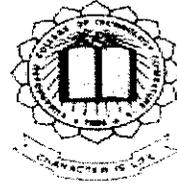


P-2787



**A STUDY ON LINE SIDE DELIVERY OF MATERIALS WITH
SPECIAL REFERENCE TO ASHOK LEYLAND LIMITED**

A PROJECT REPORT
Submitted by

P. SARAVANAKUMAR
Reg. No. 0720400040

In partial fulfilment of the requirements
for the award of the degree

Of

MASTER OF BUSINESS ADMINISTRATION

April, 2009

**KCT Business School
Department of Management Studies
Kumaraguru College of Technology
(An autonomous institution affiliated to Anna University, Coimbatore)
Coimbatore – 641 006**

CERTIFICATE FROM THE ORGANIZATION



ASSOCIATION

13th March 2009

CERTIFICATE

This is to certify that Mr. SARAVANAKUMAR P, MBA of KUMARAGURU COLLEGE OF TECHNOLOGY, COIMBATORE has successfully completed his project titled “**Line Side Delivery**” between 16/02/2009 to 13/03/2009.

During project work his conduct was found to be good.

P B Jayashankar
Sr Manager – Pers & Admin.

BONAFIDE CERTIFICATE



**DEPARTMENT OF MANAGEMENT STUDIES
KUMARAGURU COLLEGE OF TECHNOLOGY
COIMBATORE**

BONAFIDE CERTIFICATE

Certified that this project report titled “A study on Line Side Delivery of materials with special reference to Ashok Leyland limited” is the Bonafide work of Mr.P.Saravanakumar (Reg No: 0720400040) who carried out the project under my supervision. Certified further, that to the best of my knowledge the work reported herein does not form part of any other project report or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

K.R. Sathishkumar

Faculty Guide
(Mr. K.R.Sathishkumar)

S.V. Devanathan

Director
(Dr.S.V.Devanathan)

Evaluated and Viva-Voce conducted on ..05..05..2009.....

Sr
05/05/09

Examiner I

S.V. Devanathan

Examiner II

DECLARATION

I hereby declare that the dissertation entitled “**A study on Line Side Delivery of materials with special reference to Ashok Leyland limited**” submitted for the Master of Business Administration degree is my original work and the dissertation has not formed the basis reward of any degree, associate ship, fellowship or any other similar titles.



Signature of the Candidate

(P.Saravanakumar)

ACKNOWLEDGEMENT

ACKNOWLEDGEMENT

I express my sincere gratitude to our beloved correspondent **Mr. Balasubramaniam** the prime guiding spirit of Kumaraguru College of Technology.

I extend my heartfelt thanks to our principal **Dr. Joseph V. Thanikal**, Kumaraguru College of Technology, for provided facilities to do this project.

In great honour and with indebt gratitude I think my inspiring guide **Mr. K.R. Sathishkumar**, who has taken great interest in helping me on and often in the successful pursuit of my project. I am very much fortunate to get such a good guide, who encouraged me constantly with good counsel and helped me to complete the project successfully on time.

I express my heartfelt gratitude to **Mr. Shanavaskhan, Manager P&A**, for giving me an opportunity for doing the project in their esteemed organization and encouraged me with this expert counselling and guidance for successful completion of my research study.

I thank **Mr. Nagesh Kumar, Mr. Tamilselvan, and Mr. Magesh** of Ashok Leyland limited for their guidance towards the project.

I also extend my heartfelt gratitude to all the **Employees of Ashok Leyland limited**, for furnishing the information needed and being very accommodative in all aspects.

Above all, I thank **Almighty God and My Parents** for giving me the grace and constant support in successfully completing this project to the best of my ability.

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EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

Ashok Leyland has a wide supplier network. Supply chain is divided into inbound supply chain and outbound supply chain, in this project we are dealing with the inwarding of materials (inbound supply chain). The main objective of the project is to deliver the materials directly to the production line that involves inventory management, lead-time reduction in documentation, accountability, and manpower and space management. First the current system of inwarding of materials is thoroughly analyzed and lead-time for each activity is calculated. Also study reveals the obstacles in the present system. By eliminating those obstacles a new system for inwarding of materials is proposed. A comparison is made between the current system and the proposed system is made and the benefits of the proposed system are highlighted in the study. Comparison is done in the basis of lead-time, inventory carry over and material movement. The advantages of proposed system over the current system are discussed and the advantages of the proposed system are mentioned in the study. Implementation is done in trail basis for a week and the performance is observed. The results were encouraging and the project is accepted for implementation.

BACKGROUND OF THE STUDY

1.1. BACKGROUND OF THE STUDY:

Supply chain management (SCM) has dominated our lives, our thinking and our actions almost half a decade now. Industry and academicians have spent several man-years in understanding researching the intricacies of SCM. From logistics to materials management to SCM, the evolution has been slow and steady. The decade of the '90s has been the most turbulent leading to large-scale adoption of the concept of SCM. Shift in power from the manufacturer to the consumer, user-friendly technology, advent of the omnipresent Internet and economic deregulation leading to stiff competition are just some of the characteristics of this new age. This has also meant shifting of the onus of creating profit and wealth from the market (external environment outside the manufacturer's control) to inside the organization (within the manufacturer's control). The tools and techniques of SCM have come to the manufacturer's rescue. There are several stories of how companies have released locked in capital, thereby generating profits in-house by implementing SCM. The benefits are manifold and long term.

Implementing SCM is a long drawn process that necessitates restructuring of not only internal organizational activities but also demands a relook at the relationships the company shares with its suppliers, distributors and all others who participate in the value creation process.

Ashok Leyland limited has a good supply chain network internally as well as externally. So Ashok Leyland limited was chosen to do the study

INTRODUCTION TO SCM

1.2. SUPPLY CHAIN MANAGEMENT:

A supply chain includes all the processes that add customer desired value to material and bring it to the customer. This value gets added at various stages of the journey that material takes till it reaches the customer. Supply chain encompasses all these value adding stages.

Very simply put, SCM is a network of the manufacturer's suppliers, and suppliers' suppliers on the one hand and customers and customer's customers on the other hand. This network exists to ensure a free and smooth flow of information, goods, services and profits among all its participants. In supply chain parlance each player is a supplier and supplies to the next player either basic raw materials, or components or semi-finished products that manufacturer supplies to the distributor, who then supplies them to the retailer and who then supplies to the end user. It is an equivalent of a relay race where there four players one after the other. The first hands the baton to the next, who then tries to maintain and even improves upon the performance of the earlier runner and passes on the benefits so derived to the next player and the process goes on till all the players have performed. The race cannot be won by best performance of any single player. It has to be a collective effort, a joint Endeavour.

DEFINITION:

Supply chain literature is full of various definitions for supply chains. Given below are some of the famous SCM definitions:

✚ MIT official definition

" Integrated Supply Chain Management (ISCM) is a process oriented, integrated approach to procuring, producing and delivering products and services to customers. ISCM has a broad scope that includes sub suppliers, suppliers, internal operations, trade customers, retail customers and end users. It covers the management of materials, information and fund flows".

↓ **Ohio state university's Global SCM Forum**

" The integration of business process from end user through original suppliers, that provide products, services and information that add value for customers."

↓ **Cisco**

"SCM aims to increase sales, reduce costs, and make full use of assets by streamlining the interaction and communication of all participants along the supply chain. SCM solutions use networking technology to link suppliers, distributors, and business partners to better satisfy the end customer, while feeding real time data about customer demand into the partners' production and distribution processes."

IMPORTANCE TO SCM:

The world market is progressively becoming more challenging for marketers, producers and their suppliers with increased availability of world class, high quality producers at costs, which are low in both relative and absolute terms. With purchased content accounting in many organizations, of up to 70 percent and more of the total cost of manufactured goods, the strategic significance of the supply management function has become a major determinant both of competitiveness in the market and corporate profitability. For wooing and winning the end user, companies need to take everybody associated together. It has to be a joint effort with all the players optimizing their performance. Suppliers, suppliers' suppliers, and various functions within the organization, distributors, retailers and absolutes everybody who can contribute in whatever little way to grab that small inch of market share. This thought process has brought SCM into focus. A sound workable supply chain strategy has become the most important agenda of top management the world over. The competition is not between individual firms but supply chains. And the supply chain that is faster and agile wins in the ultimate market.

