



**A STUDY ON MATERIAL REQUIREMENTS PLANNING FOR BRAKING SYSTEM
ASSEMBLY IN SAKTHI AUTO COMPONENT LIMITED
ERODE**

by

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BONAFIDE CERTIFICATE

Certified that this project report titled "A Study on Material Requirements Planning for Braking System Assembly in Sakthi Auto Component Limited" is the bonafide work of **Mr.Vivek R,Reg. no: 1120400106** 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.

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I affirm that the project work titled "A Study on Material Requirements Planning for Braking System Assembly in Sakthi Auto Component Limited" being submitted in partial fulfillment for the award of Master of Business Administration is the original work carried out by me. It has not found the party other project work submitted for award of any degree or diploma, either in this or any other university.

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LIST OF TABLES

TABLE NUMBER	PARTICULARS	PAGE NUMBER
1.1	MRP TABLE	12
4.1	A NON-MRP APPROACH	25
4.2	BILL OF MATERIALS	27
4.3	DEMAND REQUIREMENTS	28
4.4	MASTER PRODUCTION SCHEDULE	28
4.5	INVENTORY RECORDS FILE	29
4.6	MRP FOR BRAKING SYSTEM ASSEMBLY	39
4.7	TOTAL INVENTORY COST	46
4.8	EOQ FOR STEERING KNUCKLE	47
4.9	EOQ FOR HUB	47
4.10	EOQ FOR BOLT	47
4.11	EOQ FOR CIRCLIP	47
4.12	EOQ FOR BEARING	48
4.13	EOQ FOR BRAKE DISC	48
4.14	EOQ FOR CYLINDRICAL HOUSING	48
4.15	EOQ FOR SCREW	48
4.16	AREA OF RESPONSIBILITY	53
4.17	POSITION WITHIN THE FIRM	54
4.18	MRP TERM USAGE	55
4.19	ACCURACY OF THE DATA	56
4.20	REASONS FOR NON-UTILIZATION OF MRP SYSTEMS	57

TABLE OF CONTENTS

CHAPTERS NO.	PARTICULARS	PAGE NO.
1	INTRODUCTION	
	1.1 ABOUT THE STUDY	1
	1.2 ABOUT THE INDUSTRY	2
	1.3 ABOUT THE ORGANISATION	4
	1.4 STATEMENT OF THE PROBLEM	14
	1.5 SCOPE OF THE STUDY	15
2	REVIEW OF LITERATURE	16
3	RESEARCH METHODOLOGY	
	3.1 TYPE OF RESEARCH	21
	3.2 OBJECTIVES OF THE STUDY	21
	3.3 DATA AND SOURCES OF DATA	22
	3.4 TIME PERIOD COVERED	22
	3.5 SAMPLE SIZE	23
	3.6 SAMPLING TECHNIQUE	23
	3.7 TOOLS AND FORMULA USED	23
	3.8 LIMITATIONS OF THE STUDY	24
4	ANALYSIS AND INTERPRETATION	25
5	FINDINGS, SUGGESTIONS AND CONCLUSION	
	5.1 FINDINGS	61
	5.2 SUGGESTIONS	65
	5.3 CONCLUSION	66
	5.4 SCOPE FOR FURTHER STUDY	67
	BIBLIOGRAPHY	68
	APPENDIX	

TABLE NUMBER	PARTICULARS	PAGE NUMBER
4.21	ATTRIBUTES INFLUENCING MATERIAL PROCUREMENT ON MRP ACQUISITION	58
4.22	ACHIEVEMENTS OF MRP SYSTEM BENEFITS	59
4.23	LEVEL OF ACCURACY OF THE ATTRIBUTES NEED FOR THE MRP SYSTEM	60

LIST OF CHARTS

CHART NUMBER	PARTICULARS	PAGE NUMBER
1.1	INPUTS AND OUTPUTS OF MRP SYSTEM	11
4.1	PRODUCT STRUCTURE	26
4.2	BRAKING SYSTEM ASSEMBLY LAYOUT	50
4.3	OUTLINE PROCESS CHART	51
4.4	AREA OF RESPONSIBILITY	53
4.5	POSITION WITHIN THE FIRM	54
4.6	MRP TERM USAGE	55

SYNOPSIS

Many companies still operate largely on a non-MRP approach for developing and maintaining the information regarding current stock levels, current outstanding purchase orders and works order which leads to duplication of effort and inaccuracies across all business processes. The companies function on a final need basis to create material order, components, raise works orders, etc. and this action fails to capture the true picture of material planning and scheduling. It results in high level of inventories and inaccurate material planning. To overcome the drawbacks of non-MRP, MRP approach was developed. Material requirements planning (MRP) is a production planning and inventory control system used to manage manufacturing processes. It is a process of calculating the material and production needs of a business in order for it to fulfill customer requirements. It allows organizations to monitor material and product levels, helping them to plan purchasing, manufacturing and delivery schedules. The aim of MRP is to provide a snapshot of the purchasing and manufacturing requirements of a business at a single moment in time. Based on the on hand inventory and lead time a MRP program for braking system assembly with dependent item characteristics is developed and lot sizing with Lot for Lot model is done in the study carried out at Sakthi Auto Components Limited. A survey is also conducted to identify the need for the MRP in the assembly line and the findings reveals that there is a requirement of MRP for material procurements of various components and also for scheduling.

CHAPTER-1

1. INTRODUCTION

1.1 ABOUT THE STUDY

Manufacturing industry is one industry that has its own characteristics in which the material and production should be scheduled in a timely manner. But in reality there exists difficulties relating to the planning and scheduling of material processes. As one method of inventory planning MRP was developed. This method has been widely used especially in the manufacturing industry.

Traditionally, manufacturing companies have controlled their parts through the reorder point (ROP) technique. Gradually, they recognized that some of these components had dependent demand, and material requirements planning (MRP) evolved to control the dependent items more effectively. MRP has been a very popular and widely used multilevel inventory control method since 1970s. The application of this popular tool in materials management has greatly reduced inventory levels and improved productivity. The introduced MRP was the first version of MRP system, named as Materials Requirements Planning (MRP I). MRP is concerned with both production scheduling and inventory control. It is a material control system that attempts to keep adequate inventory levels to assure that required materials are available when needed.

Material Requirements Planning is a time phased priority-planning technique that calculates material requirements and schedules supply to meet demand across all products and parts in industry. Currently, Information Technology plays a major role in designing and implementing Material Requirements Planning systems and processes as it provides information about manufacturing needs (linked with customer demand) as well as information about inventory levels. MRP techniques focus on optimizing inventory. It is used to explode bills of material, to calculate net material requirements and plan future production. MRP is a commonly accepted approach for replenishment planning in major companies. Nowadays MRP based software tools are accepted readily. Most industrial decision makers are familiar with their use.

1.2 ABOUT THE INDUSTRY

The Indian auto component sector is a thrust sector for India. The industry has more than 500 large to medium key participants that form the organized sector whereas there are more than 6,000 ancillary units which constitutes the unorganized sector. OEM dominates the auto component market constituting almost 75 per cent of the market while the replacement market has share of 25 per cent.

The Indian Auto component industry has transitioned from a supplier for the global aftermarket to becoming a full-scale global Tier 1 supplier. Industry policies like manufacturing and imports free from licensing and approvals, 100% FDI in auto sector and no local content regulation of the Government have helped the auto component sector to grow in the past.

The Indian auto components industry has been witnessing a moderation in its revenue growth since the beginning of this fiscal following the deceleration in sales volume growth across all automobile segments. As per industry estimates, out of the total turnover of the Indian auto components industry, around 60% is derived from sales to domestic OEMs, around 25% comes from sales to the domestic replacement market and around 15% is derived from exports. While lower year on year volume growth of domestic OEMs in 9m 2011-12, particularly those belonging to the passenger vehicle and Medium and Heavy Commercial Vehicle segments, translated into muted revenue growth for the auto components industry during this period; the sluggishness was partly arrested on the back of rise in component exports and higher domestic replacement market sales. While the long term prospects for the industry remain strong in line with the outlook for the OEM segment, the industry faces strong challenges in the form of threat of low cost imports, currency volatility and ability to invest on product development to be able to move up the value chain.

