry application of JIT. JIT has developed more than just a production and inventory control technique to more than just MRP systems in the supply chain and also in the flow of finished goods from manufacturing to distribution centers, in the backward

[5]David Upton, (1998) "Just-in-time and performance measurement systems", International Journal of Operations & Production Management, Vol. 18 Iss: 11, pp.1101 - 1110

direction flow from supplier to consumer and sometimes from suppliers of suppliers. JIT approach is achieving excellence in manufacturing as well as servicing industries, as a disciplined approach and strategy to achieving significant in continuous improvements in operation performance and overall work productivity and quality of goods and services rendered through respect of human and material resources and constant elimination of sources of waste. In manufacturing and service industry waste elimination is generally, all non-value adding activities in the operations and resources. The concept of JIT stimulates continuous improvements in quality and productivity enhancement from R&D to value engineering and final delivery to customers. JIT mind-set among employees fosters and develops latent capabilities of all organizational human resources in flexibility in response to change.

1.2.2 Assembly Line Approach

Assembly line is simply defined as an approach in manufacturing where components and products being produced passes through different work stations or cell in production flow until the production is complete. This production line approach is a process in which parts, sub-assemblies and semi-finished products moves from work station to work station in chronological sequence in continuous flow until the final assembly is produced. Assembly lines are fully controlled process flow-line in mass production systems, which are of great importance in the industrial production of high quantity standardized commodities.[6]

Production lines are mechanically arranged with automated systems where movements of parts, components or sub-assembly moves to the assembly line in steady flow as the products turn from semi-finished assembly to assembly from work station to work station until completion. In this manufacturing pattern, movement of workers is minimized or reduced, while increasing efficiency and effectiveness of the manufacturing process. The assembly line infrastructure is integrated in the warehouse management systems, as parts or assemblies are handled on partial or full automation

[6]http://www.sciencedirect.com/science/article/pii/S0377221706010435

either by conveyors or motorized vehicles such as forklifts or gravity conveyors, overhead cranes and robots.

1.2.3 Sequencing and Scheduling

Sequencing and scheduling are one of the logistical services performed in automotive warehousing, the process of organizing work cells in the assembly line, to carry out all the activities necessary to produce the desired outputs at the expected time for expected results. Sequencing and scheduling program indicates the timing of each work station as when it starts and when it will be complete, even on each work cell or machine and as well as any additional materials needed for each task. There is a relationship constraint between sequencing and scheduling in the work load activities and jobs in the production line. The optimization of such a system involves determining the customer service order (sequencing) and the inter-arrival times (scheduling).[7]

Sequencing is determining factor in which order/jobs are processed in the work centers but, also for work processed at individual times in different work stations, scheduling is arranging in order it will be performed taking in account the time period. The time in much work are piled in a particular work center or centers are heavily loaded and lengthy jobs are involved, sequencing and scheduling ensures clarity and precision are managed in accordance with maximum speed. Sequencing technological application works accurately in determining the best and most efficient production process in combination with lean tools like; JIT and JIT in sequence methods in production schedules.

Applying lean strategic tools in the supply chain of an operation is for the purpose of eliminating material waste through optimization in cycle time and costs reductions, while keeping both inventories and warehouse space under control. It will in the actual time also provides the operation with automated or semi-automated pick and pack of

[7] P.PatrickWangVolume 119, Issue 3, 16 December 1999, Pages 729–738

products to optimize your JIT delivery in the order in which is most effective for the operation.

1.2.4 Quality Control and Inspection

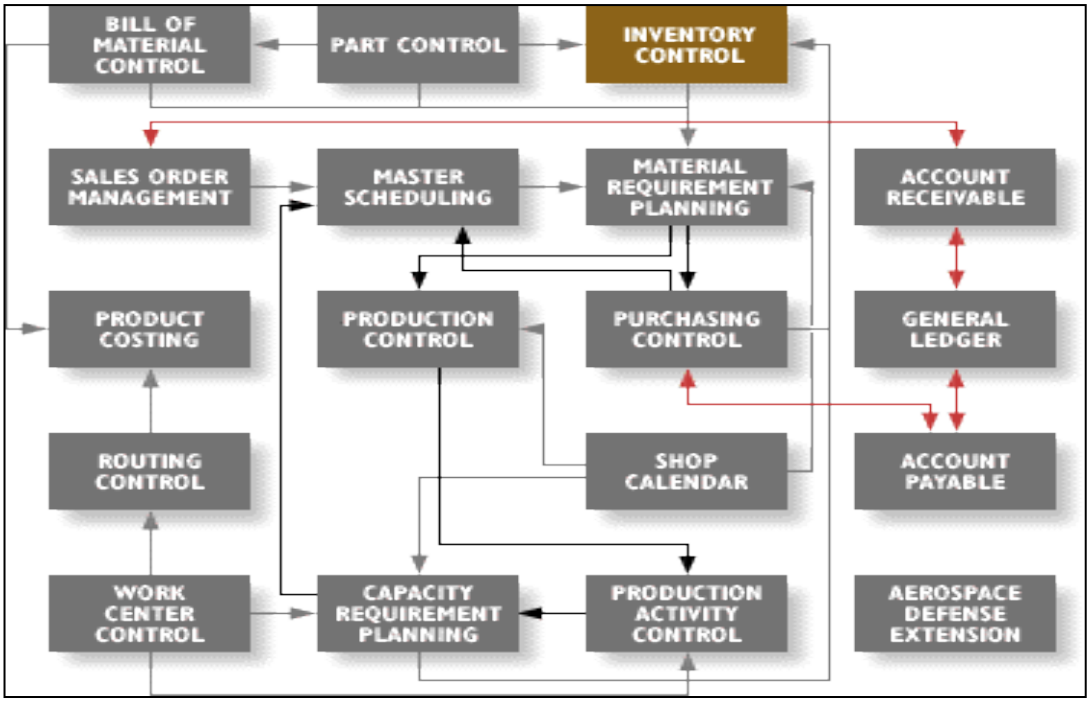
Quality control and inspection are better applied together as one needs the other to function accurately, because quality control simply means organization-wide approach to maintain set standard in all aspects of the firm that starts from top management to the least rank and file in an organization. This least work force needs to be monitored and controlled to follow the laid down rules and regulations as set standard to meet quality specification. So, quality control and inspection consists of the steps the entire organization applies in the program to create permanent environment that will maintain that which the organization forestall. The management's willed to continuously improve its ability to deliver high quality products and services to customers and maintain their competitive edge.

The approach involves all the stakeholders manufacturing facilities that supplies material parts both work-in-process and finished inventories and been monitored to ensure that TQM standards are kept in all the production stages. The process of quality control and inspection in automotive warehousing is strict and in conformance with industry total quality control standard. A key aspect of quality control and inspection is adequate supervision in all areas of a product life from material source to production line.[8] Quality control and inspection measures start at the supplier's location through monitoring the entire production systems of any non-conforming material and shield equipment. The supplier is required to quarantine and sort when the issue of quality standard is suspected within their facility or at their subcontractors, or in transit and at any facilities that coordinate supplies which may have parts in inventory.

[8]http://www.ignet.gov/pande/standards/oeistds11.pdf

1.3 INVENTORY MANAGEMENT IN AUTOMOTIVE INDUSTRY

Inventory management is not a new trend in the auto industry, for example: why does every car or truck carry a spare tire (inventory) and jack equipment for on the road replacement (JIT)? The answer is very simple, to make a quick replacement in the event of flat tire on the move. Inventory management is defined as those related activities essential for the procurement, storage, disposal of material in the right quantity, at the right time, at the right place made available to the right customer. Managing inventory in automotive supply chain is aimed at satisfying customer requirement while minimizing total operational cost.



Sources: Teamco Systems

Figure 1.2: Inventory Management in Auto Industry

Inventory management in automotive industry is complex with many cells of activities as shown in figure 1.2 above, as material inventory move across each activity in the WMS before the final journey to production as material, sub-assembly

components. Inventories are kept in the warehouse to reduce lead time and increase response to internal demand. The same rapid response approach is why organizations create warehouses to manage inventory both for raw materials and finished goods. Warehousing and distribution centers perform various activities in every stage of a supply chain such as raw material handling, distributing goods between facilities in various echelons and levels and keeping inventories, so they are crucial components in modern supply chains.[9]

1.3.1 Classification of Spare parts Inventory

Classifying spare parts in the WMS of automotive warehousing is by analyzing individual spare parts and components in groups according to similar attributes, performing functions and levels of criticality. It is not a good solution to implement the same inventory management policy on all items in stock. The inventory classification management policy is determined by the necessity inventory level, ordering quantity and the time of purchase. Each item inventory in the stock is analyzed according to certain criteria and it joins the corresponding storage policy. The three basic criteria of classification are:

- Based on spare parts usage (ABC approach)
- Based on levels of criticality (VED approach)
- Based on frequency of demand (FSN approach)

The classification, labeling for easy identification of these inventories spare parts in the WMS using afore-mentioned approaches in popular in the industry as it's in line with lean philosophy. By classifying and codifying all the spare parts in the warehouse, it becomes easy for the operation to minimize the duplication of spare parts thereby affecting reduction in the inventory.[10]

[9]Maryam Abbasi 2011 pages 181-197, Logistics Operations and Management Concepts and models

[10]http://www.productivity.in/knowledgebase

1.3.2 Value Chain Analysis (VCA)

Value chain in automotive supply chain is critical to their competitive advantage and customer satisfaction. VCA are those operational activities that an organization operating in a particular industry performs for customers in strengthening their operational capacity and capability in order to deliver a valuable products or services for the market. The impact of VCA cannot be undermined in the manufacturing industry as its seen as a multi-dimensional assessment tools in describing the performance of value chains including the analysis of product flows, information flow and the general managements of these flows. It draws on all the stakeholders to the opportunities for improvement at different stages in the value chain in strengthening them for effective change. The concept of VCA exposes the dynamics of information in the value chain from final consumption through manufacturing and potential suppliers and all the support functions influence in what consumer's value.

1.3.3 Collaborative Networks

Collaborative networks are organizational network of resourceful partners desiring to satisfy different set of customers' needs, regardless of the size, formation and capacity of the organization with willingness to be integrated into the system. In collaborative networks comprising of competitive firm, in the same industry, it changes the nature of competition and brings about mutual relationship and cooperation in delivering value to customers and members. As mist contribution are both the search for standardization and the application of techniques in project management to try to achieve success in the implementation and establishing of collaborative networks.[11]

This mutual arrangement and developed relationship results in competitive advantage to a network of collaborative networks. Collaborative networks approach to

[11]M. Otero, A. Pastor, J.M. Portela, J.L. Viguera, M.M. Huerta, Volume 63, 2013, Pages 12-19, The Standardization of Supporting Tools: Advantage Competitive for Collaborative Networks.

increase organizational capacity and capability to creating value for money in the market place and delivering same to consumers as well as the increased value a functioning collaborative network can provide to all participants.