SUPPLY CHAIN PROCESS

1.3. SUPPLY CHAIN PROCESS: INPUT:

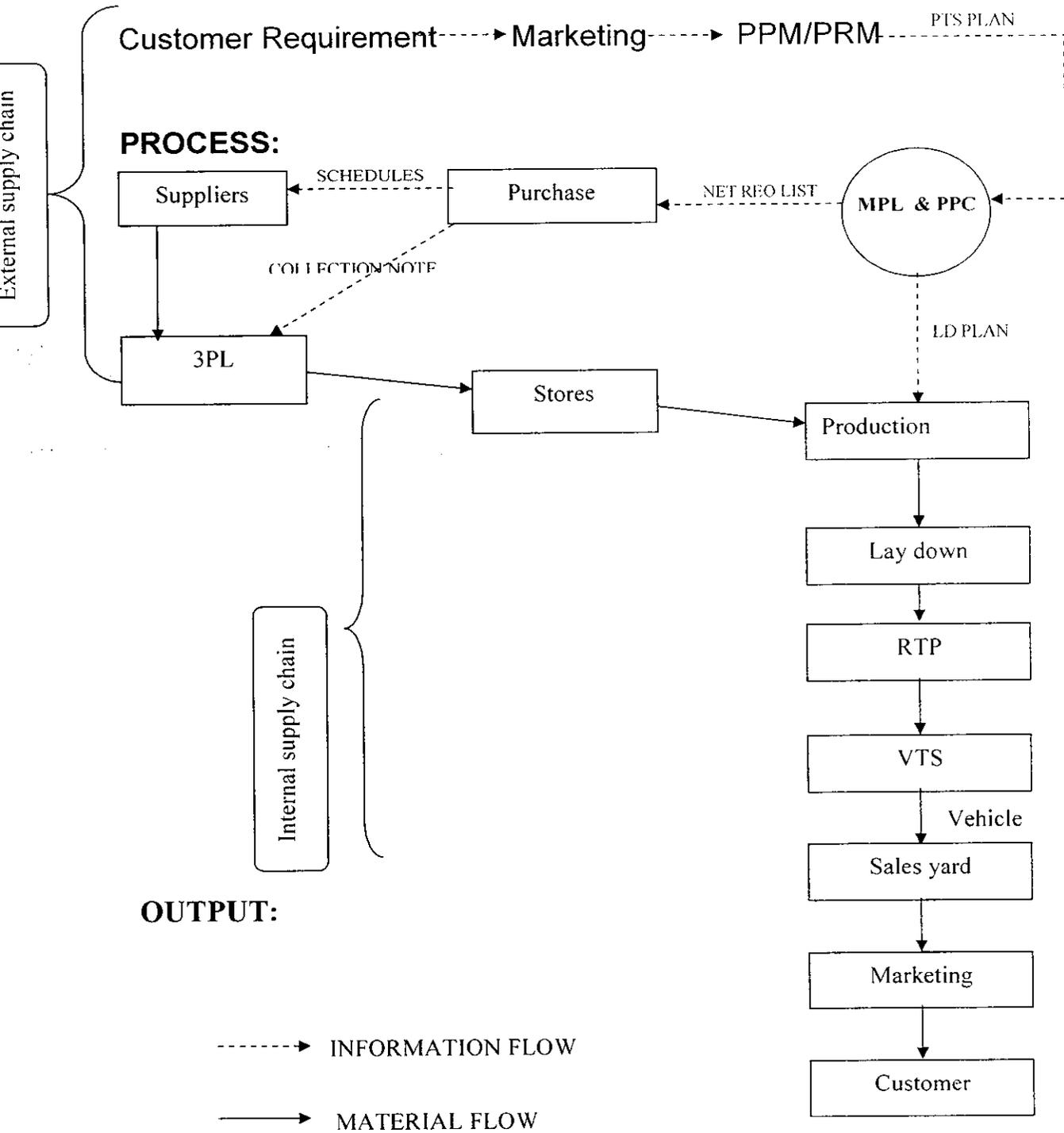


FIG.1.3.1 SUPPLY CHAIN PROCESS.

SUPPLY CHAIN PROCESS:**Input:**

The marketing department collects the input flows of information on the requirement for the customer and this information is taken to the PPM (Production Plan Meeting).

Process:

The product is being designed according to the customer requirement and this is being transferred as the manufacturing process by the PEP (Production Engineering Planning). This was then transferred to purchase department for procurement. Various verification processes for the purchased product take the flow and these items are store posted.

The following are actions done in manufacturing

- Production plan based on that aggregate plan.
- Aggregate planning
- Production lay down punching online
- Issue list generation
- Shortage capturing
- Sequence planning
- Lay down

Output;

The outputs of the production are

- Off –track
- Road test preparation
- Vehicle testing
- Delivery to sales yard

The following are the check and act actions that follow up in the output of the process:

- Volume adherence
- Model adherence
- VTS
- Metrics

PURCHASE AND MATERIAL PLANNING:

The planning of the year is being done in two major categories:

1. Master business plan
2. Monthly requirement plan (MRP)

MASTER BUSINESS PLAN:

The master business plan was carried out with the annual demand forecast that was being done by the marketing department. The planning would be done for the forthcoming year.

The rough plan would be made for next five years. The planning was done in the respect of the recruitment, infrastructure, materials, output, requirements etc., This looks after the overall planning of the various units of the company, which are located at Ennore, Hosur unit-I, Hosur unit-II, Alwar and Bandara. The sixth unit is being developed at Uttranchal.

MONTHLY REQUIREMENT PLAN:

Material planning cell would collect the requirement from the marketing department. The monthly requirement plan was made from the master business plan. Production Plan Meeting (PPM) was organized every month where overall planning was done. The allocation for each unit was made. There was a team that represents unit, which consists of members from Material planning, corporate quality, Unit head and Strategic sourcing. The team would analyze the allocations and revert backs the difficulties. Based on this meeting 12 weeks plan for material planning will be released.

PURCHASES HIERARCHY:

1. Strategic sourcing:
 - New component development
 - Vendor development
 - Vendor performance monitoring
 - Price claims (issues)
2. Purchase:
 - Scheduling
 - Procurement

PURCHASE ITEMS:

Purchases are grouped under the following categories

- Electrical
- BOF
- Sheet metal
- Machining
- Rubber plastic
- Forging & Casting
- Consumables

Sheet metal machine was further divided into

- Load body
- Sheet metal
- Material forecasting

Each item has its buyer code, this was based on the PPM's Net Requirement List (NRL)

PURCHASE OPERATIONS:

The purchase operation has classified its items into three major categories:

1. LCL
2. MRP
3. JIT

These categories have different Lead-time, different safety stock level and different Reorder level.

The basis for the classification value volume matrix

Model Rupees	Runner	Repeater	Stranger
Above 300			
30-300			
Below 30			

	JIT
	MRP
	LCL

MODEL CLASSIFICATION:

- Runner – Regularly producing model.
- Repeater – produced once in a period of time.
- Stranger – produced after receiving orders from the customers.

MATERIAL PLANNING:

Material planning was association of

1. Marketing
2. Purchase
3. Production
4. Product development

They receive the master production schedule from the PPM and NRL was produced. With NRL as base Green list was prepared.

- Gross requirement for next 12 weeks will be given.
- Net requirement for next 6 weeks will be given.
- Engineering change modification which they inform the purchases, production and the quality control for the new products and the existing products.
- Inter unit transfer allocation
- Spares are to be given to the customers
- Alternate product specification, which they do for the original components.
- The material planning was the first department, which would get the information about the allocation of units.
- Aggregate plan was created
- Sales plan was being generated for a week.
- Lay down plan was generated in day wise.

ORGANIZATION PROFILE

1.4. ORGANISATION PROFILE:

Ashok Leyland, the flagship company of the Hinduja group is the second largest manufacturer of commercial vehicles and diesel engines in India. The product range comprises commercial vehicles, special vehicles and engines for automobiles, marine and industrial applications, transmission and spare parts. Eight out of ten metro transport buses in India are from Ashok Leyland. At 70 million passengers a day, Ashok Leyland buses carry more than the entire rail network.

From 18 seated to 82 seated double Decker buses, from 7.5MT 49MT in haulage vehicles, from numerous special application vehicles to diesel engines for industrial marine and genset applications, Ashok Leyland offers a wide range of products.

For over six decades, Ashok Leyland has been the technology leader in India's commercial vehicle industry moulding the country's commercial vehicle profile by introducing technologies and product ideas that have gone on to become industry norms.

HISTORY:

The origin of Ashok Leyland can be traced to the urge for self-reliance, felt by independent India. Pandit Jawaharlal Nehru, India's first Prime Minister persuaded Mr. Raghunandan Saran, an industrialist, to enter automotive manufacture. In 1948, Ashok Motors was set up in what was then Madras, for the assembly of Austin Cars. The Company's destiny and name changed soon with equity participation by British Leyland and Ashok Leyland commenced manufacture of commercial vehicles in 1955.

Since then Ashok Leyland has been a major presence in India's commercial vehicle industry with a tradition of technological leadership, achieved through tie-ups with international technology leaders and through vigorous in-house R&D. Access to international technology enabled the Company to set a tradition to be first with technology. Be it full air brakes, power steering or rear engine busses, Ashok Leyland pioneered all these concepts. Responding to the operating conditions and practices in the country, the Company made its vehicles strong, over-engineering them with extra metallic muscles. "Designing durable products that make economic sense to the consumer, using appropriate technology", became the design philosophy of the Company, which in turn has moulded consumer attitudes and the brand personality.

Ashok Leyland vehicles have built a reputation for reliability and ruggedness. The 5,00,000 vehicles we have put on the roads have considerably eased the additional pressure placed on road transportation in independent India.

In the populous Indian metros, four out of the five State Transport Undertaking (STU) buses come from Ashok Leyland. Some of them like the double-decker and vestibule buses are unique models from Ashok Leyland, tailor-made for high-density routes.

In 1987, the overseas holding by Land Rover Leyland International Holdings Limited (LRLIH) was taken over by a joint venture between the Hinduja Group, the Non-Resident Indian transnational group and IVECO. (Since July 2006, the Hinduja Group is 100% holder of LRLIH).

The blueprint prepared for the future reflected the global ambitions of the company, captured in four words: Global Standards, Global Markets. This was at a time when liberalisation and globalisation were not yet in the air. Ashok

Leyland embarked on a major product and process upgradation to match world-class standards of technology.

In the journey towards global standards of quality, Ashok Leyland reached a major milestone in 1993 when it became the first in India's automobile history to win the ISO 9002 certification. The more comprehensive ISO 9001 certification came in 1994, QS 9000 in 1998 and ISO 14001 certification for all vehicle manufacturing units in 2002. It has also become the first Indian auto company to receive the latest ISO/TS 16949 Corporate Certification (in July 2006) which is specific to the auto industry.