The amount of cumulative foreign direct investment (FDI) inflow into the automobile industry during April 2000 to November 2012 was worth US\$ 7,518 million, amounting to 4 per cent of the total FDI inflows (in terms of US\$), as per data published by Department of Industrial Policy and Promotion (DIPP),

Ministry of Commerce. Supportive government policies, positive business environment, availability of reasonably priced talented workforce and stable outlook for the industry has made India a global hub for the international manufacturers to set up their facilities in the country. The auto components manufacturers are also reaping the benefits.

The Government of India's (GoI) recent electric vehicle (EV) policy calls for a plan worth Rs 23,000 crore (US\$ 4.26 billion), to promote the production of electric and hybrid vehicles over the next eight years, and set a sales target of 6 million units by 2020.

In a bid to improve safety features of vehicles, the Government has asked automobile manufacturers to develop a gadget which would be similar to the 'black box' installed in planes. The owner would not be able to turn the instrument off or on and the snapshot could be viewed by legal bodies, insurance companies and automakers. The Government of India has also asked manufacturers to contemplate on the option of fixing such IT-enabled instrument to improve safety and security of the vehicles. Furthermore, the thrust given by the Government to the automotive sector in the last supplement of the Foreign Trade Policy (FTP) is truly commendable.

Moulding line supplied by M/s. Disa Technologies of Denmark. The fully automatic sand plant is controlled by computers, which ensure that sand, Bentonite, Carbonaceous material and water are mixed in the right proportion. The Disa technology also facilitates easy storage and retrieval of production data, easy handling and changing of patterns. Synchronized belt conveyors system transfer the mould to the Disa cool drum where the castings are separated from sand which is transferred by conveyor systems for recycling.

SACL is one of the few facilities in the country with in-house machining facility, machining 95% of the components produced. SACL caters to the needs of Global Automobile and truck manufacturers by supplying safety critical components like Steering knuckles and Rotors to more than 3 Million Vehicles per annum. The top customers for SACL are Maruti Suzuki, General Motors, Hyundai, Honda Siel Cars, Ford, Fiat, Toyota, Volkswagen, Renault, Mahindra & Mahindra, Tafe, Haldex.

It is equipped with latest coating facilities like Geomet, Powder coating, Phosphating. SACL which has been certified with ISO/TS 16949:2009, ISO14001:2004 and OHSAS 18001:2007 has Part Level Performance .Validation Lab setup to take care of impact and durability testing for all OEM'S.

SACL is the sole vendor for many critical components like steering knuckles, brake drums, brake discs, exhaust manifolds and case differentials for leading manufacturers in India equipments for machining rough castings to like Maruti, Suzuki, Hyundai, FIAT and Delphi. Castings meant for trucks and refineries are exported to USA. The quantum of exports per month ranges between 250 MT to 500 MT. It is likely to go up to 1000 MT in near future. Sakthi Auto Component Limited has been awarded the industrial safety awards for three consecutive years. It has also been recognised by Maruti Udyog Limited as a First class critical Component Vendor.

SAKTHI PORTUGAL

The company which was operational since 1972 was later acquired by the Sakthi group in 2007 giving birth to Sakthi Portugal. It is located in Maia,

1.3 ABOUT THE ORGANISATION

The Sakthi Group is an Industrial Conglomerate and one of the fastest growing business groups in South India. The Sakthi Group has a strong market presence in a number of Industrial Domains with a host of group companies, institutions, trusts and foundations operating under its umbrella. These organizations have been playing a significant role in shaping the economic and social development of South India. Some of their vertical operations includes Sakthi Sugars Limited, Sakthi Auto Component Limited, ABT Limited, Sakthi Finance Limited, Sakthi Aerospace, ABT Info Systems, Caresoft Global, Sri Sakthi Textiles Limited, Anamalais Engineering (p) Limited.

Sakthi Auto Component Limited (SACL) is one of the multi faceted companies of the Sakthi Group. It is situated at Mukasi Pallagoundenpalayam, Tirupur District of TamilNadu State, India.

Established in the year 1983 it hosts an advanced infrastructure built on a sprawling 120 Acres Land with all amenities including housing, transport, etc, for its workmen and officers. The capacity of the plant was further enhanced to 60000 Tonnes/Annum with the High-pressure vertical Disamatic Green Sand moulding lines.

The company has got following divisions: Foundry A-Conventional foundry line, Foundry B- Disamatic mould line, Knuckling line and machining division.

In SACL, Foundry –"A" is a conventional jolt squeeze green sand moulding process where castings up to 50 kgs weight are produced. The ultimate capacity of this foundry is 1500/month.

Foundry – "B" has got the Disa Mould Making and conveyor system, which is the most advanced facility that produces dimensionally accurate castings very consistently. Capacity of first line is 1500 tonnes per month (350 moulds per hour), Disa moulding machine second line is added on 10.4.2007, whose capacity is 1200 tonnes per month (300 moulds per hour). It has integrated Auto pour furnace and Disa mould making and conveyor system.

District of Porto; Portugal. It manufactures Safety Critical Components in nodular iron. Sakthi Portugal produces Brake Housings, differential cases, suspension control arms and a host of other components and supplies them to automobile majors like Mercedes, Volvo, PSA, AMG and Ford.

SAKTHI AUTO ANCILLARY PRIVATE LIMITED

Sakthi Auto Ancillary Private Limited (SAAPL) was started in the year 1985 and was taken over by the Sakthi Auto Component as a subsidiary in the year 2006. A specialist in grey iron disc/drum for auto OEM's it also manufactures and exports valves.SAAPL has a production capacity of 24000Tonnes/Annum.The division is certified with ISO/TS 16949:2009.

QUALITY POLICY OF SACL

It is our aim to become world class in serving our customers by

- Meeting the requirements of quality consistently
- Continuous improvements
- Upgradation of human resources

QUALITY OBJECTIVES

- Manufacturing and supplying world class safety components for International Automobile Markets.
- Upgradation of manufacturing and testing techniques based on customer requirements.
- Maintaining the quality at various stages of production from receipt till delivery.
- Identifying and providing training on a continuous basis to all levels of employees.
- Controlling the pollution level as per the statutory requirement.
- Maintaining safe working practice throughout the organisation.
- Implementing and maintaining a Quality Management System as per ISO 9002: 1994.

PRODUCTS

The production includes Brake drums, Steering knuckle, brake disc, exhaust manifold, Brake calliper, wheel hub, diffcase, engine mount brackets, flywheel, housing, ARMS (short, covered), cross bar, wing nut, axle housing, pressure plate, brackets, crank case, carrier, bearing housing, shift yoke.

LIST OF PLANT AND MACHINERY

CNC MACHINE SHOP
PUMA Vertical Turning Machine - DAEWOO KOREA
AOBA Honing Machine - JAPAN
KOYO Double Disc Grinding Machine - JAPAN
FANUC ROBO Drill & Tap Centre
Special Purpose Machine line for Steering Knuckle -SUMITOMO CORPORATION - JAPAN
TESTING EQUIPMENTS
Co-ordinate Measuring Machine - MITUTOYO JAPAN
Balancing Machine - AVERY INDIA
Surface Roughness Tester - MITUTOYO JAPAN
Roundness Tester - MITUTOYO JAPAN

LIST OF FEW CUSTOMERS

MARUTI UDYOG LTD.
 GENERAL MOTORS LIMITED
 HONDA SIEL CARS INDIA LIMITED
 FORD MOTORS LIMITED
 VOLVO MOTORS LIMITED
 TAFE LIMITED
 FIAT INDIA PRIVATE LIMITED
 BOSCH CHASSIS SYSTEM INDIA LTD.
 MAHINDRA RENAULT PRIVATE LIMITED

MRP systems use four pieces of information to determine what material should be ordered and when:

- the master production schedule, which describes when each product is scheduled to be manufactured;
- bill of materials, which lists exactly the parts or materials required to make each product;
- production cycle times and material needs at each stage of the production cycle time; and,
- supplier lead times.

The master schedule and bill of materials indicate what materials should be ordered; the master schedule, production cycle times and supplier lead times then jointly determine when orders should be placed.

The Master Production Schedule includes quantities of products to be produced at a given time period. Quantities are included both at aggregate and detailed levels. Aggregate may refer to monthly production and detailed may refer to weekly or daily production. The master production schedule takes the form of a table in which rows represent products and columns represent time components.