CHAPTER TWO
THE WMS IN TURKISH AUTOMOTIVE INDUSTRY

Turkish automotive industry like their European counterparts faces enormous competitive challenges in the market place with emerging economies striving to survive in a highly competitive automotive industry. With improvement in social infrastructure in Turkey and a developing economy, automobile manufacturers are taking the advantage to increase production capacity as increase in foreign direct investment results in increase in gross domestic product (GDP) and purchasing power parity (PPP) which automatically, reflects increase in spending in important commodities like cars. Competing for automobiles market share have being the target of many companies, they must operate at maximum efficiency with innovative features and provide superior services to ensure profitability for competitive edge.

In order to effectively coordinate the operation of a warehouse in most effective and efficient way to support operational targets by coordinating everyday internal and external customer demands and supplies, and reducing costs in ensuring smooth run sales which are integrated into operations fulfillment. A WMS is a technological solution application, with special emphasis in supporting daily operational activities within the warehouse and integrated systems to ensure accuracy and efficiency in the production line of the industry.

WMS technological infrastructure fulfills this activities from beginning inbound/ receiving materials into the warehouse through order fulfillment to automated accounting systems of the warehousing activities and accurate control systems to outbound in order to achieve peak performance. The entire process is designed for flawless inventory control systems and handling accuracy, through improving human operational activities within the warehouse by reducing carrying costs of inventory and reduction of slow moving stock, through efficient pick, pack and ship orders. Since, the introduction of WMS in Turkish automotive industry’s supply chain, the application of RF and bar-coding technologies in the storing and retrieval systems has improved the

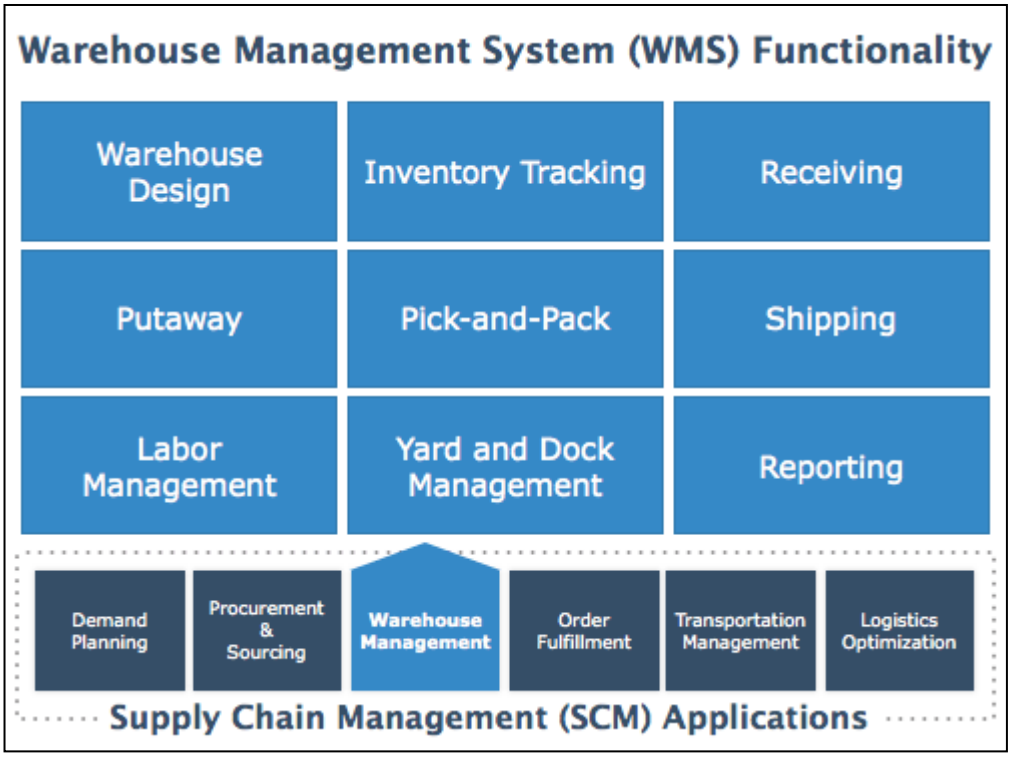
efficiency of the operation in meeting high demand at lowest time possible with core warehousing functionality.

2.1. Warehouse Management Systems

WMS is a technological application, internet enabled feature solution for automating the material handling processes that utilizes RF systems and bar-coding technologies, for creating inbound and outbound processes (order, storing, picking, packing, and shipping) for improved warehouse management operations. WMS makes order fulfillment easy by allowing warehouse operators to respond to demand and supply immediately. The separation of picking and packing processes of a warehouse management system usually brings extra storage buffers and relatively longer operating time.[12]

WMSs boost confidence of managers in guiding warehouse personnel to right location, getting to the right spot for picking and packing operations, with equipped RF based terminals. It integrate and coordinate any picking style preferred by an outfit, wave, batch, it manages the process efficiently and cost effectively. Turkish automotive warehouse supply chain efficiency and effectiveness has improved the general operation through WMS activities which operates at peak performance, enabling most warehousing to handle these tasks:

[12] Jiun-Yan Shiau, Ming-Chang Lee,Computers& Industrial EngineeringVolume 58, Issue 3, April 2010, Pages 38392,



Sources: forrest Burnson Software Advice WMS

Figure 2.1: WMS Functionality

- Increase internal and external order accuracy,
- Eliminate paper and operational error,
- Pick and pack concurrently with highest precision,
- Track inventory in multiple locations in real time,
- Print packaging and labeling slips on demand,
- Increase customer satisfaction and operational confidence.

2.1.1. Material Requirement Planning (MRP) within WMS

Material requirement planning (MRP) is simply a production planning management tools use in the materials for production planning and scheduling to manage manufacturing processes. MRP is an inventory control systems and a material scheduling tools integrated into WMS for manufacturing processes and procedures. It

consists of what is needed in terms of materials and the steps in procuring that which is needed, supplying according to scheduling requirements for the finished products components to move in the assembly line of the production plant. An MRP system is configured to meet three objectives:

- Ensure the right materials and products are made available for production purposes and finished products are delivered to customers on time.
- To maintain minimum level of inventory while achieving maximum level of customer satisfaction.
- In Planning manufacturing activities, processes and procedures in conjunctions with delivery schedules and purchasing activities.

The functions of MRP software in WMS includes inventory control planning, bill of material processing management and fundamental material scheduling. MRP also perform many functions in the manufacturing planning, execution, purchasing and delivering activities.[13]

2.1.2. Enterprises Resource Planning (ERP) and WMS

Enterprise resource planning (ERP) is technological software integrated into WMS to manage internal and external resources and processes of an organization. ERP coordinate all the resources within an organization's departments for efficiency and effectiveness. The main purpose is for information flow between all the business functions of an organization and the outside environment of the market place.

ERP is complete tailor-made information technological system that engages human and material resources within an organization and outside partners to gain competitive advantage.

[13]Waldner, Jean-Baptiste (1992). "CIM: Principles of Computer Integrated Manufacturing [1]": p47. John Wiley & Sons Ltd. http://www.share-pdf.com

2.1.3. Distribution Requirement Planning (DRP) with WMS

Distribution requirement planning (DRP) is simply a technique implored by supply chain experts to monitor and maintain inventory levels while placing order with manufacturer to replenish inventories to meet customers increasing order. DRP systems when fully integrated into WMS technology, it becomes a systematic process of determining which goods and in what quantity, location, in case of multiple warehouses is required at a particular location to meet customers demand. The main benefits of DRP is that inventories are managed in a simply and smart way, that ensures maximum efficiency, with adequate levels of stock. Inventories tend to be an asset that is expensive in terms of how much resources it requires in managing stock at a particular facility.[14]

It also helps in demand forecasting and using forecast results to create a schedule for delivering efficiency and effectiveness. DRP systems when integrated into WMS in conjunction with MRP systems gives an organization a complete solution to total inventory management by minimizing and reducing the overall cost associated with ordering, replenishing, transporting inventories and any inventory holding cost.

2.1.4. Transportation Management System (TMS)

Transport management system (TMS) is an integrated technological solution programmed into WMS to optimize supply chain networks of inbound and outbound transportation processes within the network. TMS coordinate and consolidate customer's orders into shipments load and assign them to the most efficient mode of transport as programmed in the WMS technology in order to minimize operational cost.

[14] http://www.valuestreamguru.com/?p=329

Integrated TMS helps organization to automate all global shipments and gain real-time shipment visibility, carrier selection, dock scheduling and shipment tracking in full optimization. It assists management in making informed analysis on transportation performance for better operational decisions. Intelligent transport systems (ITS) like transport management systems (TMS) technologies include state of the art wireless, electronic, and automated technologies with a goal to improve surface transportation safety, efficiency, and convenience.[15]

It enhances global shipment visibility through gaining real time shipment tracking from dock scheduling to destination delivery. When fully operational it streamline freight settlement process and procedures, improving invoice accuracy, reduce processing documentation and generally, lower administrative costs.

2.1.5. Supply Chain Planning System (SCPS)

Supply chain planning system (SCPS) is a systematic approach to planning process with the purpose of matching supply and demand in most realistic way to increase efficiency and effectiveness in the general supply dynamics. SCPS is a technological application in a supply chain model for handling supply processes and activities that are re-defining demand forecast of material, capacity and formulation of plans to supply with proposed schedules.

SCPS enhances information integration within WMS to coordinate overall logistics and supply chain decisions amongst other partnering firms, processes and functions. It enables supply chain visibility, resources utilization and optimization to create the most effective and easily analyzed plans to aid implementation.

[15] Susan A. Shaheen, Rachel Finson, Encyclopedia of Energy, 2004, Pages 487-49, Intelligent Transportation Systems

2.1.6. Advanced Planning and Scheduling Systems (APSC)

Advanced planning and scheduling systems is a technological computer program that uses advanced mathematical algorithms or logic to perform optimization simulation on capacity scheduling, sourcing, capacity planning, resources planning, forecasting, demand planning and others.[16] APS as a solution tools designed to assist production plant to develop capacity and capability in production schedule through balancing internal constraints and limited resources. APS is a technological application in the WMS that is designed to track operational requirements in order speed up production and reducing general cost levels within the factory. It also allocates production raw material and production capacity utilization to balance market demand and production capacity.

The program takes into consideration production due dates, machine production capacity, available tooling and labor to develop a realistic production plan of action to incorporate orders through various operational steps. APS program integrated into WMS offers several benefits that generate schedules through:

- Tracking each order in each respective operational routine step to know exactly where each spare parts inventory should be at the time of need.
- Keeping track of resources required by operation in each manufacturing steps and the availability of each resources at a particular time of need.

2.1.7. Manufacturing Execution Systems (MES)

A manufacturing execution system (MES) is a technological control system installed for the purpose of managing and monitoring work process and work in process on a production line. MES is a manufacturing tool designed and built for manufacturing.