MILESTONES

- 1966 - Introduced full air brakes
- 1967 - Launched double-decker bus
- 1968 - Offered power steering in commercial vehicles
- 1979 - Introduced multi-axle trucks
- 1980 - Introduced the international concept of integral bus with air suspension
- 1982 - Introduced vestibule bus
- 1992 - Won self-certification status for defense supplies
- 1993 - Received ISO 9002
- 1997 - India's first CNG powered bus joined the BEST fleet
- 2001 - Received ISO 14001 certification for all manufacturing units
- 2002 - Launched hybrid electric vehicle

1.5. ORGANISATION'S PRODUCTS:

The products are given under following classification

1. Buses

Range 30 seats to 86 seats

- Stag (mini bus)
- Viking
- Low floor bus
- Double Decker
- Vestibule bus, etc.,

2. Trucks

Range 7 tons to 49 tons

- Comet
- Tarus
- Tusker
- Ecomet
- Tractors (4921,4018,3516)

3. Defense and special vehicles

- Stallion
- LRV
- TFF
- CFT
- Hippo
- ALRD Dumper

4. Engine

- Genset application
- Industrial application
- Marine application

1.6. UNIT PROFILE:

Location:

Ashok Leyland unit-II located in sipcot industrial complex-II, Hosur with a built-up area of 95-hectare plot, is a state of the art manufacturing facility for the world-class cargo range of trucks. It has been constructed with giving due attention to ecology.

Profile:

Designed and build to deliver international quality, with an annual capacity of 36000 vehicles the plant has numerous automated conveyers in chassis assembly, cab trim, frame assembly and axle assembly. A hi-tech paint shop, a heavy-duty press shop for side members and a cab weld shop are unique features in the plant. The plant presently rolls out 35 vehicles / shift out of the two conveyors in the chassis assembly shop.

Unique features:

The unique features of the location are

1. Cabin are build only in H2 among all the Ashok Leyland
2. FSM (Frame Side Members) are being done and sent to all other units of Ashok Leyland.

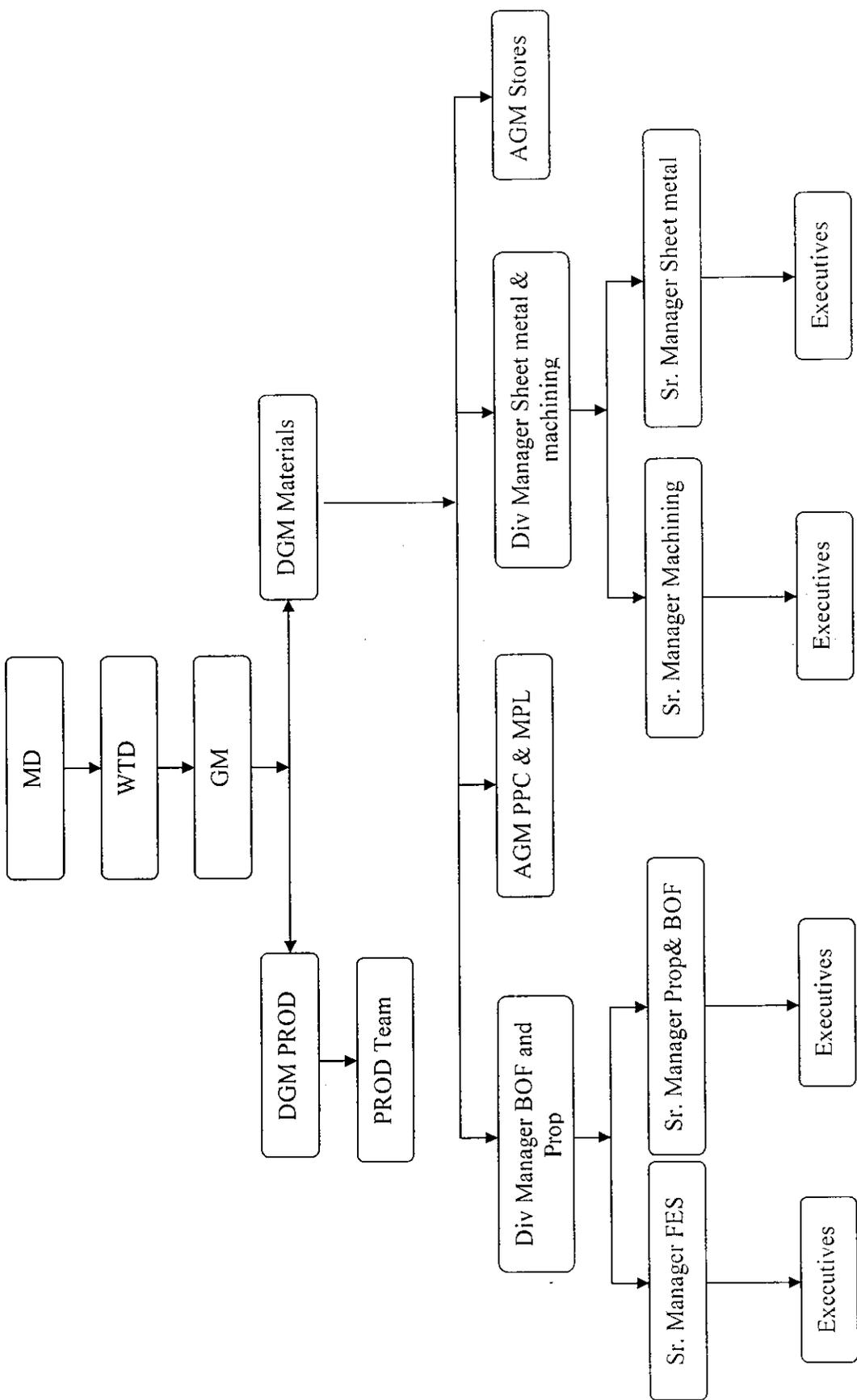


FIG.1.6.1. ORGANISATION STRUCTURE

1.7. VARIOUS FUNCTIONAL AREAS:

PRODUCTION PLANNING AND CONTROL:

The PPC takes care of planning for the daily lay down for the assembly and manufacturing sections in the unit. They have to match the aggregate and the demand in the market. The pulling of material from the stores to assembly line as per requirement is one of the vital roles of PPC.

LOGISTICS:

The materials are collected from the supplier through logistics operations. Here in Ashok Leyland (T & T) Track and Trace system is used. The schedule wise requirement was sent to the supplier and communication is being sent to logistics to collect the materials and deliver. The Milk Run Route was prepared based on the requirement of truckload. Cross Docking was done through Electronic data file.

Logistics operations are mainly handled by TVS logistics and Sequel logistics.

GR & D (Goods Receipt and Dispatch):

GR&D was the destination where the goods are received and dispatched to respective stores. The identification tag for the components will be issued there. Then goods are dispatched to respective stores and acknowledgement will be given in each store. Then the GRN (Goods Receipt Note) number was produced this serves as the proof for receiving the goods.

There are two types of goods received:

1. Self certified
2. BOF (Bought Out Finished)

The goods are said to be self certified when they provide with required testing results else the goods are sent to BOF inspection. Also the self-certification process should satisfy the certification procedure.

BOF INSPECTION:

Quality engineers for the quality and the specifications, which are given in the drawing by the Material planning, inspect the BOF items, which are unloaded in GR&D.

STORES:

The components, which are received from GR&D department after inspection was updated in online and the store posting was done. A separate location was meant for each component and the respective component was placed over there. The materials are attached with ID tag so that the retrieval can easily be done.

Each component has its own part number that was unique, it was seven digit alphanumeric codes with six numeric precede by an alphabet. These part numbers call all the items.

The stores will deliver the materials to the assembly line once the production plan was scheduled and issue list was prepared.

The stores also handle the following activities:

1. Inter unit material transfer.
2. Spare parts transfer.
3. Vehicle off road

The following are the documents that are maintained in stores:

1. Invoice
2. IMN-Inward Material Rejection Note
3. IUMTN- Inter Unit Material Transfer Note
4. MRN-Material Release Note
5. RMGP-Returnable Material Gate Pass

The material issue done in three ways:

1. Batch issue
2. Bin issue
3. KIT / String issue

PURCHASE PROCEDURE:

Supplier selection:

Strategic sourcing department was responsible for the selection of supplier. The criteria for selecting the supplier are set by strategic sourcing department. Corporate Quality Engineering will be the important criteria for evaluating the supplier. A quality team will inspect the supplier and if the supplier passes the CQE requirements the order will be given to the supplier.

PURCHASING INFORMATION:

The process owner of the purchasing ensures adequacy of specified purchase requirements in the purchase order and other purchase documents prior to communication to the supplier. These include, as appropriate, requirement for product approval, procedures, products/equipment, and requirement for the qualification of personnel and requirements on the QMS. Depending on the product, there are three approaches available to purchase and delivery

- JIT
- MRP
- LCL

Verification of the purchased product:

The organization adopts various approaches to ensure the purchased product meets the specified requirement

- Vendor Self Certification:

This was the process of certifying the products by the manufacturer himself. After auditing process the company will give self-certification status to the manufacturer. This was applicable for JIT materials only. The company

then subjects the products to periodic audit. If the manufacturer held with any quality issues then the autonomy of self-certification will be withdrawn.