Bill of Materials gives information about the product structure, i.e., parts and raw material units necessary to manufacture one unit of the product of interest. MRP was pioneered in the 1970's with the work of Orlicky. Later evolved or became part of integrated to Manufacturing Resource Planning systems (or MRPII). MRPII is a computer based planning and scheduling system designed to improve management's control of manufacturing and its support functions.

In today's corporate environment MRPII is often termed as ERP (or Enterprise Resource Planning). MRPII represents a group of software programs designed to tie together disparate company functions to create more efficient operations in areas such as assembly or delivery of products or services. Thus

AWARDS

Sakthi Auto Component Limited has been awarded the industrial safety awards for three consecutive years. It has also been recognised by Maruti Udyog Limited as a First class critical Component Vendor.

BASIC CONCEPTS

INVENTORY

Inventory is the stock of resource used in an organization. An inventory system is a set of policies and controls to monitor inventory levels and determine the level of inventory to be maintained, when stock should be provided and how much inventory to order. Inventories are a number of materials, parts and materials supplied in the process contained in the company for the production process, as well as finished goods or products provided to meet demand from consumers or subscription at any time. It can be concluded that the stock is all available resources owned by the raw materials, intermediate goods, finished goods, homemade goods, materials, labour, funds, to maintain the smooth production and the anticipation of the fulfillment of consumer demand.

INVENTORY CONTROL

Controlling inventory is a technique for determining amount of inventory at the desired level. The Company focuses on products with emphasis on the physical form of the control of raw materials. It is known that inventory control is a method or technique to maintain, estimating, and determining a company's inventory levels so as to protect the smooth production, meet consumer demand, as well as taking advantage of the spending needs of companies and can minimize the total company's operating costs.

MATERIAL REQUIREMENTS PLANNING

Material Requirements Planning is a technique for determining the quantity and timing for the acquisition of dependent items needed to satisfy master schedule requirements.

MRP has evolved to become a component of a MRPII system. Technically, MRPII extends MRP and links it with the company's information resources such as human resource information system, financial management, accounting, sales, etc. Such extension is typical according to modern trends in business management and modelling and made possible by advances in information technology. On the other hand, the need to integrate is well established in management thinking and practice. Since the pioneering work of Anthony during the sixties, management decision-making processes are viewed from extending from strategic planning, to management control and to operational control. MRP systems lay in-between management control and operational control processes. However, as detailed production data are linked with overall organizational information resources it becomes clear that MRP and MRPII system implementations play a significant role in company's corporate advantage.

MRP OBJECTIVES

The main theme of MRP is "getting the right materials to the right place at the right time". Specific organizational objectives often associated with MRP design and implementation may be identified among three main dimensions, namely: inventory, priorities and capacity:

Inventory:

- Order the right part
- Order the right quantity
- Order at the right time

Priorities:

- Order with the right due date
- Keep the due date valid

Capacity:

- Plan for a complete load
- Plan for an accurate load
- Plan for an adequate time to view future load

AN OUTLINE OF THE MRP PROCESS

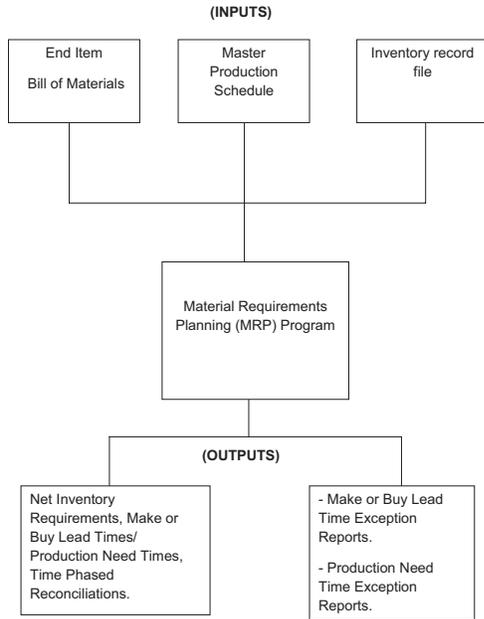


Chart 1.1 Inputs and Outputs of an MRP System

Net Requirements

- The difference between the inventory available to a period and the gross requirement of the period is the net requirement.
- Orders are placed to meet this net requirement.

$$\text{Net requirements} = \text{Gross Requirements} - \text{On-Hand inventory}$$

Planned order Receipts

- It is the existing replenishment orders for the item due in at the beginning of each period.
- Scheduled receipts result from previously made ordering decisions and represent a source of item to meet gross requirements
- It represents a commitment

Projected Available Balance

- It is the current and projected inventory status for the item at the end of each period.
- It is the projected balance after replenishment orders have been received and gross requirements have been satisfied.
- The projected available balance shown at the end of a period is available to meet gross requirements in the next periods.

Planned Order Releases

- It is the planned replenishment orders for the item at the beginning of each period.
- This is done by creating a planned order release in time to keep the projected available balance from becoming negative.
- MRP system creates a planned order by offsetting the lead-time to the beginning of a week.
- A planned order in the most immediate period or current period is in the action bucket.
- A quantity in the action bucket means some action is needed to avoid a future problem. The action is to release the order, which converts it to a scheduled receipt.

MRP PROCESS

Starting with end items the MRP process goes through the following steps

1. Establish gross requirements.
2. Determine net requirements by subtracting on hand inventory from the gross requirements
3. Time phase the net requirements.
4. Determined the planned order releases

Table 1.1 MRP Table

Week	1	2	3	4	5	6	7	8
Gross requirements								
On-hand								
Net requirements								
Planned order receipts								
Planned order releases								

Period

- Periods can vary in length from a day to a quarter or even longer. The periods are also called a time bucket. Widely used time bucket is one week.
- The current time is the beginning of the first period.
- The number of period in the record is the planning horizon.

Gross Requirements

- It is the anticipated future usage of or demand for the item during each period.
- Gross requirements are time phased which means they are stated on a unique period-by-period basis, rather than aggregated or averaged.
- A gross requirement in a particular period will be unsatisfied unless the item is available during the period.

1.4 STATEMENT OF THE PROBLEM

In response to ever-increasing regional and global competition, automotive manufacturing companies are looking to improve the efficiency and effectiveness of their operations through the adoption of sophisticated manufacturing planning and control systems and Material Requirements Planning (MRP) systems in particular. MRP helps to determine the quantity and timing of the acquisition of dependent demand items needed to satisfy master schedule requirements.

The issue related with assembly line unit at Sakthi Auto Component limited is that they are not following proper material planning and scheduling for their various component assembly. This leads to increase in level of inventory and cost of inventory. The existing non-MRP approach does not provide efficient material procurement pattern to order the materials. To improve the existing condition MRP approach is needed for the assembly unit. One of its main objectives is to keep the material availability in order, eliminating material shortages and excess stocks. It also breaks a component into parts and subassemblies, and plans for those parts to come into stock when needed.

1.5 SCOPE OF THE STUDY

Material Requirements Planning is a time phased priority-planning technique that calculates material requirements and schedules supply to meet demand. The study is focused on developing Material Requirement Planning for the braking system assembly which has dependent item characteristics. Detailed analysis of the material order, planned order release, receipts for the various components of the braking system assembly is carried out. The analysis provides the need for improving the material procurement for various components and this study can be extended by developing MRP programme for other knuckling line models also.

successful implementation. The results confirm many factors to generally believed to be related to success and highlight the importance of MRP. The companies reported better production scheduling, greater reductions in safety stocks, inventory levels, overtime, production lead times, component shortages and manufacturing costs, and improved inventory turnover after introducing MRP.

Allen J. Rembert (1989)⁴ provided an integrated MRP system for distributors, manufacture and job shops. The MRP system of the present invention is specifically directed to an user which manufactures and sells products that have a wide variety of options. The MRP system of the present invention allows the user who manufactures and sells a number of styles with a wide variety of options to employ an MRP system without a correspondingly high maintenance overhead.

RB Cooper and RW Zmud (1989)⁵ examined factors affecting MRP implementation from an innovation diffusion perspective. Within this perspective, the effect of manufacturing tasks and MRP technology on the infusion of MRP is examined. A logistical regression analysis of the data indicates that factors such as production complexity which affect MRP adoption can work in an opposite direction for MRP infusion (the use of MRP to its "fullest potential"). This implies that it may be advantageous for some firms to adopt and maintain MRP at low infusion levels rather than attempting to increase infusion over time.