[16] APICS (2007), *Using Information Technology to Enable Supply Chain Management*, APICS Certified Supply Chain Professional Learning System, APICS, Alexandria, VA.

Most manufacturing companies use a planning process tools like (MRP, ERP, and APS etc.) as mentioned above, to determine what products are to be manufactured.
Once that plan has been developed, there must be a translation of the plans that deal with real resources that are currently available.[17] MES program keeps tracks of all the necessary production information in real time and forward it for operational use. The main objective of the MES program is to improve operational productivity and reduction in operational cycle time of an order.

2.2. Automotive Supply Chain and Logistics Management

The shift in automotive supply chain today, represents a transitional change from forecasting supply chain to responsive supply chain with strategic emphasis. The major chain that exist in the industry are the material suppliers which ensure materials needed are released to production line as and when needed, for the benefit of the last member in the chain, car buyers. The effectiveness of the entire chain relies on the ability of the auto manufacturers to match supplies to demand in systematic forecast. The various approaches available to the industry from the past to present:

2.2.1. Build-To-Forecast Approach

This is the bottom-up production approach, which stipulates that, the button of production of automobiles is pressed by genuine market demand from consumers. This demand and sales forecasting collated from regional dealers and national sales companies submitting anticipated demand which is received into production planning and scheduling. The aggregate demand and forecast market demand are the framework that determines what to produce and in what quantity at each facility in time. Built-to-forecast uses anticipated demand forecasts as the major input into production planning and scheduling. The input determines production line sequence and scheduling, to ensure that production meet with actual demand and avoid vehicles stockpiling at the dealers car park.

[17] By Michael McClellan, Introduction to manufacturing execution systems, June 4-6, 2001http://cosyninc.com/papers/3.pdf

2.2.2. Built-To-Order Approach

This production approach of manufacturing a product to the buyer's specifications started in the 1960s in Japan by the Toyota Production Systems (TPS). It's a process of creating a system of producing according to customer's requisition known as customization. Built-to-order or make-to-order as its name implies is directing production line to make on strict order of the customer. In this approach of designing or customizing around customers order has received wider acceptability in the automotive industry as mass customization (MC). The concept of MC is about organizing a manufacturing business in a way that customer as solely connected to production planning and sequencing. The entire approach of MC in the automotive industry supply chain is structured around three basic production planning and scheduling methods. The first is the built-to-order as described above, and the next is;

2.2.3. Assemble-To-Order Approach

Assemble-to-order (ATO) like built-to-order is described as demand –driven manufacturing (DDM) which has a demand pull strategy. The concept is a manufacturing strategy in the auto industry which stipulates that, production or assembly line will not be completed until customer order are received, analyzed and implemented in the production. The last but, not the least;

2.2.4. Configure-To-Order Approach

Configure-to-order (CTO) is a stipulation within the assemble-to-order agreement, where customer makes a specific order in enhancement feature components to satisfy their specific needs. The contract specifies that, the customers can classify the order including the specified feature to answer to identified needs.

2.2.5. Lean and JIT

Lean and JIT approach, origin is traced to automotive industry and component manufacturers supply chain model. The approach is designed as pull systems that respond to customer needs as efficiently as possible, with minimal inventory levels, work in progress and waste. The requirements of lean and JIT to be successful is information sharing across production schedules, production data, quality, and consumer demand forecast and analysis. Lean and JIT targets are designed to cut-down general cost levels by reducing the amount of goods and materials an organization holds in stock. Lean and JIT involve:

- Manufacturing and delivering finished goods just-in-time to be sold,
- work-in-progress just-in-time to be assembled into finished goods,
- material spare parts just-in-time to go into work-in-progress,

The entire philosophy of lean and JIT is that production plan and schedule are designed to be pulled through (in response to immediate demand) rather than pushed through (in response to market demand). This simply means that manufacturing starts when a customer places order for a company's products, so that the production cycle starts in response to the order placed by the customer.

2.2.6. Just-in-Sequence (JIS)

Just-in-sequence (JIS) like just-in-time is a supply chain tools that completely fit in schedule and variation of assembly and production line. Materials and components parts arrive at a production line right in time according to production scheduled plan in a specific order before they get assembled. This implies that, material inventories and parts received into store are to be delivered on demand to production line as they are needed; in the right order, at the right time, in the right quality they will be used. Automotive manufacturing process requires components and sub-assemblies from different suppliers in different locations, which must be pulled together in response to sequence and scheduling to create a complete vehicle according to specification plan.

Materials inventories and components come in a specific order into the warehouse and sorted out to be release on demand to the assembly line to meet production requirement and scheduling.

In order for the right material to reach the customer at the right time, in the right sequence, and in the appropriate specification needed by the consumer is the major goal of this supply chain approach. JIS approach is simply to hold inventory in some places either in the manufacturing warehouses or in the integrated supplier warehouses to be released at the appropriate time, to complete the final assembly due to customer order requirements or for production schedule. The result of JIS conceptual principles application is that inventory levels are never overstocked, material flows is perfectly synchronized, processes are leaner, and consumers enjoy customized configurations.[18] This process makes material parts available at the point of assembly, with a small amount of safety stock kept in the stock to be used in just-in-time within the assembly line. Sequencing of inventory helps automotive manufacturing plants lean synchronization to be effective and efficient.

2.2.7. Vendor Managed Inventory (VMI)

Vendor Managed Inventory (VMI) is a system whereby the inventory spare parts of the distributor of OEM parts are been managed by the vendor (the manufacturer). VMI is a system that gives manufacturer confidence and control of the production requirements and materials even at the supplier's custody. VMI is an integrated supply chain approach for continuous production support. A process that enable continuous flow of materials through an electronic means that control the entire system, the manufacturer usually communicate with suppliers or vendors as they are synchronized into sequencing and scheduling programs with the aid of efficient communication infrastructures.

[18]Hebeler, P.: Achieving Automotive Supplier Excellence: Flawless Delivery Execution *Oracle Corporation. 2003*.

The communications gadgets gives both real time material requirements situation in the warehouse as integrated partners, no individual takes material decision without informing the other with mutual understanding. Under a constant demand rate, optimal solutions are obtained analytically for the customer's order quantity, the vendor's production quantity, hence the parties' individual and total costs in the three cases. Inequalities are obtained to delineate those situations in which VMI is beneficial.[19]

2.2.8. Greening the Supply Chain

The term 'going green' has become popular in recent times and target has been set globally in cutting carbon emission. Greening the supply chain initiatives are part of a process for implementing a sustainable development plan aimed at achieving improved environmental, health and safety performance, increasing efficiencies in the use of energy, water and other natural resources or raw materials; and their environmental and social impact of business operations

[19]MehmetGümüş & Elizabeth M. Jewkes, Volume 48, issue 19, 2010.International Journal of Production Research

2.3. APPLICATION OF WMS IN TURKISH AUTOMOTIVE INDUSTRY

The importance of WMS in the automotive industry warehouse cannot be over-emphasizing because it is more than stock control system and also more than data collection system. WMS is actually a system that helps the entire manufacturing operation to automate their warehousing function with no errors, with maximum efficiency. By automating warehouse operation with WMS, we mean getting optimum productivity in warehousing function and there impacts in production line through people and equipment, getting the desired result in space utilization while reducing general paper work in record keeping, even as it thrives to give 100 percent stock accuracy. WMS in automotive industry supply chain helps in streamlining operations by improving high performance and eliminating waste.

Constant changes in the industry has resulted in the increase in demand for improved customer services, today's automotive warehouses and vendor managed warehouses are under intense pressure to meet organizational targets in maintaining inventory accuracy, timely delivery service to meet scheduling requirements, individualized order fulfillment, flexible value added service and rapid response needs. The use of WMS that is designed to speed up order turnaround time, improve inventory accuracy, provide instant order status information, manage warehouse space and enhance labor productivity.[20]

2.3.1. Pull versus Push Systems

The rudiment of push-pull manufacturing systems in automotive industry supply chain has been a subject of research and discussion among supply chain practitioners and academicians in recent times. A "push" manufacturing systems is simply a situation

[20] International Journal of Logistics Research and Applications: A Leading Journal of Supply Chain Management

Volume 9, Issue 2, 2006

in which production and inventory management decisions are characterized by demand forecast or a schedule-driven system. The major benefit of the push system is economies of scale by maintaining excessive material inventory. Its major disadvantage is its inability to incorporate demand uncertainties and variability in production. A “pull” manufacturing systems is driven by the customer’s order at the end of the chain, which implies reduced lead times and inventory, leads to high service levels as companies are able to manage fluctuations in market demand.

This approach in automotive industry means that cars manufacturing only flow through the supply chain when there is a customer demand at the end of the chain. In this type of strategy, demand is driven by sales and marketing which kick-start production line schedule. A situation where the strengths of push and pull systems are taken into consideration to get the best out of production systems as push-pull systems, where the organization benefits in economies of scale.

2.3.1.1. Reverse Logistics in Pull and Push Systems

Reverse logistics as its name implies is when the wheel of supply chain returns back from the receiving end of the chain to the supplying end of the chain with a lower value of used products. The entire approach of reverse logistics in automotive supply chain is for the purpose of old spare parts returns, repair of used parts, refurbish and recycling of used products without value and with environmental health hazard. In order to completely recover value from returned products through reverse logistics, companies need to optimally design their reverse logistics networks in order to facilitate the collection and flow of the goods in an optimal way.[21]

Push-pull manufacturing systems play an important role also in reverse logistics of recycling and refurbishing of automotive spare parts retrieval systems. There are

[21]Fleischmann, M. (2001).Recycling solid wastes: A channel-of-distribution problem. ERIM Report Series Research in Management, ERS-2001-52-LIS.

several ways to process the recovery and retrieval of scrap and used vehicular parts and other accessories depending on its economic and ecological recovery value. The location of collection points and processing centers, recovery facilities and equipment for the reverse logistics need to be carefully designed for easy flow.

2.3.2. Assembly Line Balancing (ALB)

Automotive assembly line balancing (ALB) is simply about production process optimization with regard to certain factors in manufacturing business models. Due to the complexity of automotive manufacturing, maintaining and operating line balancing is often costly in installation and management. The objective of line balancing is operational optimization with existing assembly lines production and facilitation. ALB layout is structured to increase production processes of automobiles with definite precision, as products moves from one stage to the other in a particular timing in a continuous flow in the assembly line of manufacturing process.

The number of factory workers or the resources needed to execute the work stage based on the specific requirements. The effectiveness of the proposed procedure is demonstrated by application to an actual redesign of an assembly line for a major auto industry supplier.[22] Efficient ABL process is to minimize total operational time to finish a particular process with the introduction of robotic technology that performs each task, while minimizing number of work stations in sequencing and maximized efficiency.