- The rest of the supplier products are subjected to inspection as per requirements of IPS
- Also the quality team has rights to inspect the subcontract premises as per the contract. Quality department have to maintain the record of such visits.
- Materials received from other ALunits are not inspected at receipt stage.

2.1. OBJECTIVE OF THE STUDY:

PRIMARY OBJECTIVE:

To supply the materials directly to the production line by reducing the physical supply chain links.

SECONDARY OBJECTIVE:

- To reduce the inventory carrying cost by eliminating the inventory carries over.
- To reduce the occupying space by neglecting the storage.
- Develop a system to inward materials with less manpower employed in the system.
- Ease of accountability and eliminates mismatch between online stock and physical stock.

2.2. SCOPE OF THE STUDY:

The project analyzes the lead time involved in material inwarding to the production line and has the following benefits

1. Time reduction of 14 hours
2. Inventory control
3. Space management

After implementation and attaining improvement, we can extend the system to all components and inventory cost can fully be reduced.

2.3. LIMITATIONS:

- Study has been conducted in Ashok Leyland, Hosur unit –II only.
- Study has been conducted for selected eleven components.
- Time given to complete the study was only one month.

2.4. METHEDODOLOGY:

TYPE OF STUDY:

Since the study was conducted for the first time in the organization, it was explorative study.

- ♦ Designed to generate basic knowledge, clarify relevant issues uncover variables associated with a problem, uncover information needs, and/or define alternatives for addressing research objectives.
- ♦ A very flexible, open-ended process.

TYPE OF DATA:

- Primary data - Information that researchers gather first hand
- Secondary data
Information from secondary sources, i.e., not directly compiled by the analyst; may include published or unpublished work based on research that relies on primary sources of any material other than primary sources used to prepare a written work

METHOD OF DATA COLLECTION:

- Observation

TOOLS FOR ANALYSIS:

- Flow charts
- Inventory value analysis
- Lead time analysis

2.5. REVIEW OF LITERATURE:

Nozick, Linda 2008¹, As supply chains become more and more dependent on the efficient movement of materials among facilities that are geographically dispersed there is more opportunity for disruption. One of the common disruptions is the loss of production capability at supplier sites. We formulate a two-stage stochastic program and a solution procedure to optimize supplier selection to hedge against these disruptions. This model allows for the effective quantitative exploration of the trade-off between cost and risks to support improved decision-making in global supply chain design. A realistic case study is explored.

Katzenberg, Michael 2008², the researcher explores the value of information in the context of a firm that faces uncertainty with respect to demand, product returns, recovery yield, and capacity utilization. Capacity is finite and shared between new production and recovery operations. The operational decisions of interest are the quantity of new product to produce, the quantity of returns to recover, and the quantity of returns to dispose. Product recovery is uncertain in that each returned unit can be successfully recovered with a known probability, and otherwise it is discarded at a cost. Demand in a period is satisfied with new production, recovered returns, or a mix of both types. The researcher measure and evaluate the value of information through three information cases that separately address different types of information: demand, recovery yield, and capacity utilization. The researcher find that there is no dominance in value amongst the different types of information, although information on capacity

¹ Nozick, Linda 2008, Modelling supplier selection and the use of option contracts for global supply chain design, *Computers & Operations Research*; Oct2008, Vol. 36 Issue 10, p2786-2800, 15p

² Katzenberg, Michael 2008, the value of information in a capacitated closed loop supply chain, *European Journal of Operational Research*; Oct2008, Vol. 198 Issue 2, p491-503, 13p

utilization provides the highest average value and exceeds the value of the other two types of information in 55% of the cases studied. The researcher also identify the operating conditions in which each type of information is most valuable, compare the value of information to other types of investments, and also assess robustness with respect to the accuracy of information.

Kung, Ling-Chieh Chern, Ching-Chin 2008³ this study focuses on solving the factory planning (FP) problem for product structures with multiple final products. In situations in which the capacity of the work centre is limited and multiple job stages are sequentially dependent, the algorithm proposed in this study is able to plan all the jobs, while minimizing delay time, cycle time, and advance time. Though mixed integer programming (MIP) is a popular way to solve supply chain factory planning problems, the MIP model becomes insolvable for complex FP problems, due to the time and computer resources required. For this reason, this study proposes a heuristic algorithm, called the heuristic factory planning algorithm (HFPA), to solve the supply chain factory planning problem efficiently and effectively. HFPA first identifies the bottleneck work centre and sorts the work centers according to workload, placing the work centre with the heaviest workload ahead of the others. HFPA then groups and sorts jobs according to various criteria, for example, dependency on the bottleneck work centre, the workload at the bottleneck work centre, and the due date. HFPA plans jobs individually in three iterations. First, it plans jobs without pre-empting, advancing, and/or delaying. Jobs that cannot be scheduled under these conditions are scheduled in the second iteration, which allows pre-emption. In the final iteration, which allows jobs to be pre-empted, advanced, and delayed, all the remaining jobs are scheduled. A prototype was constructed and tested to show HFPA's effectiveness and efficiency. This algorithm's power was demonstrated using computational and complexity analysis

³ Kung, Ling-Chieh Chern, Ching-Chin2008, Heuristic factory planning algorithm for advanced planning and scheduling, Computers & Operations Research; Sep2008, Vol. 36 Issue 9, p2513-2530, 18p

Sourirajan, Karthik 2008⁴ The researcher considers a two-stage supply chain with a production facility that replenishes a single product at retailers. The objective is to locate distribution centers in the network such that the sum of facility location, pipeline inventory, and safety stock costs is minimized. The researcher explicitly models the relationship between the flows in the network, lead times, and safety stock levels. The researcher use genetic algorithms to solve the model and compare their performance to that of a Lagrangian heuristic developed in earlier work. A novel chromosome representation that combines binary vectors with random keys provides solutions of similar quality to those from the Lagrangian heuristic. The model is then extended to incorporate arbitrary demand variance at the retailers. This modification destroys the structure upon which the Lagrangian heuristic is based, but is easily incorporated into the genetic algorithm. The genetic algorithm yield significantly better solutions than a greedy heuristic for this modification and has reasonable computational requirements.

Chen, Kebing 2008⁵ This paper develops two coordination models of a supply chain consisting of one manufacturer, one dominant retailer and multiple fringe retailers to investigate how to coordinate the supply chain after demand disruption. We consider two coordination schedules, linear quantity discount schedule and Groves wholesale price schedule. We find that, under the linear quantity discount schedule, the manufacturer only needs to adjust the maximum variable wholesale price after demand disruption. For each case of the disrupted amount of demand, the higher the market share of the dominant retailer, the lower its average wholesale price and the subsidy will be under the linear quantity discount schedule, while the higher its fraction of the supply chain's profit will be under Groves wholesale price schedule. When the increased

⁴ Sourirajan, Karthik 2008, A genetic algorithm for a single product network design model with lead time and safety stock considerations, *European Journal of Operational Research*; Sep2008, Vol. 197 Issue 2, p599-608, 10p

⁵ Chen, Kebing 2008, Demand disruption and coordination of the supply chain with a dominant retailer, *European Journal of Operational Research*; Aug2008, Vol. 197 Issue 1, p225-234, 10p

amount of demand is very large and production cost is sufficiently low, linear quantity discount schedule is better for the manufacturer. However, when the production cost is sufficiently large, Groves wholesale price schedule is always better. We also find that the disrupted amount of demand largely affects the allocation of the supply chain's profit.

Mohammadi Bidhandi, Hadi 2008⁶ This paper proposes a mixed integer linear programming model and solution algorithm for solving supply chain network design problems in deterministic, multi-commodity, single-period contexts. The strategic level of supply chain planning and tactical level planning of supply chain are aggregated to propose an integrated model. The model integrates location and capacity choices for suppliers, plants and warehouses selection, product range assignment and production flows. The open-or-close decisions for the facilities are binary decision variables and the production and transportation flow decisions are continuous decision variables. Consequently, this problem is a binary mixed integer linear programming problem. In this paper, a modified version of Benders' decomposition is proposed to solve the model. The most difficulty associated with the Benders' decomposition is the solution of master problem, as in many real-life problems the model will be NP-hard and very time consuming. In the proposed procedure, the master problem will be developed using the surrogate constraints. We show that the main constraints of the master problem can be replaced by the strongest surrogate constraint. The generated problem with the strongest surrogate constraint is a valid relaxation of the main problem. Furthermore, a near-optimal initial solution is generated for a reduction in the number of iterations.

⁶ Mohammadi Bidhandi, Hadi 2008, Development of a new approach for deterministic supply chain network design, *European Journal of Operational Research*; Oct2008, Vol. 198 Issue 1, p121-128, 8p

Gordon, Valery S.2008⁷ we consider single machine scheduling and due date assignment problems in which the processing time of a job depends on its position in a processing sequence. The objective functions include the cost of changing the due dates, the total cost of discarded jobs that cannot be completed by their due dates and, possibly, the total earliness of the scheduled jobs. We present polynomial-time dynamic programming algorithms in the case of two popular due date assignment methods: CON and SLK. The considered problems are related to mathematical models of cooperation between the manufacturer and the customer in supply chain scheduling.