Patty W. Cheng (1997)⁶ conducted a survey study of manufacturing companies in Virginia and Tennessee was to evaluate the current use and

[4] Allen J. Rembert (1989), "Material requirements planning system" U.S. patents: US5101352 A.

[5] RB Cooper and RW Zmud (1989), "Material Requirements planning system infusion", Omega 17.5, 471-481.

[6] Patty.W.Cheng (1997), "Effective use of MRP-type computer systems to support manufacturing", Doctoral Dissertation-Virginia Polytechnic Institute and State University.

CHAPTER- 2 REVIEW OF LITERATURE

Douglas W. Edgar (1983)¹ presented the extent of MRP system utilization within the defence industry and the anticipated effects of revised MYP policies on the defence industry's acquisition of MRP systems are unknown. Knowledge of MRP usage within the defence industry is necessary to assess the impact of the revised MYP policies on weapons system acquisition costs. Based on the author's overall assessment of the research, the receipt of an MYP contract has little influence on a defence contractor's decision to acquire an MRP system, MYP does have a stronger influence on the decision to enhance an existing MRP system.

Harish C. Bahl and Larry P. Ritzman (1983)² presented that Master production scheduling, component lot sizing, and capacity requirements planning represent three important modules of material requirements planning (MRP) systems. Coordinating these three modules has been largely dependent on managerial judgment and experience. In this research, five different strategies for integrating these modules are empirically investigated. The research findings so obtained provide several guidelines on the effectiveness of each strategy in different environmental settings.

Peter Duchessi, et.al (1988)³ reports on a nationwide survey of companies having implemented or currently implementing MRP and other MRP-based systems. The study uses survey responses to identify the steps that lead

[1] Douglas W. Edgar (1983), "Material Requirements Planning (MRP) within the Defense Industry: The Linkage to Multiyear Procurement (MYP)".

[2] Harish C. Bahl and Larry P. Ritzman (1983), "An empirical investigation of different strategies for material requirements planning", Journal of Operations Management Volume 3, Issue 2, 67-77.

[3] Peter Duchessi, Charles M. Schaninger, Don.R.Hobbs, Lawrence.P.Pentak (1988) "Determinants of Success in Implementing Material Requirements Planning (MRP)" Elsevier Science Publishing Co., Inc., 1, 263-304 .

performance of computer systems to support manufacturing applications. This study explores the reasons why organizations chose to use these systems, the problems and benefits derived from the MRP and ERP systems and the characteristics of the types of companies that have benefited from the use of MRP-type systems.

Edmund W. Schuster (2000)⁷ developed a two-level, spreadsheet-based procedure at Welch's, the largest processor of Concord and Niagara grapes, to perform integrated capacity planning. In addition to contending with capacity limitations, Welch's, like many companies in the process industries, must consider the logistics of inter-plant transfers, special processing requirements, as well as proprietary product recipes when designing an MRP system.

Patrick J. Rondeau (2001)⁸ proposed a stage model as a useful way of organizing and defining our thoughts concerning the nature and content of manufacturing planning and control systems. The MPC stage model presented within this article discusses the evolution of computerized manufacturing planning and control. For each stage, the major attributes of that stage as well as the forces driving the evolutionary process between stages discussed.

Salaheldin Ismail (2004)⁹ presented the critical factors influencing the stage of implementation of materials requirements planning (MRP) in the Egyptian Industrial Sector. The current study differs from previous investigations of the stage of MRP implementation in two main ways: in dealing with MRP implementation stage in a developing nation i.e. Egypt and in having a wider coverage of critical factors affecting the level of MRP implementation.

[7] Edmund W. Schuster, Allen S.J and D'Itri, M. P. (2000), "Capacitated MRP and its Application in the Process Industries", Journal of Business Logistics, 21(1), 169-188.

[8] Rondeau, Patrick, and Lewis A. Litteral (2001), "The evolution of manufacturing planning and control systems: From reorder point to enterprise resource planning." Production and Inventory Management Journal, 34(2): 1-7.

[9] Salaheldin. Ismail (2004), "Factors influencing the stage of MRP Implementation: An Empirical Study", International Scientific Journal "Problems & Perspectives in Management", Vol. 1. No. 3.

The major findings of this research indicate that the organizational willingness to change is positively associated with the stage of MRP implementation achieved.

Vichayanan Rattanawiboonsom et.al (2006)¹⁰ concerns our empirical investigation of the way in which MRP systems are being implemented in Thai automotive manufacturing companies. The investigation is based on a major questionnaire survey of about 120 companies, of which about 67 companies are currently using some kind of MRP system. In addition to more general question on the nature of the companies concerned and the production processes used, the survey posed specific questions on the (actual or expected) costs and benefit to be obtained from MRP, as well as the implementation process used.

Davood Gharakhani (2010)¹¹ demonstrated the usefulness and significance of the Goal programming model for Optimization of Material Requirement Planning. A set of real data from an automobile Gearbox manufacture is used to test the effectiveness and the efficiency of the proposed model. The model of the example case is solved and the computational results are given. The corresponding results show that the proposed models can help manufacturers make better decisions when they have multiple objectives.

Ramin Sadeghin (2010)¹² presented a new form of MRP known as Continuous Materials Requirements Planning (CMRP) approach in his study. The Materials Requirements Planning (MRP) method that is applied in production planning and management has some weakness. One of its

[10] Vichayanan Rattanawiboonsom, Meer, Robert Van Der and Williams, Terry (2006), "A study on material requirement project implementation in Thai automotive organization" *Journal of Management Science and Information Science* 2, 1 (May 2550) 1905-3746.

[11] Davood Gharakhani (2010), "Optimization of material requirement planning by Goal programming model", *Asian Journal Of Management Research*, 297, Volume 2 Issue 1.

[12] Ramin Sadeghin (2010), "How to use MRP in continuous Production Industries when order type is Lot for Lot", *International Journal of Industrial Engineering & Production Research*, pp.17-22.

CHAPTER- 3

RESEARCH METHODOLOGY

Research methodology is the systematic way to solve the research problem. It gives an idea about various steps adopted by the researcher in a systematic manner with an objective to determine various relations among the variables taken for study.

3.1 TYPE OF RESEARCH

The research design used for this study is descriptive and analytical research type. Descriptive research is mainly done to have a quantitative idea of the variables under study. It is concerned with describing the characteristics of a particular individual or a group. Analytical research involves in-depth study and evaluation of available information in an attempt to explain complex phenomenon. The information already available is used to evaluate about the material.

3.2 OBJECTIVES OF THE STUDY

- To analyse the material requirements planning need to manufacture the product in the auto components industry
- To find the planned order release for a braking system assembly part.
- To determine the number of parts, components, and materials needed to produce each end item.
- To provide time schedules for ordering materials & parts.
- To maintain a bill of materials sequencing the assembly parts of the final product.
- To aid stores manager in taking decision regarding material release orders based on planned schedule.

weaknesses is that the time in MRP method is discrete. Hence it is difficult to order the requirements based on the discrete time period at irregular time moments or periods. In this study disadvantage of applying CMRP is analyzed using mathematical functions.

Yolanda Masnita and Tania Ananda Mahdani (2012)¹³ presented the implementation process factors and results of the conduct of Materials Requirement Planning (MRP), and to know the relationship between these factors. The purpose of this study is to identify the elements of MRP implementation that are required to ensure successful implementation. Data collected by distributing questionnaires to 55 supervisor level employees who directly handle the Material Requirement Planning (MRP) in manufacturing industries in SME'S industrial estates. The results show there is a positive relationship between these factors and the results of the implementation process of the implementation of Material Requirement Planning (MRP) in manufacturing industry.

[13] Yolanda Masnita and Tania Ananda Mahdani (2012), "Factors of MRP Implementation in Manufacturer for Small and Medium-Sized Firms"- The 2012 International Conference on Business and Management.

3.3 DATA AND SOURCES OF DATA

Data is the raw material for almost all research studies. In this study there is a need to gather primary as well as secondary data. The source of the information and the manner in which data are collected could well make a big difference to the rigor and effectiveness of the research project.

3.3.1 PRIMARY DATA

Primary data refer to first hand information obtained by the researcher on the variables of interest for the specific purpose of the study. Here observational survey and questionnaire method is used. The respondents considered for the survey are from various departments of Sakthi Auto Components Limited.