2.3.3. Total Quality Management (TQM)

Total quality management (TQM) is the continuous efforts of an organization in improving the competitiveness and effectiveness in delivering high precision goods and services to the customers. TQM is about improving in customer service and benefits

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[22] Peter A. PintoDavid G. DannenbringDavid G. Dannenbring, Volume 29 Issue 7, July 1983, pp. 817-**830** Assembly Line Balancing with Processing Alternatives

derived from the product use. It is a way of planning, organizing and controlling of supply chain in delivering quality from the customer's perspective, as customer satisfaction is the major target of TQM and it's a process committed in doing the right things both internally and externally all the time.

This implies that TQM is not only a process of doing things but, a way of managing the process and product for the future assurance of the product and the continuous progress of the organization. It is a way of managing people, products and process with effective leadership to ensure complete customer satisfaction at every stage of the entire product life. The content of TQM is capable of producing a cost or differentiation based advantage and that the tactics and complexity that are inherent in the process of TQM have the potential to generate the barriers to imitation that are necessary for sustainability.[23] In implementation of TQM in an organization which is based on customer-supplier interfaces, the entire process and procedure will be tailored to achieve the overall objective of the institution from human resources to material resources and supply sources to create total quality.

2.3.4. Research and Development Needs

Research and Development (R&D) is the act of investigative activities that an organization embarks in order to improve existing process or product with the intention of improving or developing new products for competitive advantage. R&D in automotive industry is an instrument of competitive advantage, as it's a means a company prepares for growth and gaining favorable market share in the industry, is by developing new products through improving or modifying existing model/brand.

R&D section of an organization constantly and consistently indulges in programs and projects to re-modify the capability of their products to suit to increasing demand of

[23] Richard Reed, David .J. Lemak, Neal. P. Mero, Journal of Quality Management, Volume 5, Issue 1, Spring 2000, page 5-26, Total Quality Management and Sustainable Competitive Advantage.

consumers as they stimulate innovative methods of production with costs reduction and product improvement in quality. Automotive companies create R&D departments and allocate a significant part of their budget for R&D activities, improving performance and increasing profitability. An R&D strategy in most automobile companies leads to innovation and increased productivity with higher product performance in other to boost business and products competitive advantage. The benefits of R&D are often long term targets with increased customer satisfaction and loyalty at the root of the projects.

CHAPTER THREE
A CASE WITH SUPPLY CHAIN APPROACH

The strategic approach in this thesis is based on SCM principles and practice according to the articles of international logistics and supply chain institutes and other SCM organizations across the globe. The general definition of "SCM is the integration of key business processes from end user through original suppliers that provides products, services and information that add value for customers and other stakeholder" with the organization.[24] For the purpose of this thesis, we are considering SCM in automotive industry, which is complex and highly competitive with large number of suppliers and large variety of products each of these suppliers has on offer.

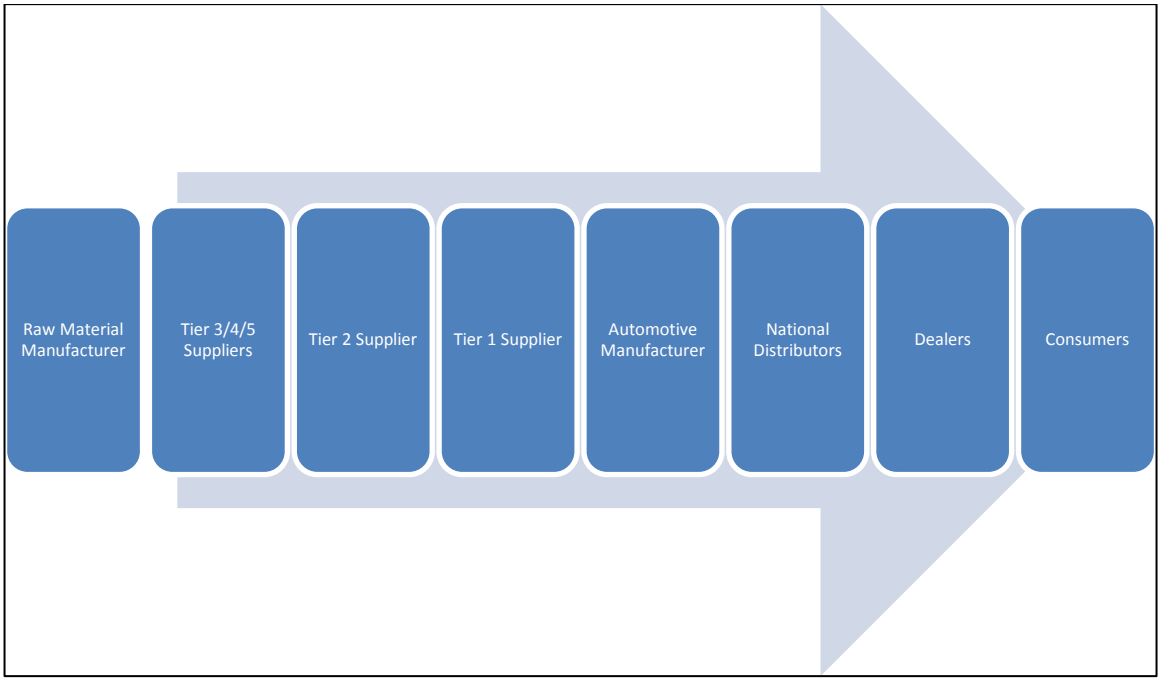


FIGURE 3.1: SCM in Automotive Industry

[24] Lambert, D. M., Cooper, M. C., et al. Supply Chain Management: Implementation Issues and Research Opportunities. *The International Journal of Logistics Management,* 9, 2 (1998), 1-19.

The automotive industry is the early adaptors of the concept. Because of their early exposure to the Japanese challenge, western automakers have been working longer than most other firms to adopt the kinds of close supplier relationships used by their Asian rivals.[25] The automotive industry focus is especially interesting, because of the shift made by suppliers. From small players that deliver individual parts they have developed to become partners and assemblers of components and sub-assemblies, with design, testing and manufacturing responsibilities.[26] The SCM developments in Turkish automotive industry have ripple effects on the production capacity and capability, with an increase in the quality of supplier requirements both in OEMs and ACMs.

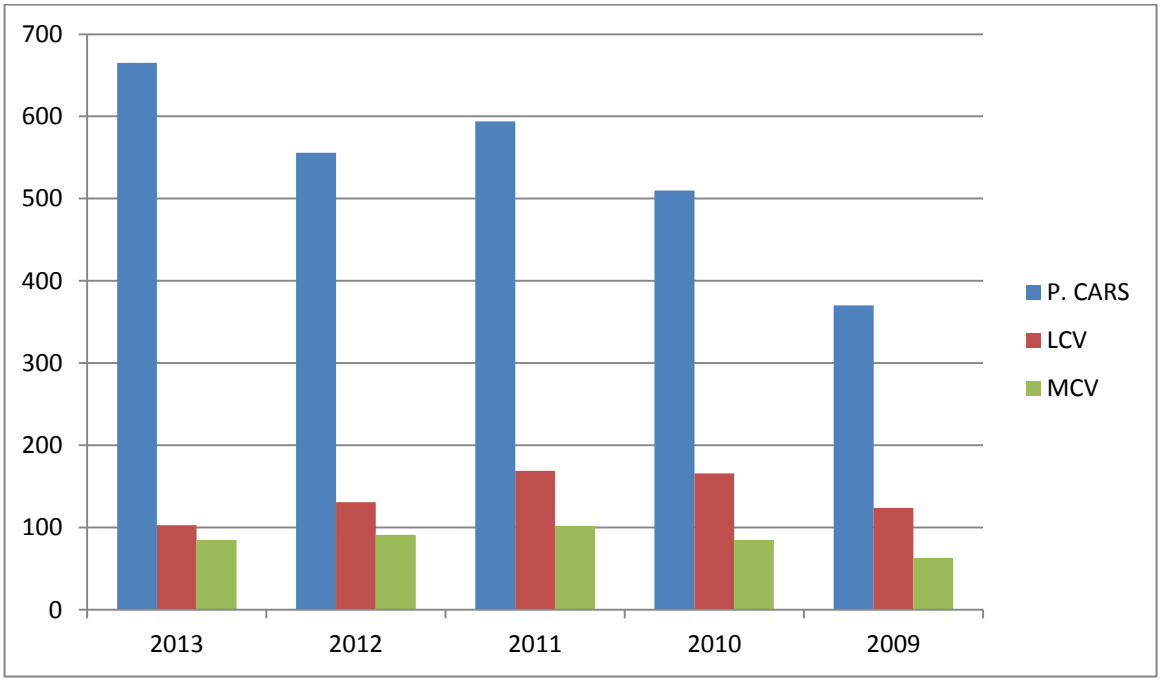
3.1. RESEARCH DESIGN AND METHODOLOGY

The methodology in this thesis consists of two independent studies where each study has its own research question, its own research design, and its own intended academic contribution. Despite the independent relationship of each element, they are all part of a greater whole of operational activities with one purpose. Since 2007, the investments in Turkish automotive industry has increased tremendously, and has resulted in increase in the production capacity of 1.3 million vehicles, making it the world's 16th largest automotive manufacturer and one of the leading production bases in Europe. The increase in production capacity among 13 automotive manufacturing companies operating in the sector, this has reflected on the WMS impact in the productivity of the industry despite economic slowdown.

The constant growth achieved in the industry over the last 5 years as depicted in figure 3.1 and the level of SCM evolvement in the industry. Looking at the general growth level in all the production segments in the Turkish automotive industry in 2013, there is rapid increase in passenger cars segment as shown in figure 3.2. Sales volume grew by 19% and reached a record high of 664,655 units. The industry's sales

[25]Helper, S. R. How Much Has Really Changed between U.S. Automakers and Their Suppliers? *Sloan management review,* 32, 4 (1991), 15-28.
[26]Towill, D. R., Childerhouse, P., et al. Integrating the automotive supply chain: where are we now? *International Journal of Physical Distribution & Logistics Management* 32, 2 (2002), 79-95.

performance across all segments were slow especially, in light commercial vehicles and medium commercial vehicle but, increase in passenger cars continued, the total market share of passenger cars rose from 69% to 75%.The market experienced growth at the rate of 9% in general sales of vehicles in 2013 as shown in the figure above, with domestic market improvement in sales of 885,180 units of production compared to other years. This research will focus on three vehicular segments; passenger cars, light and medium commercial vehicles productions.



Source: Ford Otosan Annual Report 2013

Figure 3.2: Turkish Automotive industry 5 year Sales Report (1000 units)

The industry is targeting an increase in production capacity of up to 2 million units by 2015. This thesis focuses on the OEM companies operating in Turkey and is listed on floor of the Turkish stock exchange (TSE), with the intention of exploring the WMS as key to the effectiveness of the industry. The research will gather and analyze the annual reports of the quoted automotive companies in TSE. Data gathered will be classified into these concentrations for clarity:

- Production output,
- Sales turnover,
- Performance and demand managements

To identify the production systems input, output and returns on investment (ROI) during the period under review. Capacity utilization has a strong effect on sales turnover and increase in capital. This thesis will concentrate on sales turnover reported on the latest annual reports of 2013 for these companies compared to previous reports. This study is by nature exploratory and contains quantitative and qualitative aspects. Interviews were intended to be carried out in order to gain better understanding of the WMS situation in these companies' warehouses and to identify issues and challenges facing these facilities and strategic solutions to improve them.