Zhao, Yao 2008⁸ we consider a multi-product and multi-component Assemble-to-Order (ATO) system where the external demand follows compound Poisson processes and component inventories are controlled by continuous-time batch ordering policies. The replenishment lead-times of components are stochastic, sequential and exogenous. Each element of the bill of material (BOM) matrix can be any non-negative integer. Components are committed to demand on a first-come-first-serve basis. We derive exact expressions for key performance metrics under either the assumption that each demand must be satisfied in full (non-split orders), or the assumption that each unit of demand can be satisfied separately (split orders). We also develop an efficient sampling method to estimate these metrics, e.g., the expected delivery lead-times and the order-based fill-rates. Based on the analysis and a numerical study of an example motivated by a real world application, we characterize the impact of the component interaction on system performance, demonstrate the efficiency of the numerical method and quantify the impact of order splitting.

⁷ Gordon, Valery S.2008, Single machine scheduling and due date assignment with positional dependent processing times, *European Journal of Operational Research*; Oct2008, Vol. 198 Issue 1, p57-62, 6p

⁸ Zhao, Yao 2008, Analysis and evaluation of an Assemble-to-Order system with batch ordering policy and compound Poisson demand, *European Journal of Operational Research*; Nov2008, Vol. 198 Issue 3, p800-809, 10p

Chang, Tsung-Sheng, Wan, Yat-wah 2008⁹, Just-in-time (JIT) trucking service, i.e., arriving at customers within specified time windows, has become the norm for freight carriers in all stages of supply chains. In this paper, a JIT pickup/delivery problem is formulated as a stochastic dynamic travelling salesman problem with time windows (SDTSPTW). At a customer location, the vehicle either picks up goods for or delivers goods from the depot, but does not provide moving service to transfer goods from one location to another. Such routing problems are NP-hard in deterministic settings, and in our context, complicated further by the stochastic, dynamic nature of the problem. This paper develops an efficient heuristic for the SDTSPTW with hard time windows. The heuristic is shown to be useful both in controlled numerical experiments and in applying to a real-life trucking problem.

Warsing, Don 2008¹⁰, Managers have begun to recognize that effectively managing risks in their business operations plays an important role in successfully managing their inventories. Accordingly, we develop a model based on fuzzy-set representations of various sources of uncertainty in the supply chain. Sources of risk and uncertainty in our model include demand, lead time, supplier yield, and penalty cost. The naturally imprecise nature of these risk factors in managing inventories is represented using triangular fuzzy numbers. In addition, we introduce a human risk attitude factor to quantify the decision maker's attitude toward the risk of stocking out during the replenishment period. The total cost of the inventory system is computed using defuzzification methods built from techniques identified in the literature on fuzzy sets. Finally, we provide numerical examples to compare our fuzzy-set computations with those

⁹ Chang, Tsung-Sheng, Wan, Yat-wah 2008, A stochastic dynamic travelling salesman problem with hard time windows, *European Journal of Operational Research*; Nov2008, Vol. 198 Issue 3, p748-759, 12p

¹⁰ Warsing, Don2008, Inventory policies in a fuzzy uncertain supply chain environment, *European Journal of Operational Research*; Sep2008, Vol. 197 Issue 2, p609-619, 11p

generated by more traditional models that assume full knowledge of the distributions of the stochastic parameters in the system.

Boysen, Nils, Fliedner, Malte 2008¹¹, Production processes in a wide range of industries rely on modern mixed-model assembly systems, which allow an efficient manufacture of various models of a common base product on the same assembly line. In order to facilitate a just-in-time supply of materials, the literature proposes various sequencing problems under the term “level scheduling”, which all aim at evenly smoothing the part consumption induced by the production sequence over time. Among these approaches, the popular product rate variation (PRV) problem is considered to be an appropriate approximate model, if either (i) all products require approximately the same number and mix of parts or (ii) part usages of all products are (almost completely) distinct. These statements are (iii) further specified by analytical findings, which prove the equivalence of product and material oriented level scheduling under certain conditions. These three prerequisites commonly cited in the literature when justifying the practical relevance of the PRV are evaluated by means of three simple computational experiments and are then discussed with regard to their relevance in practical settings. It is concluded that the PRV is in fact inappropriate for use in today’s real world mixed-model assembly systems

¹¹ Boysen, Nils, Fliedner, Malte 2008, The product rate variation problem and its relevance in real world mixed-model assembly lines, *European Journal of Operational Research*; Sep2008, Vol. 197 Issue 2, p818-824, 7p

ANALYSIS & INTERPRETATION

3.1. EXISTING SYSTEM:

The material flow and the information flow in the existing system are given in the form of flow chart.

MATERIAL MOVEMENT IN EXISTING SYSTEM:

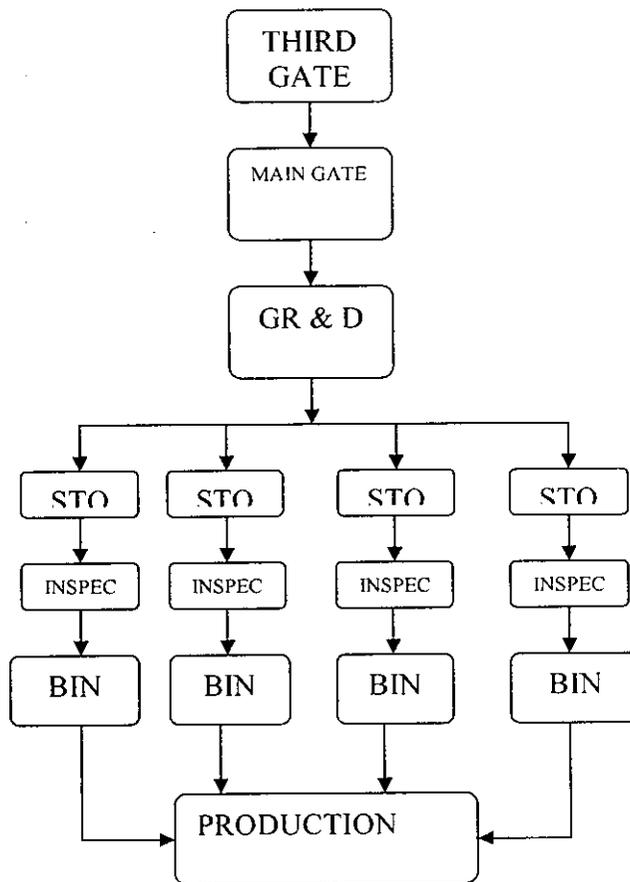


FIG.3.1.1.MATERIAL MOVEMENT IN EXISTING SYSTEM:

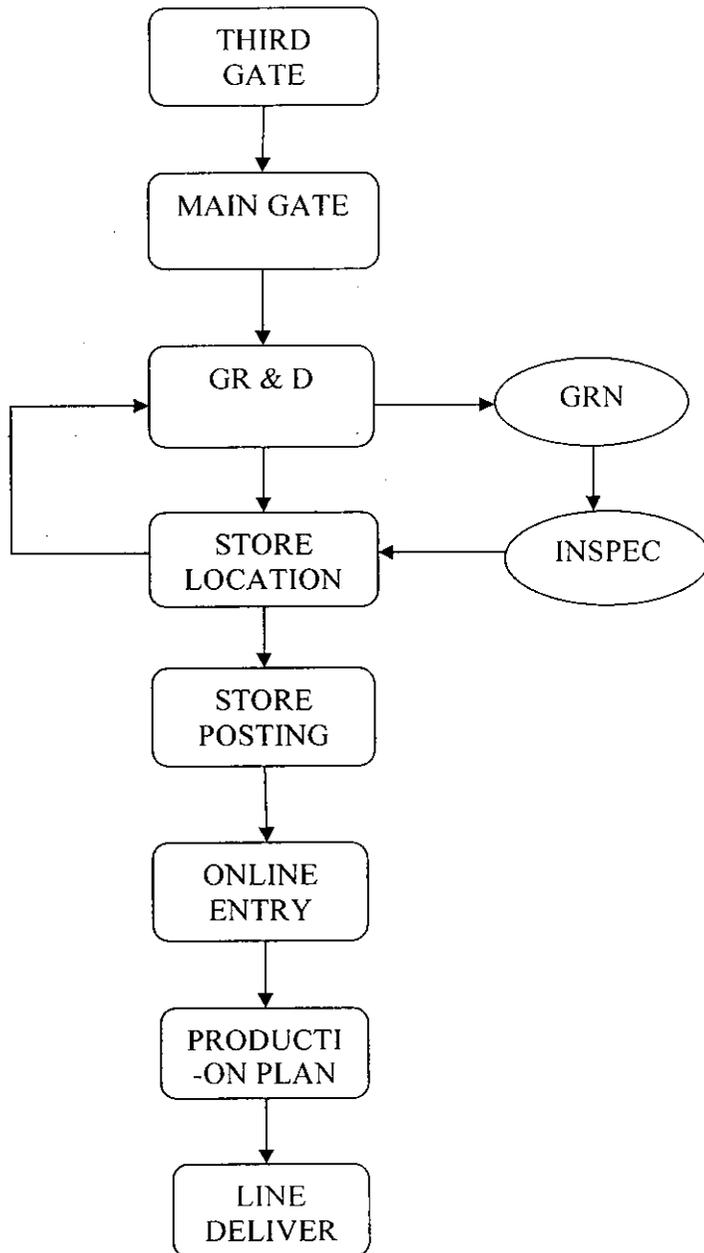
INFORMATION FLOW IN EXISTING SYSTEM:

FIG.3.1.2. INFORMATION FLOW IN THW EXISTING SYSTEM

THIRD GATE:

The vehicles should be parked in the parking area and the following activities are done.

- Checking for valid invoice.
- Emission certificate for the vehicle was checked over there. The vehicles with valid emission certificate are allowed inside the premises.
- License of the driver of the vehicle was checked.
- Entry in the ledger manually and put a seal in the DELIVERY CHELAN.