3.3.2 SECONDARY DATA

Secondary data refer to information gathered from sources already existing. Such data can be internal or external to the organization and accessed through the internet or perusal recorded or published information. There are several sources of secondary data, including books and periodicals, statistical abstracts, data bases, the reports of the companies. Here the data is collected from the production department of Sakthi Auto Components Limited.

The advantage of seeking secondary data sources is savings in time and cost of acquiring information. However, secondary data as the sole source of information has the drawback of becoming obsolete, and not meeting the specific needs of the particular situation or setting. Hence, the source that offers current and up to date information is taken for analysis.

3.4 TIME PERIOD COVERED

The data taken for the study is from January 2013 to May 2013 and planning horizon of three months is considered for MRP construction.

3.5 SAMPLE SIZE

The braking system includes eight components namely Steering Knuckle, Hub, Bolt, Circlip, Bearing, Brake Disc, Cylindrical Housing and Screw. Sample size of 30 respondents was taken for study.

3.6 SAMPLING TECHNIQUE

The sample is selected based on the judgement sampling technique.

3.7 TOOLS AND FORMULA USED

➤ Percentage analysis

Percentage analysis is the method to represent raw streams of data as a percentage (a part in 100 - percent) for better understanding of collected data.

➤ Mean value

The mean is just the average of the numbers. It is used to find the mean of collected data.

➤ MRP model for dependent items

EOQ (units)	Lead time (weeks)			
Period	1	2	3	4
Gross Requirement				
On-hand				
Net Requirements				
Planned order receipt				
Planned order release				

➤ EOQ method

For purchase model:

Economic order size, $Q_1 = \sqrt{(2C_0D)/C_c}$ (units)

For manufacturing model:

Economic production size, $Q_2 = \sqrt{\frac{2SD}{C_c(1-\frac{D}{R})}}$ (units)

where,

D – Demand/year

P – Purchase price/unit

C_c – Carrying cost/unit/year

C₀ – Ordering cost/order

S – Setup cost/setup

R – Production rate (units/year)

➤ Outline Process chart for showing the activities "operation" and "inspection" which are involved in manufacturing the assembly.

➤ Total Inventory Cost is used for calculated using inventory carrying cost and ordering cost.

Total Cost (Rs.) = Inventory carrying cost + Ordering cost

3.8 LIMITATIONS OF THE STUDY

- The study made on the particular model of the braking system assembly.
- The planning horizon selected for study is for three months only.
- Lot for lot sizing method is used.
- All the factors for the planning and scheduling are not fully covered.
- The final decision on purchasing and manufacturing should always be reviewed by a competent authorised person.

CHAPTER 4

ANALYSIS AND INTERPRETATION

4.1 A Non-MRP Approach.

A simplistic but often used approach for determining material requirements before a production run is as follows:

Net Requirements= Components Required - Components on-hand

Table 4.1 A Non-MRP Approach

Components	No of components required to meet a demand for 5000 units	On-Hand (units)	Net requirements (units)
Steering Knuckle	5000	200	4800
Hub	5000	100	4900
Bolt	5000	200	4800
Circlip	5000	150	4850
Bearing	5000	120	4880
Brake Disc	5000	100	4900
Cylindrical housing	5000	80	4920
Screw	5000	100	4900

The above table 4.1 shows the non-MRP approach followed in determining net requirements. This approach recognizes neither the "time phasing" of requirements nor the possibility of subassembly quantity dependency on end-item quantities. Thus, the non-MRP approach cannot fully exploit the opportunity for material savings offered by material procurements.

4.2 A MRP Approach

4.2.1 PRODUCT STRUCTURE

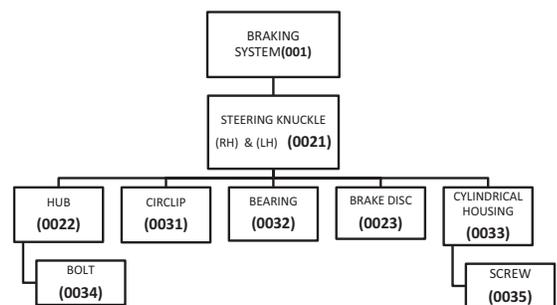


Chart 4.1 Product Structure

From the chart 4.1 it is clear that the braking system has a steering knuckle and it is of two types namely left hand and right hand. Each hand requires a hub, a circlip, a bearing, a break disc and cylindrical housing. Each hub and cylindrical housing needs four bolts and four screws respectively.

4.2.2 BILL OF MATERIALS

Table 4.2 Bill of Materials

ITEM CODE	PART	NUMBER OF UNITS REQUIRED	LEAD TIME (WEEK)
0001	Braking System	1	
0021	Steering Knuckle (Left hand & Right hand)	1	2
0022	Hub	1	1
0023	Brake Disc	1	2
0031	Circlip	1	1
0032	Bearing	1	1
0033	Cylindrical Housing	1	1
0034	Bolt (M12)	8	1
0035	Screw (M8)	8	1

Order quantities, lead times at the beginning of period 1 for above components are shown in the table 4.2. The lead time for Steering knuckle and Brake Disc is 2 weeks and both are manufactured in-house.

4.2.4 INVENTORY RECORDS (ITEM MASTER) FILE

Table 4.5 Inventory records file

ITEM CODE	PART	NUMBER OF UNITS REQUIRED	LEAD TIME (WEEK)	ON-HAND INVENTORY
0001	Braking System	1	2	
0021	Steering Knuckle (Left hand & Right hand)	1	2	200 each
0022	Hub	1	1	100
0034	Bolt (M12)	8	1	200
0031	Circlip	1	1	150
0032	Bearing	1	1	120
0023	Brake Disc	1	2	100
0033	Cylindrical Housing	1	1	80
0035	Screw (M8)	8	1	100

Order quantities, lead times at the beginning of period along with on-hand inventory for above components are shown in the table 4.5.

4.2.3 MASTER PRODUCTION SCHEDULE

FORECASTING DEMAND

Future requirements for final braking system based on the demand conditions from the known customers are shown in table 4.3.

Table 4.3 Demand Requirements

MONTH	DEMAND
1	8000
2	10000
3	7500
4	8000
5	10000

MASTER PRODUCTION SCHEDULE (MPS)

The following schedule shown in table 4.4 is framed assuming that all items are to be available at the first week of the month. The months taken are March, April and May of 2013.

Table 4.4 Master Production Schedule

	Period									
	9	10	11	12	13	14	15	16	17	
Total Production	7500				8000					10000
Steering Knuckle (Left Hand)	3750				4000					5000
Steering Knuckle (Right Hand)	3750				4000					5000

4.2.5 MRP CALCULATION FOR MARCH MONTH (9th week)

STEERING KNUCKLE (LH) -0021A Table 4.2.5-1 Lead time: 2 Weeks

Period	5	6	7	8	9	10
Gross Requirement					3750	
On-hand				200	0	
Net Requirements					3550	
Planned order receipt					3550	
Planned order release			3550			

STEERING KNUCKLE (RH) -0021B Table 4.2.5-2 Lead time: 2 Weeks

Period	5	6	7	8	9	10
Gross Requirement					3750	
On-hand				200	0	
Net Requirements					3550	
Planned order receipt					3550	
Planned order release			3550			

HUB-0022 (for one hand)

Table 4.2.5-3 Lead time: 1 Week

Period	5	6	7	8	9	10
Gross Requirement			3550			
On-hand		100	0			
Net Requirements			3450			
Planned order receipt			3450			
Planned order release		3450				

BOLT-0034 (for one hand)

Lead time: 1 Week

Table 4.2.5-4

Period	5	6	7	8	9	10
Gross Requirement		13800				
On-hand	200	0				
Net Requirements		13600				
Planned order receipt		13600				
Planned order release	13600					

CIRCLIP-0031 (for one hand)

Lead time: 1 Week

Table 4.2.5-5

Period	5	6	7	8	9	10
Gross Requirement			3550			
On-hand		150	0			
Net Requirements			3400			
Planned order receipt			3400			
Planned order release		3400				

BEARING-0032 (for one hand)

Lead time: 1 Week

Table 4.2.5-6

Period	5	6	7	8	9	10
Gross Requirement			3550			
On-hand		120	0			
Net Requirements			3430			
Planned order receipt			3430			
Planned order release		3430				