3.1.1. Sample Selection

The research work intended to explore the entire automotive industry operating in Turkey, which comprises of OEMs, ACMs and all SCM networks as mentioned in figure 3.1 above. In order to maintain the validity and reliability of data sources, we are concentrating on OEM operators who are members of accredited automotive institutions like; Automotive Manufacturers Association (OSD), Automotive Supply Industry (TAYSAD), Motor Vehicle Technical Committee (MARTEK), Automotive Technology and R&D Center (OTAM), Turkish Standard Institute (TSE), Automotive Industry Promotion Committee (OETK), Union of Uludag Automotive Parts and Components Exporters Association (UTAYSIB) etc.

No	Companies	Ownership Structure	Global Partner	Products
1	TOFAS/FIAT	Joint Venture	FIAT	Passenger Car
2	OYAK/RENAULT	JV	RENAULT	P. Car
3	TOYOTA	Foreign Direct Investment (FDI)	TOYOTA	P. Car
4	HYUNDAI ASSAN	JV	HYUNDAI	P. Car
5	HONDA	FDI	HONDA	P. Car
6	FORD/OTOSAN	JV	FORD	Commercial Vehicle
7	KARSAN	LOCAL	PSA/RENAULT TRUCK/HYUNDAI TRUCK	CV
8	BMC	LOCAL	LOCAL	CV
9	M.BENZ TURK	JV	M.BENZ	CV
10	ANADOLU ISUZU	JV	ISUZU	CV
11	TEMSA	LOCAL	MITSUBISHI	CV
12	OTOKAR	LOCAL	LAND ROVER	CV
13	M.A.N	FDI	M.A.N	CV

Sources: OSD 2010 Report

Table 3.1: Automotive manufacturers in Turkey

The sample selection will be limited to the OEMs listed in table 3.1 above, their annual reports will be analyzed to extract the impacts of WMSs to automotive SCM.

Sources: OSD 2010 Report

Figure 3.3: Location and Production Site of ACMs in Turkey

3.1.2. Problem Statement

The impact of warehousing management and WMS in the automotive industry supply chain is in three types which will be explained in the levels of WMS operation.

- **Basic WMS**: These are basic technological application to support basic warehouse operations of inbound and outbound including inventory control management with RF infrastructures.

- **Advanced WMS**: The next level in warehouse infrastructural development is advance in resource planning and management technology which synchronizes the material flow in real time with KPI analysis and reporting.

- **Complex WMS**: This is highest level of WMS infrastructural endowment in this 21st century technological development. In this system, the application has tracking and tracing capabilities with real time locator enabler and ability to connect warehouse with other warehouses in real time information sharing and

full time integration. Inventory status and destination, through planning, execution and control capabilities. With the application of complex system which offers additional functionality like transportation, dock door, and value added logistics planning which help to optimize the warehouse operation.[27]

3.2. RESEARCH HYPOTHESIS

The WMS information is simple and focuses on through-put and rapid response. The specific research hypothesis for the basic WMS include:

Hypothesis 1: There is a significant organizational change in warehouse operation on WMS implementation.

Hypothesis 2: There is a significant relationship between warehouse management and WMS in the overall effectiveness of the warehouse operation.

Hypothesis 3: There is a significant relationship with all integrated technological infrastructures with the effectiveness of the WMS.

The research focuses on examining the annual reports of the automotive manufacturer's, articles and industry's journals in the study; methodology was applied to gather qualitative and quantitative data in analyzing the research questions. Company's journal was examined in the context of warehouse performance improvement to meet production capacities. WMS comes in different packages, with manual or automated systems which can be deployed as a paper based RF / wireless based or combination of both or as full integrated system with real time enabler empowerment.

[27] Ramaa.A,K.N.Subramanya, T.M.RangaswamyInternational Journal of Computer Applications (0975 – 8887) Volume 54– No.1, September 2012,Impact of Warehouse Management System in a Supply Chain

3.2.1. Measuring Production Output and Sales Turnover

This research will focus on production output and sales turnover analysis based on the two companies with the highest annual production capacity based on 2013 annual report presented on AGM. Productivity is evidence of work performance expressed in output and is a measure of the efficiency of production; this can be expressed as the ratio of outputs to inputs used in the production process. Productivity is the relationship between the quantity of output and the quantity of input used to generate the output. It is basically a measure of the effectiveness and efficiency of your organization in generating output with the resources available.[28]

Productivity is defined as a ratio of output to input:

$$\text{PRODUCTIVITY} = \frac{\text{OUTPUT}}{\text{INPUT}}$$

Sales turnover on the other hand is a measurement of how a company's produce ends in the market place with a return in cash to support the operation, within a specified period of time in an accounting year. Sales turnover has a direct effect to productivity which is efficiency expressed in monetary value or as ROI. Let's look at the productivity and sales turnover of the selected automotive company's based on the published annual report of 2013, and this research will continue with the data analysis of these companies in the next chapter. To further, explain the impacts of WMS to the productivity and sales turnover of the automotive industry in Turkey, as efficiency and effectiveness of WMS is expressed in output figures.

3.2.2. TOFAŞ/FIAT Report:

In 2013, Turkish automotive market reached the second highest level after 2011 with 853.378 units of sales. The growth experienced in domestic market was originated

[28] A guide to productivity measurement, Spring Singapore 2011. http://www.spring.gov.sg

from higher level of automobile sales as happened in the previous year, whereas light commercial vehicle market showed a contraction.

Production Output in Units	**2012**	**2013**
Linea	36,909	40,570
Doblo	682	1,428
New Doblo	10,298	14,398
Minicargo	29,649	26,421
Passenger Car Total	**77,538**	**82,817**
Doblo	19,503	7,742
New Doblo	73,223	76,210
Minicargo	86,164	77,845
L.C.V. Total	178,890	161,797
TOTAL	**256,428**	**244,614**

Sources: TOFAŞ/FIAT 2013 Annual Report Sheet

Table 3.2: Production Output by Brand

There is a production volume decline in 2013 by 4.6% compared to 2012 operation results due to developments in the market place. The growth experienced in domestic market was originated from higher level of automobile sales as happened in the previous year, whereas light commercial vehicle market showed a contraction. The retails sales and exports results further clarify the production capacity and efficiency.

Local Retail Sales (Units)	**2012**	**2013**	**Change (%)**
Automobile	46,461	53,104	14.3%
Light Commercial vehicle	58,137	47,337	-18.6%
Total	**104,598**	**100,441**	**-4.0%**

Sources: TOFAŞ/FIAT 2013 Annual Report Sheet

Table 3.3: Domestic Retail Sales

The production output performance depicted in the table 3.2 and table 3.3 above showed a contraction in domestic sales in 2013 and an increase in export sales. This performance increase in export was as a result of strategy employed in entering new and different markets beyond Europe.

Exports (Units)	**2012**	**2013**	**Change (%)**
Automobile	46,869	43,477	-7.2%
Light commercial Vehicle	107,200	116,842	9.0%
Total	**154,069**	**160,319**	**4.1%**

Sources: TOFAŞ/FIAT 2013 Annual Report Sheet

Table 3.4: Export Sales

Other brands made by TOFAŞ/FIAT with their sales turnover rate in 2013: Fiat brand achieved 50,256 units in sales gained 7.6% in market share, Alfa Romeo, Lancia and Jeep brands automobile sales reached 2,785 units and raised by 30.9%, 40 units of Maserati and 23 units of Ferrari was sold in 2013.

3.2.3. FORD OTOSAN Report:

Since, the installation of Real Time Locator Systems (RTLS) at the plants of Ford Otosan, the productivity of the company has increased and it has worked to increase their capacity utilization rate to 85% which is above the obtainable averages among Turkish industry's and have manufactured 281, 287 vehicles in 2013. In the year under review, the company's manufacturing plants in Kocaeli and İnönü, with a total work force of 2,518 white and 6,926 blue collar jobs produced 144,101 units of Transit, 75,600 Transit Connect, 55,293 Transit Custom and Tourneo Custom vehicles, and 6,293 Cargo trucks. The industry recorded a contraction in the LCV which fell from 16% to 12%, in this segment the company captured 2nd place with a total sales of 103,446

vehicles and 3rd place in passenger car segment, with a sales volume of 58,405 and a market share of 8.8%.

3.2.4. Performance and Demand Management

Performance and demand management in automotive industry is changing rapidly due to technological advancement in the industry. With the aid of technology, performance management systems make it possible to monitor and analyze all production channels on continual basis to improve utilization and optimize production processes. Technological impact on demand management has also taking a new dimension to the way businesses are conducted in today's automotive industry. Technological development and improvement in high-tech has enabled automotive manufacturers to have a more direct relationship with customers and dealers. Unlike the traditional model through which automobile dealers were responsible for managing customer relationships, this direct link to customers opens doors to new marketing and sales opportunities for OEMs and introduces speed in all operations.[29]

Performance Management Systems (PMS) at TOFAŞ/FIAT is a human resources management tool to measure the productive work-force contribution to general activities of the employee both the blue and white collar jobs in achieving the overall corporate goals. PMS covers the entire employee from White-Collar to Blue-Collar. The output of PMS is the performance evaluations and contribution of each unit in each department, which are used in individual development and career planning for all employees, the results are also used for the calculation of performance bonus for White-Collar employees.[30]

Ford Otosan's PMS like other automotive company's aims to improved performance in other to achieve general corporate objectives, and to manage employees by objectively evaluating their individual performance within a framework of

[29]Deloitte Research – Integrating Demand and Supply Chains in the Global Automotive Industry. www.deloitte.com

[30]TOFAŞ/FIAT annual financial reports 2013

common set standards. Employee's individual achievements are monitored and supervised by a unit head or departmental manager periodically, every quarter, to highlight areas of improvement or areas of commendation and rewards. In addition to the goals, competencies also play a significant role in the system and provide opportunities for employee development. Ford Otosan encourages employees to change for the better, in line with the principle of continuous development by evaluating the skills, performance potential of each employee.[31]

3.3. THE QUALITATIVE RESEARCH

A qualitative study inspires us to "understand a situation that would otherwise be enigmatic or confusing"[32] The rationale for using a qualitative approach in this research was to explore and describe the level of dependence automotive industry has on WMS technologies and their impacts on KPI. Qualitative research is simply "any kind of research that produces findings not arrived at by means of statistical procedures or other means of quantification".[33] Qualitative research also uses a naturalistic approach that seeks to understand the issues in context settings, such as "as the real world setting" the researcher does not try to manipulate the issues to suit research interest.

3.3.1. Performance Improvement with WMS

Research reveals that if warehouses and WMSs are going to contribute to purposes of its set-up in increasing value to the supply chain of the organization, it will need constant evaluation analysis. The metrics for measuring performance in a warehouse fall into three major categories which includes order fulfillment, inventory management and warehouse productivity.