All the activities followed in the third gate are identified as non-value added activities and those activities are eliminated in the proposed system.

MAIN GATE:

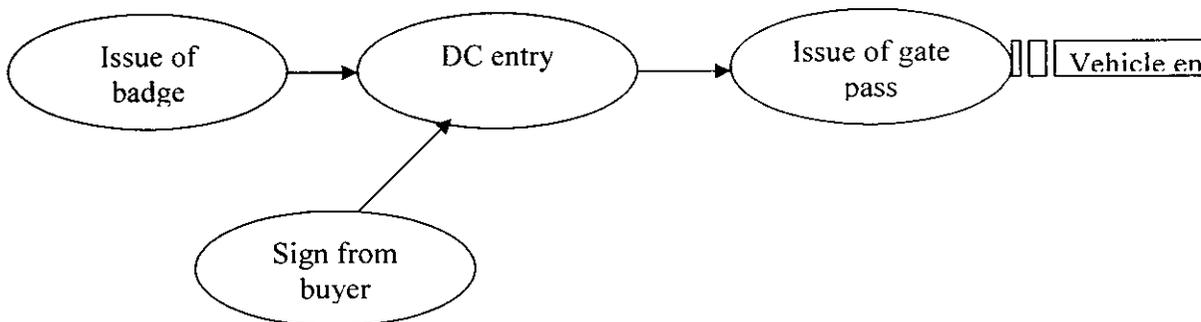


FIG.3.1.3. PROCESS FLOW IN MAIN GATE

The delivery Chelan with that seal then comes to main gate. There the suppliers are provided with supplier badge that should be displaced on their chest. Then the suppliers are asked to get a no due signature from the respective buyer. If any schedule error the buyer was responsible to clear that. If there was any quality error the manufacturer was responsible. The cleared

deliveries Chelan are entered in ERP and Sequence number for that DC was generated and that sequence number are mentioned in the DC. Then in the next counter license number, vehicle number was verified and entered in system and the gate pass was issued to that particular vehicle. Then the token for vehicle was issued and entered in ledger manually. Now the vehicle was allowed inside the premises to deliver the materials. The average waiting time of the vehicle in main gate was found to be more.

GR & D:

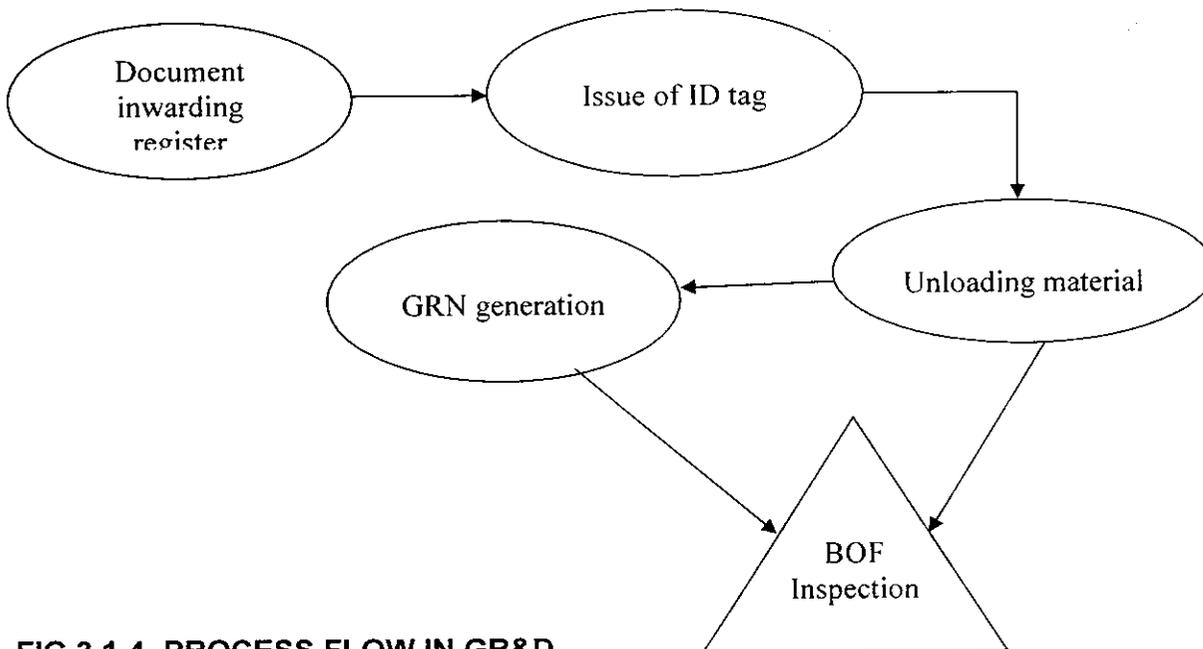


FIG 3.1.4. PROCESS FLOW IN GR&D

After getting the gate pass the vehicle was now allowed inside the premises. The vehicle now goes to Goods Receipt and Dispatch department. There first entry made in the document inwarding register and in the next counter the ID tag was provided with the part number. This ID tag helps to find out the particular

component easily. Then the materials are unloaded in the respective stores. The authorized person in the stores acknowledges the document. Again the document was brought to GR&D to prepare Goods Receipt Note number. Then the goods are subjected to inspection.

STORES:

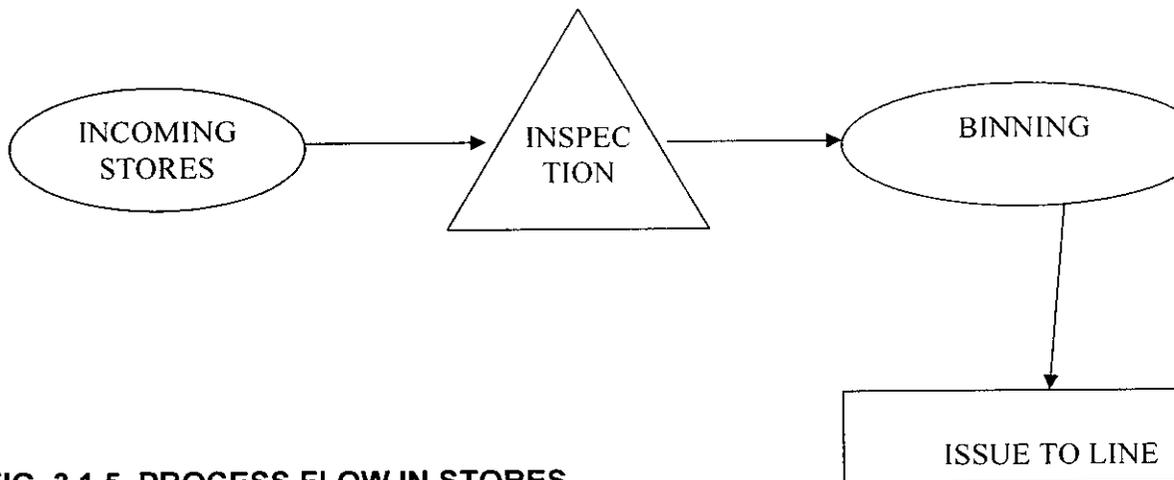


FIG. 3.1.5. PROCESS FLOW IN STORES

Once the materials are dispatched from GR&D they are delivered in the respective stores. There are separate store for axle, chassis, cab, stallion and frame. In stores they receive materials and placed in different locations. The locations are mentioned in the respective document. With that as reference the quality control people will come to the specific location and inspection was carried over there. If any material found with defect of if does not meet the quality standards that particular material will be rejected. The approved materials are kept in bin specifically meant for that material. Then these stock details entered in ERP. As per the production schedule the materials are issued to line.

OBSTACLES IN EXISTING SYSTEM:**TABLE 3.1.1. OBSTACLES IN EXISTING SYSTEM**

OBSTACLES IN THE EXISTING SYSTEM	SUGGESTIONS	BENEFITS
1. Checking the invoice, emission certificate, license no. done in third gate and the details are entered in the ledger manually. The same operation was done in main gate with computer	<ul style="list-style-type: none"> • Eliminate that manual entry and introduce a system in third gate itself. 	<ul style="list-style-type: none"> • Eliminate the non value added activity • Retrieving the same data at the time of issuing gate pass
2. Waiting time of the vehicles in the main gate was more	<ul style="list-style-type: none"> • Introducing one more counter • Allowing line side delivery vehicles through the third gate 	<ul style="list-style-type: none"> • Quick processing of invoices • Less waiting time
3. Vehicle idle time was more while unloading	<ul style="list-style-type: none"> • Responsibility should be given to people 	<ul style="list-style-type: none"> • Idle time of vehicles was eliminated i.e., we can save more than 15 minutes
4. Unloading materials from vehicle to storage area, insufficient trolley	<ul style="list-style-type: none"> • Providing separate trolley to GR&D 	<ul style="list-style-type: none"> • Uncomplicated material movement

5. Lack of involvement among employees	<ul style="list-style-type: none"> • Create awareness by conducting awareness programs 	<ul style="list-style-type: none"> • Employee involvement will be high • Quick processing
6. Lack of involvement among suppliers	<ul style="list-style-type: none"> • Create awareness 	<ul style="list-style-type: none"> • On time delivery • Improved rapport
7. Poor handling of materials by the supplier	<ul style="list-style-type: none"> • Create awareness about quality 	<ul style="list-style-type: none"> • Damage caused by poor handling can be eliminated
8. Difficulty to check quantity and arrange	<ul style="list-style-type: none"> • Proper pallet for components should be introduced 	<ul style="list-style-type: none"> • Easy to check the quantity • Neat arrangement • Retrieval will be quick and effortless
9. Unloading takes more time because supplier himself have to unload the materials and to place in the specific location	<ul style="list-style-type: none"> • Providing some help for unloading 	<ul style="list-style-type: none"> • Time savings up to 10 minutes