MRP CALCULATION FOR APRIL MONTH (13th week)**STEERING KNUCKLE (LH) -0021A** Table 4.2.5-10 Lead time: 2 Weeks

Period	9	10	11	12	13	14
Gross Requirement					4000	
On-hand				200	0	
Net Requirements					3800	
Planned order receipt					3800	
Planned order release			3800			

STEERING KNUCKLE (RH) -0021B

Lead time: 2 Weeks

Table 4.2.5-11

Period	9	10	11	12	13	14
Gross Requirement					4000	
On-hand				200	0	
Net Requirements					3800	
Planned order receipt					3800	
Planned order release			3800			

HUB-0022 (for one hand)

Lead time: 1 Week

Table 4.2.5-12

Period	9	10	11	12	13	14
Gross Requirement			3800			
On-hand		100	0			
Net Requirements			3700			
Planned order receipt			3700			
Planned order release		3700				

BRAKE DISC-0023 (for one hand)

Lead time: 2 Weeks

Table 4.2.5-7

Period	5	6	7	8	9	10
Gross Requirement			3550			
On-hand		100	0			
Net Requirements			3450			
Planned order receipt			3450			
Planned order release	3450					

CYLINDRICAL HOUSING-0033 (for one hand)

Lead time: 1 Week

Table 4.2.5-8

Period	5	6	7	8	9	10
Gross Requirement			3550			
On-hand		80	0			
Net Requirements			3470			
Planned order receipt			3470			
Planned order release		3470				

SCREW-0035 (for one hand)

Lead time: 1 Week

Table 4.2.5-9

Period	5	6	7	8	9	10
Gross Requirement		13880				
On-hand	100	0				
Net Requirements		13780				
Planned order receipt		13780				
Planned order release	13780					

BOLT-0034 (for one hand) Table 4.2.5-13 Lead time: 1 Week

Period	9	10	11	12	13	14
Gross Requirement			14800			
On-hand	200	0				
Net Requirements			14600			
Planned order receipt			14600			
Planned order release	14600					

CIRCLIP-0031 (for one hand)

Lead time: 1 Week

Table 4.2.5-14

Period	9	10	11	12	13	14
Gross Requirement			3800			
On-hand		150	0			
Net Requirements			3650			
Planned order receipt			3650			
Planned order release		3650				

BEARING-0032 (for one hand)

Lead time: 1 Week

Table 4.2.5-15

Period	9	10	11	12	13	14
Gross Requirement			3800			
On-hand		120	0			
Net Requirements			3680			
Planned order receipt			3680			
Planned order release		3680				

BRAKE DISC-0023 (for one hand) Table 4.2.5-16 Lead time: 2 Weeks

Period	9	10	11	12	13	14
Gross Requirement			3800			
On-hand		100	0			
Net Requirements			3700			
Planned order receipt			3700			
Planned order release	3700					

CYLINDRICAL HOUSING-0033 (for one hand) Table 4.2.5-17 Lead time: 1 Week

Period	9	10	11	12	13	14
Gross Requirement			3800			
On-hand		80	0			
Net Requirements			3720			
Planned order receipt			3720			
Planned order release		3720				

SCREW-0035 (for one hand) Table 4.2.5-18 Lead time: 1 Week

Period	9	10	11	12	13	14
Gross Requirement		14880				
On-hand	100	0				
Net Requirements		14780				
Planned order receipt		14780				
Planned order release	14780					

BOLT-0034 (for one hand) Table 4.2.5-22 Lead time: 1 Week

Period	13	14	15	16	17	18
Gross Requirement		18800				
On-hand	200	0				
Net Requirements		18600				
Planned order receipt		18600				
Planned order release	18600					

CIRCLIP-0031 (for one hand) Table 4.2.5-23 Lead time: 1 Week

Period	13	14	15	16	17	18
Gross Requirement			4800			
On-hand		150	0			
Net Requirements			4650			
Planned order receipt			4650			
Planned order release		4650				

BEARING-0032 (for one hand) Table 4.2.5-24 Lead time: 1 Week

Period	13	14	15	16	17	18
Gross Requirement			4800			
On-hand		120	0			
Net Requirements			4680			
Planned order receipt			4680			
Planned order release		4680				

MRP CALCULATION FOR MAY MONTH (17th week)

STEERING KNUCKLE (LH) -0021A Table 4.2.5-19 Lead time: 2 Weeks

Period	13	14	15	16	17	18
Gross Requirement					5000	
On-hand				200	0	
Net Requirements					4800	
Planned order receipt					4800	
Planned order release			4800			

STEERING KNUCKLE (RH) -0021B Table 4.2.5-20 Lead time: 2 Weeks

Period	13	14	15	16	17	18
Gross Requirement					5000	
On-hand				200	0	
Net Requirements					4800	
Planned order receipt					4800	
Planned order release			4800			

HUB-0022 (for one hand) Table 4.2.5-21 Lead time: 1 Week

Period	13	14	15	16	17	18
Gross Requirement			4800			
On-hand		100	0			
Net Requirements			4700			
Planned order receipt			4700			
Planned order release		4700				

BRAKE DISC- 0023 (for one hand) Table 4.2.5-25 Lead time: 2 Weeks

Period	13	14	15	16	17	18
Gross Requirement			4800			
On-hand		100	0			
Net Requirements			4700			
Planned order receipt			4700			
Planned order release	4700					

CYLINDRICAL HOUSING - 0033 (for one hand) Table 4.2.5-26 Lead time: 1 Week

Period	13	14	15	16	17	18
Gross Requirement			4800			
On-hand		80	0			
Net Requirements			4720			
Planned order receipt			4720			
Planned order release		4720				

SCREW - 0035 (for one hand) Table 4.2.5-27 Lead time: 1 Week

Period	13	14	15	16	17	18
Gross Requirement		18880				
On-hand	100	0				
Net Requirements		18780				
Planned order receipt		18780				
Planned order release	18780					

4.2.6 CONSOLIDATED

- The master production schedule is developed assuming that all the items are to be available during the first week of the month i.e. week 9, 13 and 17.

FOR MARCH MONTH

- The 200 units of the Steering knuckle left hand and 200 units right hand on - hand inventory result in a net requirement of 3550 units of Steering knuckle left hand and right hand each (3750 units – 200 units=3550 units). To receive the product in week 9, the order must be placed in week 7 of March to account for the two week lead time.
- The gross requirements for Hub in week 7 are 3550 units, taking into account the 100 units on hand and the one week lead time, 3450 units of Hub must be ordered in week 6 of March.
- The planned order releases for the Hub become the gross requirement for the bolt for the same week. So the 3450 units of hub results in gross requirement of 13800 units for 8 units of bolt including both hand. Based on the on-hand inventory 200 units the no. of units ordered in the week 5 must be 13600 units considering one week lead time.
- The planned order releases of the steering knuckle of 3550 units become input for the Circlip gross requirement and on week 7. On-hand inventory of 150 units and one week lead time is considered for finding the net requirement of Circlip which is 3400 units and the order placed during the week 6 of March.
- The gross requirements for Bearing in week 7 are 3550 units, taking into account the 120 units on hand and the one week lead time, 3430 units of Bearing must be ordered in week 6 of March.
- The Brake Disc gross requirements are 3550 units on week 7, considering 100 units of on-hand inventory the net requirements are 3450 units and it is placed during week 5 with two week lead time.
- The gross requirements for Cylindrical housing in week 7 are 3550 units, taking into account the 80 units on hand and the one week lead time, 3470 units of Cylindrical housing must be ordered in week 6 of March.

- Based on the inventory record 4 units of Screw is required for each Steering knuckle hand, so total of 8 units. The 3470 units planned order release for Cylindrical housing in week 6 becomes the gross requirement for 13880 units in the same week. The net requirement based on the on-hand inventory 100 units is 13780 units and order in week 5 of March.