[31] FORD OTOSAN annual financial reports 2013

[32] Eisner, E. W. (1991). The enlightened eye: Qualitative inquiry and the enhancement of educational practice. New York, NY: Macmillan Publishing Company

[33] Strauss, A., & Corbin, J. (1990).P. 17, Basics of qualitative research: Grounded theory procedures and techniques. Newbury Park, CA: Sage Publications, Inc.

Warehousing Activities	Time savings Per Order (In Minutes)	Activities Improvement (%)
Receiving Activities	**169**	**78**
Put-Away Activities	**24**	**46.84**
Picking Activities	**59**	**87.78**
Packing Activities	**45**	**78.68**
Dispatch Activities	**414**	**84.2**

Table 3.5: Warehouse Evaluation after WMS Implementation

3.3.2. Validity and Reliability of the Research

To understand the meaning of validity and reliability, it is necessary to present the various definitions of reliability and validity given by many qualitative researchers from different perspectives. It further states that, validity and reliability are two factors which any qualitative researcher should be concerned about while designing a study, analyzing results and judging the quality of the study. This corresponds to the question that "How can an inquirer persuade his or her audiences that the research findings of an inquiry are worth paying attention to?"[34]

This relates to the concept of a good quality research when reliability is a concept to evaluate quality in quantitative study with a "purpose of explaining" while quality concept in qualitative study has the purpose of "generating understanding"[35] The discussion of quality in qualitative research initiated from the concerns about validity and reliability in quantitative tradition which "involved substituting new term for words

[34]Lincoln, Y. S., &Guba, E. G. (1985).P.295, Naturalistic inquiry. Beverly Hills, CA: Sage.

[35]Stenbacka, C. (2001). Qualitative research requires quality concepts of its own. Management Decision, 39(7), 551-555

such as validity and reliability to reflect interpretive [qualitative] conceptions"[36] In order to show clarity while, establishing good quality studies through reliability and validity in qualitative research, states that the "trustworthiness of a research report lies at the heart of issues conventionally discussed as validity and reliability".

3.3.3. Validity

The concept of validity is described by a wide range of terms in qualitative studies. This concept is not a single, fixed or universal concept, but "rather a contingent construct, inescapably grounded in the processes and intentions of particular research methodologies and projects"[37] Validity determines whether the research truly measures that which it was intended to measure or how truthful the research results are. In other words, does the research instrument allow you to hit "the bull's eye" of your research object? Researchers generally determine validity by asking a series of questions, and will often look for the answers in the research of others.[38]

3.3.4. Reliability

The term 'Reliability' is a concept employed in the testing of quantitative research; the basic idea is always used in different types of research work. The approach in the testing of any kind of research work is for edification of information filtration for the purpose of getting the fundamental truth of the research, the target of any qualitative study is its quality. To ensure reliability in qualitative research, examination of the sources is crucial in the quality. In this thesis reliability issue concerns measurements then it has no relevance in qualitative research. She adds the issue of reliability is an irrelevant matter in the judgment of quality of qualitative

[36]Seale, C. (1999). Quality in qualitative research. Qualitative Inquiry, 5(4), 465-478

[37]Winter, G. (2000).A comparative discussion of the notion of validity in qualitative and quantitative research.The Qualitative Report, 4(3&4). Retrieved February 25, 1998, from http://www.nova.edu/ssss/QR/QR4-3/winter.html

[38]Joppe, M. (2000).The Research Process. Retrieved February 25, 1998, from http://www.ryerson.ca/~mjoppe/rp.htm

research. Therefore, if it is used then the “consequence is rather that the study is no good”.[39]

3.4. DATA PRESENTATION AND ANALYSIS

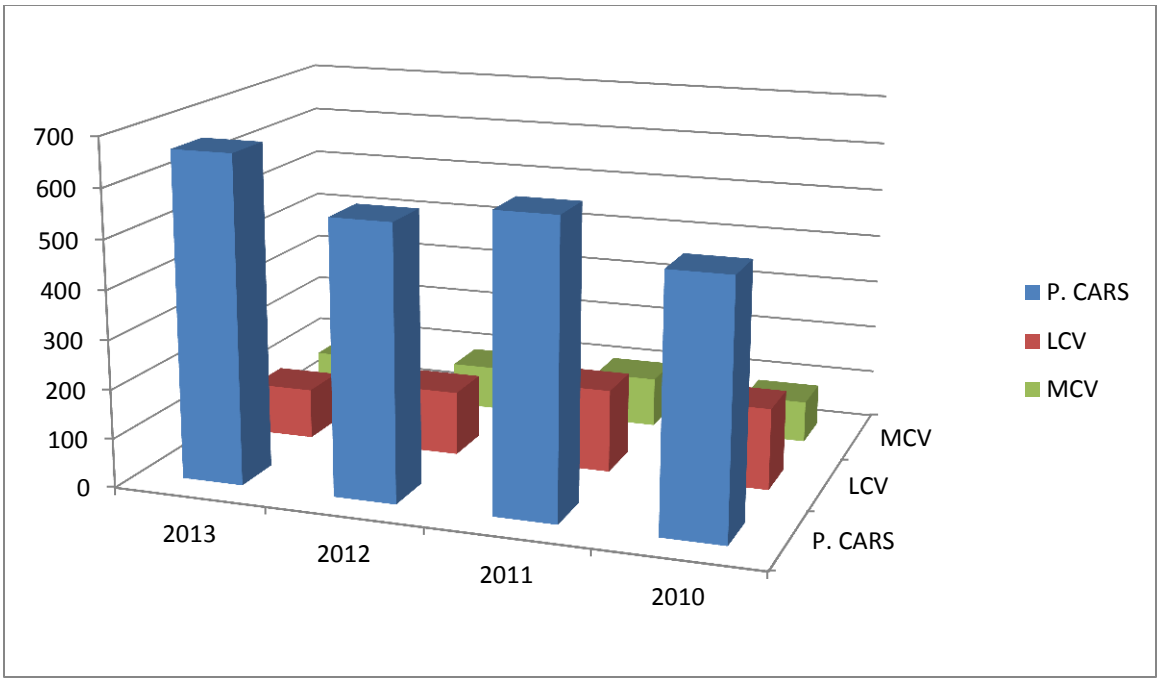
This section covers the automotive industry in numbers with the analysis to describe the results and progress in the industry. Data presentation and analysis is the process of developing answers to research questions through sample analysis and interpretation of data. The basic steps in the analytic process consist of identifying issues, determining the availability of suitable data, deciding on which methods are appropriate for answering the questions of interest, applying the method and evaluating, summarizing and communicating the results.[40] The research presentation results and analysis of the model used and a test of the hypothesis are exemplified in the section of the thesis.

3.4.1. Data Presentation

This section highlights the automotive industry data results as mentioned earlier in this thesis using the products segment and brand production and performance results. This work will measure four year data reports and analysis to uncover the growths and developments in the industry. Later in the section, this thesis has focused on the two companies with high production capacity to explain the effectiveness and efficiency of the production systems and the technical ability of the R&D.

[39]Stenbacka, C. (2001). Qualitative research requires quality concepts of its own. Management Decision, 39(7), 551-555. P. 552

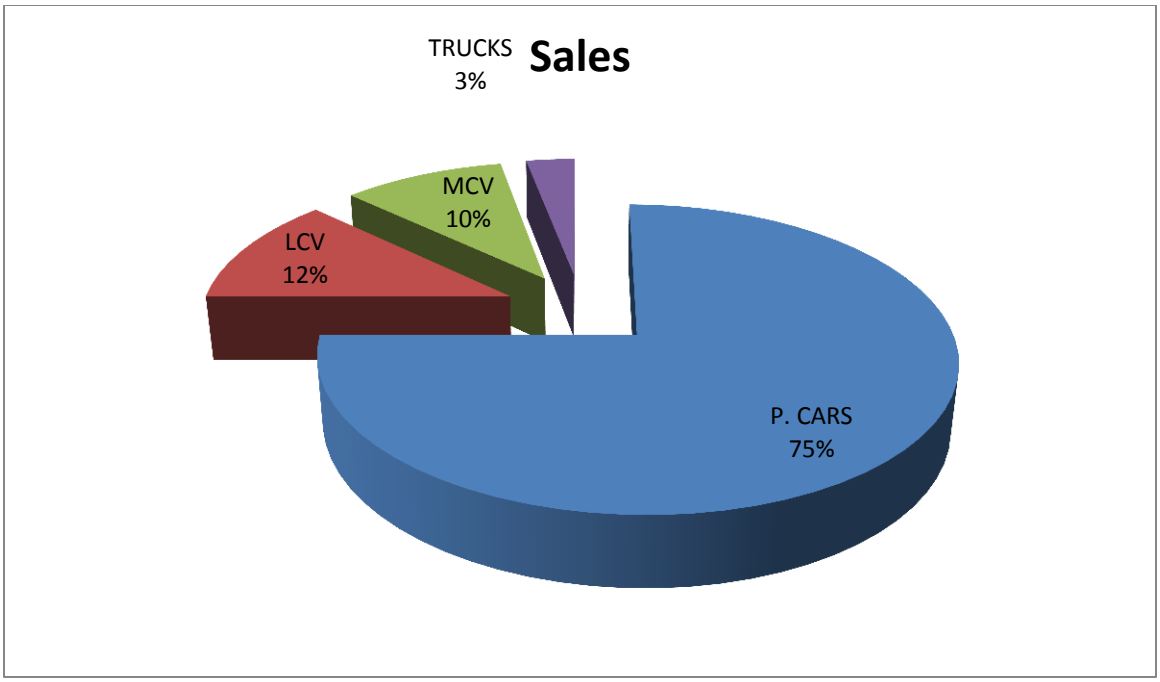
[40]Binder, D.A. and G.R. Roberts. 2003. "Design-based methods for estimating model parameters." In Analysis of Survey Data.R.L. Chambers and C.J. Skinner (eds.) Chichester.Wiley. p. 29-48.



Sources: TOFAŞ/FIAT Annual Report 2013

Figure 3.4: Turkish Automotive Industry Production Chart

The industry's four year performance showed that, there is constant growth in all vehicle segments but, passenger cars reached record high in 2013. General Sales showed an increase by 19% and reached a record 664,655 units, with intense competition across the industry with market shares of each segment showing drop from company to company as well as price competition within the same segment. This stiff competition across different segments has encouraged foreign brands to continue their influence in the market for imported automobiles which the market share rose from 74% in 2012 to 78% in 2013. The market share of passenger cars represents a continued increase in that segment in 2013 which rose from 69% to 75%, both domestic consumptions and exports.