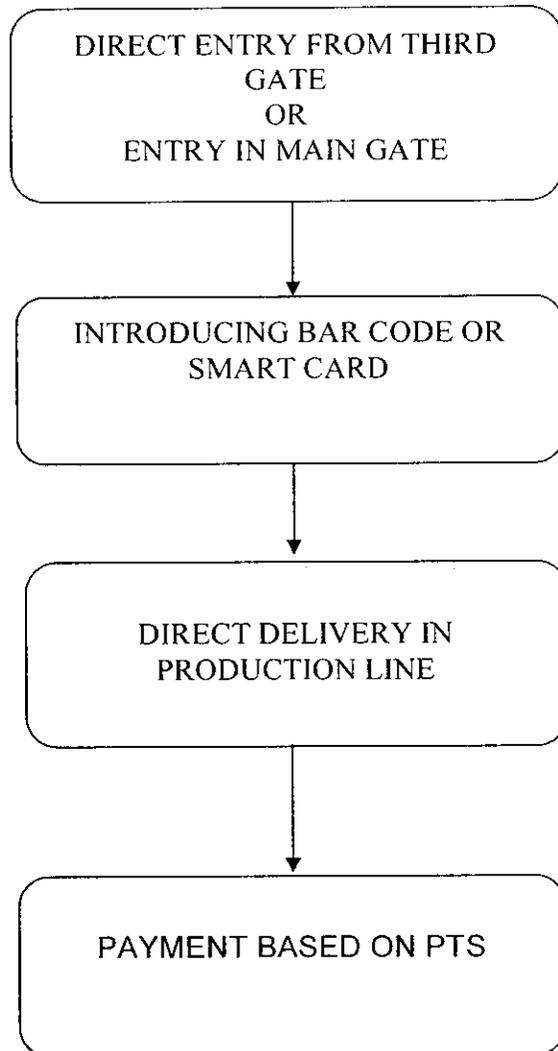
3.2. PROPOSED SYSTEM:

TABLE 3.2.1.LIST OF COMPONENTS:

S.NO	PART NO	DESCRIPTION
1	F4108700	Wheel choke
2	B5503201	Anti sag RH
3	B5503202	Anti sag LH
4	F7206514	Stay Anti sag LH
5	F7205914	Stay Anti sag RH
6	B8401501	Stay AS MBR LH
7	B0908101	Spare wheel carrier
8	B5030602	Fuel tank (2214,4018,3516)
9	B5092103	Fuel tank (stallion)
10	B5092104	Fuel tank (stallion)
11	B5095901	Fuel tank (2516 RMC)

REQUIREMENTS OF NEW SYSTEM:

- The main objective of new system is to deliver the materials directly to the production line
- The waiting time in the gate should be eliminated
- There should not be any non value added activities in the new system
- Idle time of vehicle at the time of unloading must be eliminated
- Vehicles should be given with special identification
- Check for quantity delivered
- There should not be any difficulties in the material movement
- Materials should be retrieved as quickly as possible so the system should consider palletization also.
- Quick settlement cycle.
- Prior intimation of production schedule (D+2) to the suppliers through SCM portal.

PROPOSED SYSTEM:**FIG.3.2.1.PROSED SYSTEM**

In the new system the vehicle was allowed through third gate or main gate. In gate we introduce a new system like bar code identification or smart card identification. The vehicles are given with special identification to avert confusion. All the identification about that vehicle was traced through that identification check. Now the vehicle was allowed directly to the production line and unloading was done in respective location. Once the produced vehicle passes the PTS (Passes To Sales) stage payment was done to the supplier.

FACILITY PLANNING:

The suppliers should be educated about the new system. This will fetch the benefits for long term. Suppliers provided with the production plan a week in advance and the confirmation of daily requirement was sent through mail. The suppliers must know the importance of production and quality. In future the system can be expand to all components. Also the materials should be in ready to use condition there should not be any packages, covers etc,

The facilities are made in the following perspectives:

- Production plan
- Vendor Managed Stores
- Quality
- Payment system

PRODUCTION PLAN:

Suppliers provided with the production plan a week in advance and the confirmation of daily requirement was sent through mail. The scheduling cycle was d+2. Requirements are sent to the suppliers two days in advance.

VENDOR MANAGED STORES:

At beginning stage of the system implementation the company should provide a place for suppliers. In that place suppliers can keep their stock or they can do their minor corrective actions. The ultimate goal was, supplier have to deliver the materials with in time. For keeping inventory Ashok Leyland was not responsible and Ashok Leyland shares no cost. It was the inventory of the supplier M/s. PRABHA Engineering. Ashok Leyland will carry zero inventories. Once the supplier was familiar with the system he will be asked to do the operations from his place. By implementing this system the company can reduce

the inventory carries over and at one point of time the inventory can completely be eliminated.

QUALITY:

The quality control department should approve the selected components as self- certified components. Also the quality team from Ashok Leyland will go to the supplier's place and check for the quality. Periodic inspection can be done. If the materials found with defect it will be rejected.

PAYMENT SYSTEM:

In the existing system credit period to the suppliers was 45 days. In the new system once the producing vehicle passes PTS stage payment will be paid as earlier as possible. Also if there was any production loss due to supplier negligence the supplier was responsible for that. And the amount will be detected from his payment.

COMPARISON ANALYSIS

3.3. COMPARISON OF CURRENT AND PROPOSED SYSTEM:

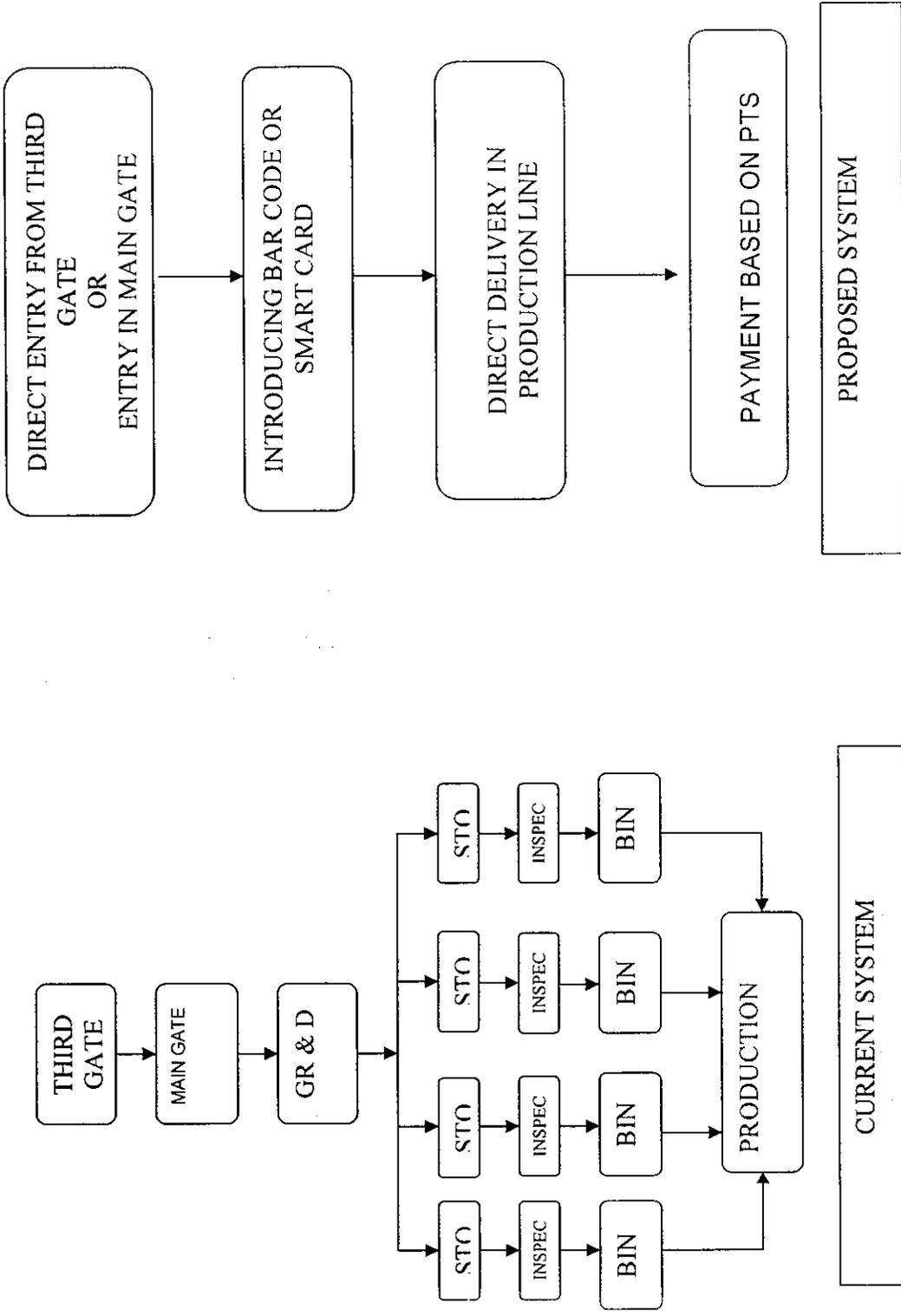


FIG 3.3.1.COMPARISON OF MATERIAL MOVEMENT

INVENTORY VALUE ANALYSIS:

TABLE 3.3.1. INVENTORY VALUE ANALYSIS

S.No	Part no	Description	Consum/annum	Pallet /Batch qty	Rate	Inv holding days	Avg consumption/day	Per day	Inventory value
1	F4108700	Wheel choke	34000	50	415.2	7	40		116256
2	B5503201	Anti Sag RH	8000	25	181.6	7	40		50848
3	B5503202	Anti sag LH	8000	25	181.6	7	40		50848
4	F7206514	Stay Anti sag LH	645	25	94.4	7	20		13216
5	F7205914	Stay Anti sag RH	7700	25	94.4	7	40		26432
6	B8401501	Stay AS MBR LH	7500	25	11.8	7	25		2065
7	B0908101	Spare wheel carrier	12500	25	1117.8	4	25		111780
8	B5030602	Fuel Tank	6800	25	3492	1	25		87300
9	B5092103	Fuel Tank	550	10	3492	1	15		52380
10	B5092104	Fuel Tank	550	10	2663	1	15		39945
11	B5095901	Fuel Tank	3000	10	2527	1	20		50540
total inventory value									601610

PROPOSED INVENTORY VALUE - NIL

INTERPRETATION:

The existing system carries inventory value of Rs.601610 for a week. In the proposed system the inventory becomes zero. Ashok Leyland won't carry any inventory; instead it was transferred as supplier's inventory. For trail run of this system company will carry buffer stock of 5 nos in each component. The new system will reduce the cash out flow of the organization.

LEAD TIME ANALYSIS:**TABLE 3.3.2. LEAD TIME ANALYSIS**

APPROXIMATE TIME TAKEN OF EXISTING SYSTEM AND PROPOSED SYSTEM			
LOCATION	ACTIVITY	TIME IN MIN(S)	PROPOSED SYSTEM TIMINGS
THIRD GATE	invoice, emission certificate, license check	5	
MAIN GATE	entering invoice in system, generation of sequence no	10	
	vehicle data entry, issue of gate pass	2	
	ledger entry, issue of token	1	
GR&D	document invading register	1	
	issue of ID tag	1	
STALLION STORE			
CAB STORE			
FRAME STORE			
GR&D	generation of GRN	10	
STORE			
	total time taken	920	35
		15 HOURS 20 MINS	THIRTY TWO MINUTES

INTERPRETATION:

The lead-time for each activity in the system was observed and tabulated. In third gate existing system took 5 minutes, in main gate operations take 38 minutes. In various stores idle time of the vehicle was more, also unloading of materials took more time. Then GRN generation took 10 minutes. In existing system BOF inspection should be cleared within 24 hours. Then it took 15 minutes to put the materials in their bin. The issue of material took 15 minutes. In the proposed system the vehicle entry will take a max of 2 minutes in main gate and to deliver it will take a maximum of 30 minutes. The total lead-time of the system can be reduced from 15 hour 20 minutes to 32 minutes.

EXPECTED BENEFITS OF PROPOSED SYSTEM:

- The lead-time of inwarding the material can be reduced to 35 minutes.
- Ease of accountability.
- Mismatch between the current stock and physical stock can be cleared.
- Zero inventory for the selected components
- Less manpower required
- **Supplier should stand up with their quality**
- Improved vendor relationship
- Quick payment system
- Inventory cost can be minimized
- Improved supply chain link
- Rapid material movement

IMPLEMENTATION

3.4. IMPLEMENTATION:

Supplier was educated and the system was implemented. Supplier was provided with smart card. In that card the details about the supplier and the vehicle details, which carry the material, are stored. The performance was measured for a week on trial basis since low volume during this period and frequent change in production plan. The actual results are compared with the expected results.

INVENTORY VALUE ANALYSIS:

ACTUAL INVENTORY VALUE:

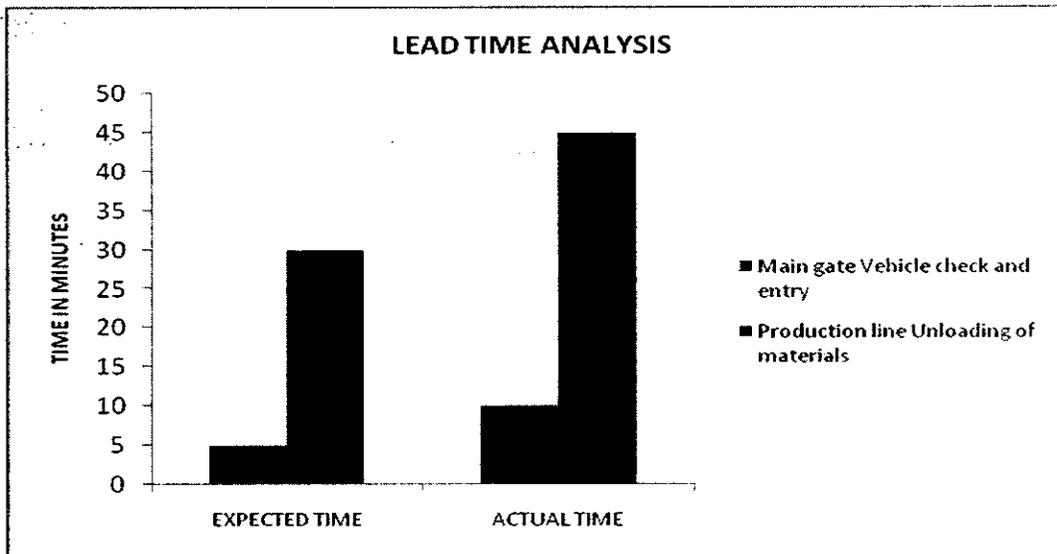
TABLE 3.4.1. ACTUAL INVENTORY ANALYSIS

S.No	Part no	Rate	Safety holding	Inventory value
1	F4108700	415.2	5	2076
2	B5503201	181.6	5	908
3	B5503202	181.6	5	908
4	F7206514	94.4	3	283.2
5	F7205914	94.4	5	472
6	B8401501	11.8	3	35.4
7	B0908101	1117.8	3	3353.4
8	B5030602	3492	3	10476
9	B5092103	3492	2	6984
10	B5092104	2663	2	5326
11	B5095901	2527	2	5054
		Total inventory value		35876

The company expected to carry zero inventories, for safety purpose in the trail period the company keeps buffer stock. So the actual inventory value of new system was Rs.35856, which has the scope of further reduction when implemented permanently.

LEAD-TIME ANALYSIS:**TABLE 3.4.2. COMPARISON BETWEEN ACTUAL LEAD TIME AND EXPECTED LEAD TIME**

LOCATION	ACTIVITY	EXPECTED TIME IN MINUTES	ACTUAL TIME TAKEN
Main gate	Vehicle check and entry	5	10
Production line	Unloading of materials	30	45

**FIG 3.4.1. COMPARISON BETWEEN ACTUAL LEAD TIME AND EXPECTED LEAD TIME****INTERPRETATION:**

In main gate it took 15 minutes as against 5 minutes expected. This was because of the system was new and not familiar to the people handling. Once the security and drivers familiar with the system it will be reduced. In production line delivery it took 45 minutes as against 30 minutes expected. To unload the materials further improvements like proper palletization will help to achieve the expected results.

FINDINGS AND SUGGESTIONS

4.1. FINDINGS AND SUGGESTIONS:

FINDINGS:

1. Checking the invoice, emission certificate, driver license no. done in third gate and the details are entered in the ledger manually. The same operation was repeated in the main gate. This took more time in the entire cycle.
2. Also waiting time in the main gate is more because the number of vehicles were more at peak hours
3. In GR&D idle time of the vehicles were more due to insufficient trolley.
4. Lack of awareness among the employees and suppliers.
5. Poor handling of materials by the supplier.
6. Inspection operation took minimum of 12 hours; this is the lengthiest process in the cycle.
7. Difficulty to check quantity and arrange the materials due to improper palletization.
8. Unloading takes more time because supplier himself have to unload the materials and to place the materials in specific location.
9. Since the production volume is low and frequent change in production plan, the system cannot be implemented completely.
10. Existing inventory holding cost was reduced from Rs.601610 to Rs.35876 and still has the scope to reduce further once the system implemented completely.
11. Lead time of inwarding cycle reduced from 15 hours to 55 minutes against 40 minutes expected. This was because of the system was new and not familiar to the people handling. Once the security and drivers familiar with the system it will be reduced.

100

100

100

100

CONCLUSION

SUGGESTIONS:

1. Introducing a separate counter in main gate for line side delivery vehicles will reduce the time up to ten minutes.
2. Eliminate non value added activities in each and every stage of material movement.
3. Create awareness among the employees and suppliers by conducting awareness programs.
4. Responsibility for specific activities should be given to people in the respective department.
5. Company should provide some help to suppliers during unloading of materials.
6. Proper palletization will help to reduce time while unloading and materials can be retrieved easily from the pallet.
7. By expanding the system to all materials will help to achieve zero inventories and cost of inventory can completely be eliminated.
8. The company now giving credit period of 45 days. For line side delivery materials the payment should made while vehicle passes PTS.

4.2. CONCLUSION:

The results / benefits during trial run were encouraging even though the volume was low. There is a scope of achieving the expected results in 100% implementation of project when volumes are picked up. Thus the project accepted for implementation.

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