FOR APRIL MONTH

- The 200 units of the Steering knuckle left hand and 200 units right hand on - hand inventory result in a net requirement of 3800 units of Steering knuckle left hand and right hand each (4000 units – 200 units=3800 units). To receive the product in week 13, the order must be placed in week 11 of April to account for the two week lead time.
- The gross requirements for Hub in week 11 are 3800 units, taking into account the 100 units on hand and the one week lead time, 3700 units of Hub must be ordered in week 10 of April.
- The planned order releases for the Hub become the gross requirement for the bolt for the same week. So the 3700 units of hub results in gross requirement of 14800 units for 8 units of bolt including both hand. Based on the on-hand inventory 200 units the no. of units ordered in the week 5 must be 14600 units considering one week lead time.
- The planned order releases of the steering knuckle of 3800 units become input for the Circlip gross requirement and on week 11. On-hand inventory of 150 units and one week lead time is considered for finding the net requirement of Circlip which is 3650 units and the order placed during the week 10 of April.
- The gross requirements for Bearing in week 11 are 3800 units, taking into account the 120 units on hand and the one week lead time, 3680 units of Bearing must be ordered in week 10 of April.
- The Brake Disc gross requirements are 3800 units on week 11, considering 100 units of on-hand inventory the net requirements are 3700 units and it is placed during week 9 with two week lead time.

- The Brake Disc gross requirements are 4800 units on week 15, considering 100 units of on-hand inventory the net requirements are 4700 units and it is placed during week 13 with two week lead time.
- The gross requirements for Cylindrical housing in week 15 are 4800 units, taking into account the 80 units on hand and the one week lead time, 4720 units of Cylindrical housing must be ordered in week 14 of May.
- Based on the inventory record 4 units of Screw is required for each Steering knuckle hand, so total of 8 units. The 4720 units planned order release for Cylindrical housing in week 14 becomes the gross requirement for 18880 units in the same week. The net requirement based on the on-hand inventory 100 units is 18780 units and order in week 13 of May.

4.2.7 CALCULATION OF TOTAL INVENTORY COST

MODEL CALCULATION FOR STEERING KNUCKLE

$$\begin{aligned}
 \text{Inventory carrying cost} &= \text{Rs. } 20/\text{unit/period} \\
 \text{Ordering cost} &= \text{Rs. } 395/\text{order} \\
 \text{Total Cost (Rs.)} &= \text{Inventory carrying cost} + \text{Ordering cost} \\
 &= ((200+0)/2 + (200+0)/2)*20 + (395 *1) \\
 &= \text{Rs. } 4395
 \end{aligned}$$

FOR CIRCLIP

$$\begin{aligned}
 \text{Inventory carrying cost} &= \text{Rs. } 2/\text{unit/period} \\
 \text{Ordering cost} &= \text{Rs. } 10/\text{order} \\
 \text{Total Cost (Rs.)} &= \text{Inventory carrying cost} + \text{Ordering cost} \\
 &= ((150+0)/2 + (150+0)/2)*2 + (10 *1) \\
 &= \text{Rs. } 310
 \end{aligned}$$

- The gross requirements for Cylindrical housing in week 11 are 3800 units, taking into account the 80 units on hand and the one week lead time, 3720 units of Cylindrical housing must be ordered in week 10 of April.
- Based on the inventory record 4 units of Screw is required for each Steering knuckle hand, so total of 8 units. The 3720 units planned order release for Cylindrical housing in week 6 becomes the gross requirement for 14880 units in the same week. The net requirement based on the on-hand inventory 100 units is 14780 units and order in week 9 of April.

FOR MAY MONTH

- The 200 units of the Steering knuckle left hand and 200 units right hand on - hand inventory result in a net requirement of 5000 units of Steering knuckle left hand and right hand each (5000 units – 200 units=4800 units). To receive the product in week 9, the order must be placed in week 15 of May to account for the two week lead time.
- The gross requirements for Hub in week 15 are 4800 units, taking into account the 100 units on hand and the one week lead time, 4700 units of Hub must be ordered in week 14 of May.
- The planned order releases for the Hub become the gross requirement for the bolt for the same week. So the 4700 units of hub results in gross requirement of 18800 units for 8 units of bolt including both hand. Based on the on-hand inventory 200 units the no. of units ordered in the week 13 must be 18600 units considering one week lead time.
- The planned order releases of the steering knuckle of 4800 units become input for the Circlip gross requirement and on week 15. On-hand inventory of 150 units and one week lead time is considered for finding the net requirement of Circlip which is 4650 units and the order placed during the week 14 of May.
- The gross requirements for Bearing in week 15 are 4800 units, taking into account the 120 units on hand and the one week lead time, 4680 units of Bearing must be ordered in week 14 of May.

The total inventory cost for each component is calculated based on carrying cost and ordering cost of each one and it is shown in the table 4.7.

Table 4.7 Total inventory cost

Item	Inventory carrying cost/unit/period (Rs.)	Ordering cost/order (Rs.)	No. of orders	On-hand inventory (Units)	Inventory carrying cost (Rs.)	Ordering cost (Rs.)	Total cost (Rs.)
Steering Knuckle	20	395	1	200	4000	395	4395
Hub	10	210	1	100	1000	210	1210
Bolt	4	25	1	200	800	25	825
Circlip	2	10	1	150	300	10	310
Bearing	8	150	1	120	960	150	1110
Brake Disc	15	230	1	100	1500	230	1730
Cylindrical housing	12	300	1	80	960	300	1260
Screw	0.5	5	1	100	50	5	55

From the above table 4.7 it is found that the total cost of steering knuckle is Rs.4395, Brake Disc - Rs.1730, Hub- Rs.1210, Bolt- Rs.825, Circlip-Rs.310, Bearing-Rs.1110, Cylindrical Housing-Rs.1260 and screw- Rs.55.

4.2.8 ECONOMIC ORDER QUANTITY

STEERING KNUCKLE- 0021

Table 4.8 EOQ for Steering Knuckle

Demand (Units)	Setup cost/setup (Rs.)	Carrying cost/unit/period (Rs.)	Production rate (units/period)	EOQ (Units)
938	395	20	1250	385

HUB-0022

Table 4.9 EOQ for Hub

Demand (Units)	Setup cost/setup (Rs.)	Carrying cost/unit/year (Rs.)	Production rate (units/period)	EOQ (Units)
887	210	10	1250	358

BOLT-0034

Table 4.10 EOQ for Bolt

Demand (Units)	Ordering cost/order(Rs.)	Carrying cost/unit/period (Rs.)	EOQ (Units)
13800	25	4	415

CIRCLIP-0031

Table 4.11 EOQ for Circlip

Demand (Units)	Ordering cost/order(Rs.)	Carrying cost/unit/period (Rs.)	EOQ (Units)
3550	10	2	188

BEARING-0032

Table 4.12 EOQ for Bearing

Demand (Units)	Ordering cost/order(Rs.)	Carrying cost/unit/period (Rs.)	EOQ (Units)
3550	150	8	365

BRAKE DISC- 0023

Table 4.13 EOQ for Brake Disc

Demand (Units)	Setup cost/setup (Rs.)	Carrying cost/unit/period (Rs.)	Production rate (units/period)	EOQ (Units)
887	230	15	1250	306

CYLINDRICAL HOUSING – 0033

Table 4.14 EOQ for Cylindrical Housing

Demand (Units)	Ordering cost/order(Rs.)	Carrying cost/unit/period (Rs.)	EOQ (Units)
3550	300	12	421

SCREW - 0035

Table 4.15 EOQ for Screw

Demand (Units)	Ordering cost/order(Rs.)	Carrying cost/unit/period (Rs.)	EOQ
13880	5	0.50	527

- Based on the cost components, demand and production rate the optimal order size for the steering knuckle is calculated and it is 385 units as shown in the table 4.8.
- From the table 4.9, the EOQ for the Hub is found out that it is 358 units.
- For the Bolt based on the cost components, demand and production rate the optimal order size is 415 units as shown in the table 4.10.
- Based on the cost components, demand and production rate the optimal order size for the Circlip is calculated and it is 188 units as shown in the table 4.11.
- The optimal order size for the Bearing is calculated as 365 units as shown in the table 4.12.
- The EOQ for Brake Disc is calculated as 306 units, shown in table 4.13.
- Based on the cost components, demand and production rate the optimal order size for the Cylindrical Housing is calculated as 421 units as shown in the table 4.14
- From the table 4.15, the EOQ for the Screw is found as 527 units.