Sources: Annual Report of Ford Otosan

Figure 3.5: Turkish Automotive Industry Sales Report 2013

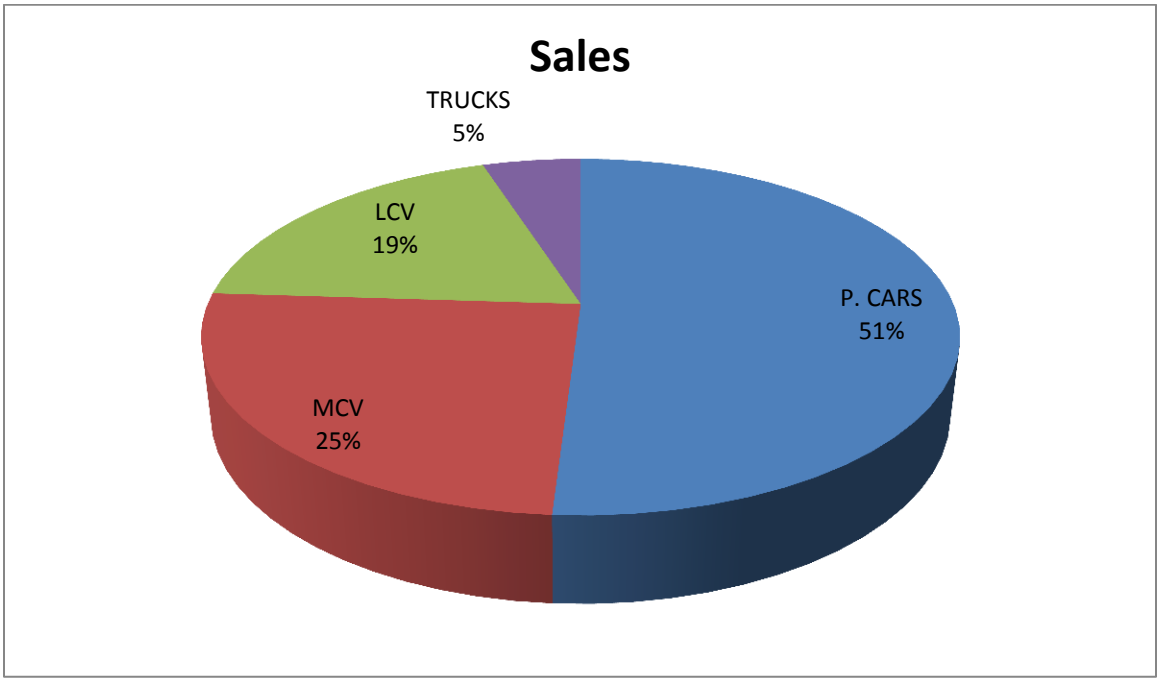
The industry experienced continued growth in the sector especial in the passenger cars segment, as sales continued to increase in domestic markets as well as exports to all the continents of the world which resulted in growth at the rate of 19%, 664,655 passenger cars, 103,446 light commercial vehicles, 85,277 medium commercial vehicles and 28,159 trucks were sold in 2013 both in domestics and export markets. The year also experienced decreased in sales of some segments like; light commercial vehicle sales slumped from 16% t0 12% and 6% decrease in medium commercial vehicle with sales of 85,277 units.

3.5. **DESCRIPTIVE ANALYSIS OF THE DATA**

The data above is based on the automotive annual reports from 2010 to 2013 of major operators in the industry. The descriptive analysis is carried out to determine the link between WMS effectiveness to high production performance.

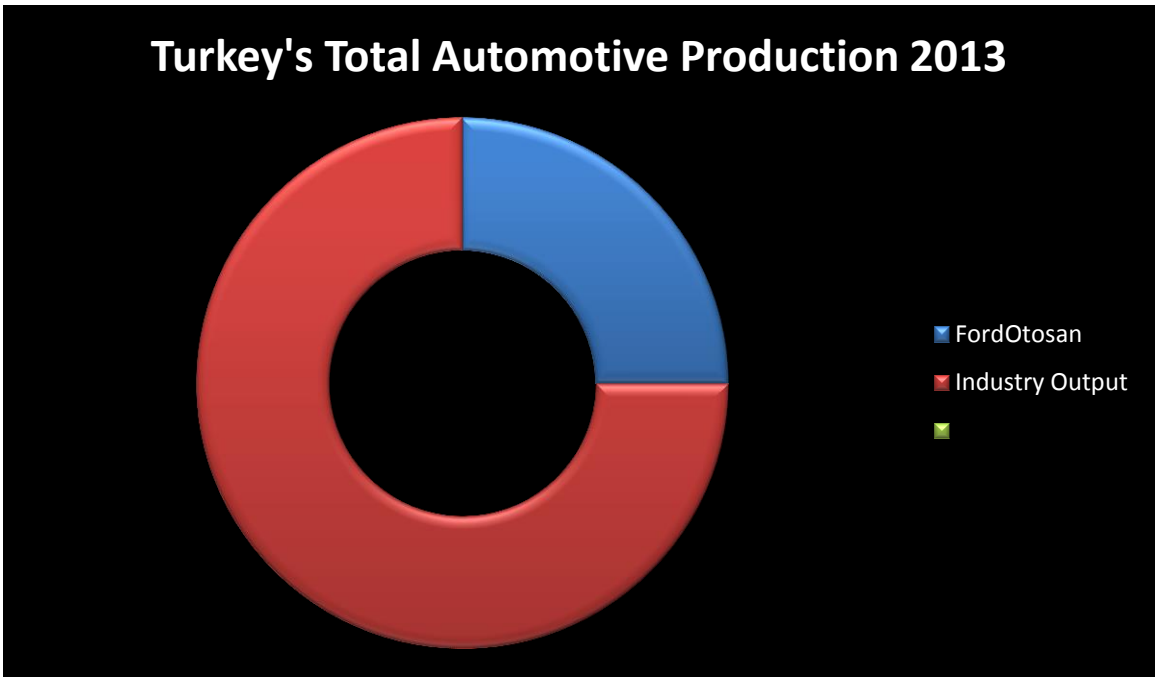
3.5.1. Ford Otosan's Data Presentation and Analysis

The performance of the Turkish automotive industry in 2013 was commended by the automotive institute despite the fluctuations in foreign exchanges and a struggling economy caused by political and social unrest. The market share of some company's rose and others contracted with intense competition and strategic exchanges, Ford Otosan experienced increase in market share by 12.9%, with a sales volume of 114,141 units in all segments in 2013, and continued to maintain leadership in the market place for the 12th time as a preferred local brand. 45% of metropolitan taxi passenger cars are made by Ford Otosan.



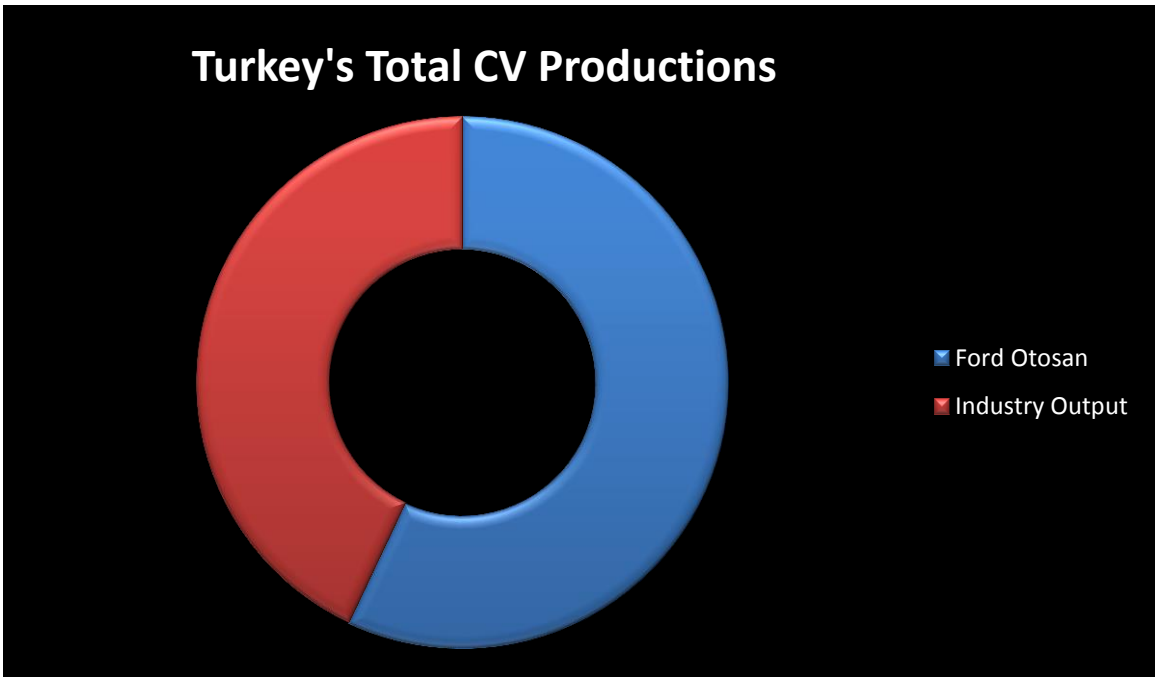
Source: Ford Otosan Annual Report 2013

Figure 3.6: Ford Otosan's Sales Analysis in all Segments



Sources: Ford Otosan's Investors Report 2014

Figure 3.7: Performance Chart of Ford Otosan 2014



Source: Ford Otosan's Investors Report 2014

Figure 3.6: Ford Otosan's CV Market Share

Data collected from the company's annual report in 2013 analyzed, shows respective results of each company operating in the industry according to their performance and market share through total sales made within the year. Ford Otosan came 3rd with recorded total sales of 58,405 vehicles in the passenger segment and a market share of 8.8%. She got 2nd place in the light commercial vehicles segment, with a total number of 103,446 vehicles sold, and a market share of 20.7%. In the medium commercial vehicles segment, which contracted by 6%. While in the trucks segment, it again got 2nd place with a sales volume of 5,986 cargo vehicles, and a market share of 21.3%.

3.5.2. TOFAŞ/FIAT Data Presentation and Analysis

Fiat brand achieved 13.5% increase in domestic automobile sales compared to 2012 with total sales of 50,256 units gained 7.6% market share. The most preferred automobile in domestic market with its 5.6% market share was Fiat Linea again as in 2012. Alfa Romeo, Lancia and Jeep brands automobile sales rose by 30.9% and reached 2,785 units. In 2013, while a total of 40 Maserati was sold, Ferrari sales included 23 units making the total retail results reached 53,104 units.

Light commercial vehicle market, however, shrank by 14.8% in 2013 compared to previous year and finished the year with 188,723 units. Contrary to passenger car market, contraction seen in share of light commercial vehicle demand in the overall market, which is mostly supplied by domestic production, has negative influence on national economy and especially on the current account deficit. It achieved 25.1% market share in light commercial vehicle market and realized 47.337 vehicle retail sales. Fiat Doblo model has achieved to be the most preferred model of its segment with its market share of 11.5%.

Source: TOFAŞ/FIAT Annual Report

Figure 3.9: TOFAŞ/FIAT Performance Report

3.5.3. WMS Evaluation and Capability Analysis

WMS's technological advancement in the industry has shown the industry's level of adaptability to emerging trends; it has shown an increase in the productivity and performance levels as shown in Figure 3.7. The industry has demonstrated improvement in the WMS adoption in different capacities from medium to high number of functionalities which represents medium-high technology contents, medium-high adaptability to fit into warehouse operations and to integrate functions and support for warehouse automation.

	(N=16)		(N=8)		(N=8)			
Evaluation Criteria	Mean Score*	Standard Deviation	Mean Score	Standard Deviation	Mean Score	Standard Deviation	Gap**	%
Number of Functionalities	2.25	0.58	2.00	0	2.50	0.76	-0.50	-20%
Technology Content	2.06	0.77	1.63	0.52	2.50	0.76	-0.87	-34.8%
Adaptability	2.19	0.75	2.13	0.64	2.25	0.88	-0.12	-0.53%
Integration & Support for Warehouse Automation	1.81	0.75	1.63	0.52	2.00	0.93	-0.37	-18.5%

*Mean Score in Scale of 3:1 = Low 2, = Medium, 3 = High

** Difference b/w Mean score of small and medium – large warehouse

Table 3.6: Evaluation of WMS

It is worth noting that integration and support for warehouse automation only gives a mean score of 1.81 with standard deviation of 0.75.

In Ford Otosan facilities in Kocaeli and İnönü Plants where 16,000 and 8,000 vehicles were respectively, monitored in real time with the aid of RTLS technology. The system allows vehicles to move in chronological sequence by smart computerized systems to a preferred location within the stock areas, depending on the final destination of the product, for local consumption or for export immediately after completion of production.

3.5.4. R&D Needs for WMS

R&D is the future development or redevelopment of a structure within the framework of improving the feature or functionalities of a product with the intention of re-engineering the technological features with increase in functionality is the major objective of any research. The scope of these thesis research work on R&D needs of

WMS will focus on the automotive industry in Turkey revealing their present and future activities in R&D as uncovered during course of this work. In product redevelopment or improvement of technologies features, TOFAŞ/FIAT R&D focuses on user friendly, innovative, efficient and simply techniques in analyzing optimizations. The R&D department focuses on the redesign and redevelopment based on the industry's set standards and safety measures in feature verification and testing components for meeting set targets.

Taking a closer look at the researches of TOFAŞ/FIAT R&D department in products, production technologies are in factory automation for mass production flow with zero error tolerance. The decision during the configuration of the R&D drawings which supports already existing system is done with the aid of, computer-aided process simulation and automation, for the innovative process systems developments to be visual for physical implementation. Robotic measurement is integrated in quality assurance systems, developing energy efficient production with production management systems and prototype manufacturing.[41]

[41]TOFAŞ/FIAT Annual Report 2013

CONCLUSION

This section ends the research work by making conclusions based on the research results and providing recommendations accordingly for further research. This research reveals that WMS helps in the general effectiveness and efficiency of the entire organization by reducing operating costs, inventory levels and increase responsiveness to demand in strengthening the overall competitive advantage of the organization. When installing WMS in automotive manufacturing facilities, the clear goals and objectives of the project should be discussed prior and analyzed by all the sections and departments that will apply the systems in their individual functions. After implementation with automation, this will advance the productivity and output of the plant and ensure that the production site is producing at full capacity.

In Turkish automotive industry about 65% of companies operating in this sector are planning to update or replace their WMS in the next few months to reposition operational competitiveness, because companies are looking for more agile and visible capabilities in their new WMSs. Looking at the WMS in largest automotive warehouse and parts distribution center at Ford Otosan's Kartal facility, with a warehouse operating floor area of 25,000m2 among the largest facility in Ford group in Europe with about 96.5% fill rate featuring all the WMSs to manage processes and procedures in real time, the efficiency and effectiveness have always increased operational capacity, hence, the company maintains leadership in the industry.

Coordinating and managing operations in 25,000m2 indoor floor requires most effective and efficient WMS installations which have five basics capabilities in processing inbound, based on information received from other integrated systems, full documentation of outbound connected with other systems, reporting and updating inventory control activity to the accounting systems, managing exceptions, and feeding data to reporting systems. WMS is powered by high speed internet infrastructure for maximum efficiency. In Ford Otosan's production facility which have the latest WMS in operation with these features; voice and data communications, IP telephony, email and

video conferencing capabilities across three manufacturing locations with IP-based technologies.

The new WMS network is installed with highly secure, high speed capability supporting all of its manufacturing functions with real time features. After the installation of the new network of WMS infrastructure in those facilities to increase the operation capabilities following the growing demand of the brand. The networks improved employee efficiency, enabling 24/7 production at these plant with accuracy in all the integrated sections. Turkish automotive industry warehousing has experienced developmental cycle stages, with different approaches imported from abroad and benchmarked to consolidate the improvement made. At TOFAŞ/FIAT WMS programs to increase efficiency through their WCPP instituted 7 years ago with the intent of improving productivity, through VSM techniques and lean thinking approach as mentioned earlier in chapter 2 of this thesis. ALB, sequencing and scheduling were greatly improved with full automation and robotic technology integrated into WMS for flawless production in all the manufacturing plants. This improvement has increased production capacity and competitive advantage. A CI technique is one of the tools that have revived the industry through reviewed feedbacks analyzed and improved with targeted goal objective. CI main goal in automotive supply chain is customer service and satisfaction oriented in products and services.

TQM in Turkish automotive industry is critical issue monitored by accredited institutions and supervised by automotive institutes to ensure compliance to acceptable standards. In TOFAŞ/FIAT's TQM programs which is based on supplier's selection management. In conforming to TQM, suppliers expected to meet certain standards criteria, which are;

- Having technical (quality, cost competitiveness, delivery performance) and organizational competencies for meeting the expectations of automotive sector,
- Holding ISO TS 16949 and ISO 14001 quality certifications
- Having developed production and design skills,

- Being audited by PSA and
- PA
- Being able to contribute to the competitiveness of TOFAŞ/FIAT's in
- quality and cost improvement,
- Continuously improving itself and Its competitiveness through following closely foreign and local competitors.[42]

The TQM system is a set standard guiding the processes and procedure in the industry in protecting consumer expectations and satisfaction. This approach starts from supply sources to supplier requirements through production and assembly lines.

[42]TOFAŞ/FIAT's Annual Reports 2013

RECOMMENDATIONS

In this section of the research, I am making reasonable suggestion for academic references and industrial application. Turkish automotive industry has an installed capacity of 1.5 million in PC, LCV and MCV segments, but, the industry is performing below installed capacity compared with her European counterparts. This section will focus on the reasons behind under-performance and under-utilization, as we offer our constructive criticism and recommendation for further research. Let's consider the existing installed production capacity among the major players in the industry;

- Hyundai, Ford and Renault 100% installed capacity are operating on > 80%
- Toyota and Hyundai recently announced capacity increase in the Turkey plants
- Fiat plant in Bursa produces > 90% installed capacity and bears the 'silver' production quality which remains highest in the industry.
- In HVC, Daimler, M.A.N., Karsan, Isuzu, Otokar, Temsa and BMC have production facilities in Turkey with installed capacity of 100,000 in total.

The inability to meet expected production capacity in the industry, in general, it can be caused by the challenges facing the industry globally like;

- Demographic changes and shift in global economic power
- Increasing consumer expectation

New technologies are dramatically changing the features in a vehicle from conventional support systems to enhanced driver support systems and to better fuel efficiency and new or improved carbon emissions. In my recommendation to the afore-mentioned challenges facing the industry can be classified within the internal and external environments, which the former can be controlled while the latter can only be managed with the frame-work of the institution. The former can be controlled by the invested interest within the family. The major internal problem facing the Turkish automotive industry is the power of invested interest, which means; the families that own or have a major stake in the company, many of the Turkish companies are owned and managed by the families or her members. They assume management positions

whether skilled in the area top executive management or not. Another issue facing the industry is language barrier as the knowledge of logistics and automotive technical engıneering is imported and so, is the educational materials. When a new idea is adopted, implementation takes longer time to assimilate into rank and files of the workforce. Training and retraining the workforce outside the immediate and limited environment to a more high tech research centers will empower and improve their technical know-how and further impact the host company. The human resources in automotive industries and her suppliers are confronted daily with increasing operational complexity as a result of increasing numbers of products and options, increasing pressure to innovate, shorter technological cycles, and global supply networks. Those trained among the global leader will import unusual skills with new techniques to tackle emerging trends as a solution to the challenges facing them through;

- Understanding their market and its dynamics
- Through building brands among existing products
- Adapting production strategies to existing cultures
- Balancing and taking a long-term view in perspective

Those trained leaders should be allowed by management to take the responsibility for driving automotive companies forward through creating a coherent strategy, defining goals and find ways and the right people to meet them without strong family intervention and influence. This thesis doesn’t have all the answers, but I hope it will provide some useful starting points for further thought and future discussion.

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ÖZET

Otomotiv sektöründe depolama, tedarik zincirinin bir parçası olarak yüksek öneme sahiptir. Bugünün Pazar koşullarında, otomotiv sektöründeki işletmeler rekabet edebilmek için depolama yeteneklerini iyileştirmek zorundadır. Farklı segmentlerindeki araç modellerindeki değişim, tip ve tasarım özelliklerindeki hızlı artış parka sayısında da etkili olmakta ve tedarik zincirini daha karmaşık bir hale getirmektedir.

Bu durum bir çok işletmeyi kendi değer zincirlerini yeniden planlamaya ve müşteri hizmetlerini geliştirmeye ve bunun için depolama sistemlerini incelemeye itmiştir. Bu tezde günün ekonomik koşullarında ve araç çeşitliliğindeki artış durumunda Depo Yönetim Sistemi (WMS)'nin verimliliğini sürdürmesi amacıyla bir çerçeve oluşturulmuştur. Bu tezde Türkiye'de yer alan 14 otomotiv üreticisinin üretim kapasitesi, yıllık satışları ve pazar payı göz önünde bulundurularak Depo Yönetim Sistemi (WMS)'nin geliştirilmesinin Türkiye Otomotiv Sektörü'ne etkisi incelenmiştir.

ABSTRACT

In automotive industry, warehousing has a great importance as a part of supply chain. In today's competitive automotive market, companies are under pressure by market forces to improve their warehousing capabilities if they are to compete in the market place. The rising modifications in vehicles models, types and designs across different segments with increase in the differentiation of spare parts has also made the SCM more complex in a lean environment of the auto industry.

This has also forced many companies to customize their value stream mapping and value chain analysis to increase their customer service levels, which has led to the changes in the role of WMSs. In this thesis it is also explained the framework and functionality of WMS in productiveness of the industry in times of economic melt-down and expansion in products. The thesis, measures the impacts of improved WMS in Turkish automotive industry supply chain against the 14 automotive manufacturers operating as OEMs and ACMs in Turkey with emphasis on production capacity, annual sales and market share of each company as reported in the annual company report presented to shareholders.