4.3 BRAKING SYSTEM ASSEMBLY UNIT LAYOUT

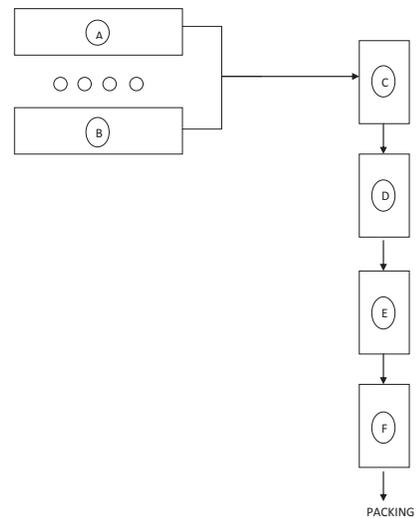


Chart 4.2 Braking System Assembly Layout

STATION A – STEERING KNUCKLE RIGHT

STATION B – STEERING KNUCKLE LEFT

STATION C – STEERING KNUCKLE + CIRCLIP + BEARING

STATION D - STEERING KNUCKLE + CIRCLIP + BEARING +HUB + BOLT

STATION E - STEERING KNUCKLE + CIRCLIP + BEARING +HUB + BOLT + BRAKE DISC + SCREW

STATION F - STEERING KNUCKLE + CIRCLIP + BEARING +HUB + BOLT + BRAKE DISC + SCREW + CYLINDRICAL HOUSING

4.3.1 OUTLINE PROCESS CHART FOR ASSEMBLING BRAKING SYSTEM

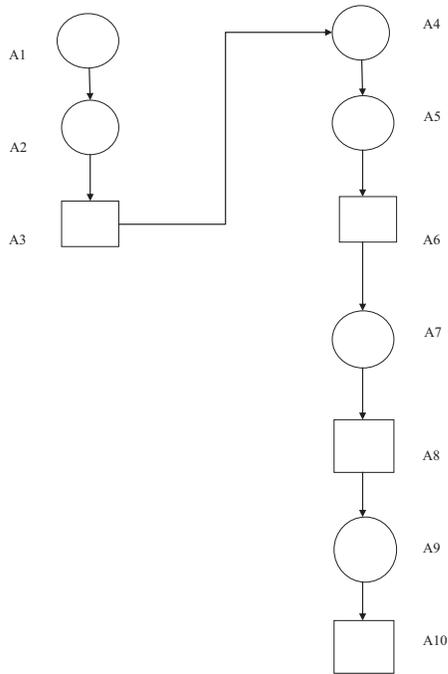


Chart 4.3 Outline Process Chart

4.3.2 ACTIVITIES

Activities of assembling the Braking System

- A1: Position the steering knuckle in the table
- A2: Insert the circlip in the steering knuckle
- A3: Inspect for the correct positioning of the circlip hold inside the steering knuckle
- A4: Bearing is pressed into the steering knuckle assembly
- A5: Fix the hub on the steering knuckle using studs on four ends
- A6: Inspect for the level of tightness of the studs
- A7: Brake disc is assembled with the steering knuckle set
- A8: Inspect for the torque setting
- A9: House the steering knuckle set in the cylindrical housing using the screws
- A10: Inspect the final assembly for fittings and tightness

4.4 ANALYSIS OF QUESTIONNAIRE

This chapter provides a summary of the data collected and the analysis of the data gathered from survey respondents.

4.4.1 Area of responsibility of respondents

The distribution of respondents area of responsibility is shown in the table 4.16.

Table 4.16 Area of responsibility

Area	Frequency	Percentage
Production	12	40
Financial	3	10
Engineering	8	26.7
Inventory	7	23.3
Materials	0	0
Others	0	0

The graph shows most of the respondents are from production (manufacturing) /Operations management area (40 percentage), followed by Engineering department which is 26.7 percentage, Inventory management is 23.3 percentage and 10 percentage belongs to Financial management.



Chart 4.4. Area of responsibility

4.4.2 Respondent position within the firm

The position of the respondent within the firm is shown in the table 4.17.

Table 4.17 Position within the firm

Position	Frequency	Percentage
Executive management	1	3.3
Middle management	16	53.3
Foreman	9	30
Non-supervisory	4	13.3
Other	0	0

53.3 percentage of the respondents hold middle management position within the firm. Next comes the Foreman/Line supervisor level with 30 percentage and 13.3 percentage of Non-supervisory/Worker level and 3.3 percentage of Executive management.



Chart 4.5 Position within the firm

4.4.3 Type of plant

Sakthi Auto Component Limited consists of multiple plants and it includes two foundry units and Machining line.

4.4.4 Utilisation of MRP

All the Respondents agree that the firm does not utilise an MRP system for the management of material and material-related costs.

4.4.5 MRP term usage in the company

The ways in which the MRP is used in the company can be grouped into three namely broad, narrow and other. The distribution under various usages is shown in the table 4.18.

Table 4.18 MRP term usage

MRP term	Frequency	Percentage
Broad sense	11	36.7
Narrow sense	13	43.3
Other	6	20

43.3 percentage of the respondents used the MRP term in narrow sense, as a closed loop manufacturing control system and 36.7 percentage used in narrow sense, as parts explosion and order launching. 20 percentage used in other term.

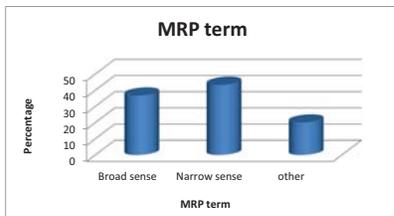


Chart 4.6 MRP term usage

4.4.7 Reasons for non-utilization of MRP system in the firms

Table 4.20 Reasons for Non-utilization of MRP systems

Reasons	Mean
High acquisition cost	3.40
High implementation cost	2.53
Lack of top management support	2.60
Better system is currently in place	4.13
Unaware the MRP existed	2.36

The reasons provided by the 30 respondents responding to question for not utilizing an MRP system are depicted in table 4.20. The responses (based on a scale of 1 to 7; 1=none, 7=very much) indicated that the predominant reason for not utilizing an MRP system was "A better system is currently in place."

4.4.6 Accuracy of the data

Table 4.19 Accuracy of the data

Data Type	Mean
Inventory Records	4.13
Bill of Materials	3.63
Market Forecasts	4.30
Master Production Schedule	3.77
Production lead times	2.90
Vendor lead times	3.60
Shop Floor Control Data	3.87
Capacity Plan	4.30

For the question regarding the accuracy of the data used in the firm's commercial activities the mean values are shown in table 4.19. The responses (based on a scale of 1 to 7; 1 = poor, 7 = excellent) indicated that a moderate level of accuracy exists for all categories of data in the firm's commercial activities of the responding firm.

The elements of the material management system used in the responding firm are mostly manual process. The elements of the material management system are as follows: Forecasting end items, Bills of materials, Inventory System, Master Production Schedule, Parts Explosion, Order Release, Purchasing, Capacity Planning and Operation Scheduling.

4.4.8 Attributes Influencing material procurement on MRP acquisition

Table 4.21 Attributes influencing material procurement on MRP acquisition

Attribute	Degree of influence Mean
Firmer requirements	4.70
Long range planning opportunities	5.26
Advance material buys	5.73
Inclusion of material costs	4.66
Others	0.00

The reasons provided by the respondents responding for influencing attributes of material procurement to introduce the MRP system is shown in table 4.21. The responses (based on a scale of 1 to 7; 1=none, 7=very much) indicated that the most influencing one is "Advance material buys".

4.4.9 Achievements of MRP system benefits

Table 4.22 Achievements of MRP system benefits

Condition/Benefit	Degree of Improvement Mean
Improved competitive position	6.27
Improved customer satisfaction	6.43
Better production scheduling	6.13
Improved plant efficiency	6.16
Better cost estimating	5.67
Better control of inventory	6.13

The responses to survey question regarding the actual and anticipated "achievements" of MRP system benefits are provided in table 4.22. The responses (based on a scale of 1 to 7; 1=none, 7=very much) indicated that the utilization of an MRP system significantly improved customer satisfaction.

4.4.10 Level of accuracy of the attributes need for the MRP system

Table 4.23 Level of accuracy of the attributes need for the MRP system

Applicable	Poor	Fair	Good	Excellent
Inventory records	0%	0%	50%	50%
BOM records	0%	3.3%	43.3%	53.3%
Market forecasts	0%	6.7%	56.7%	36.7%
Master Production Schedule	0%	0%	50%	50%
Production lead times	3.3%	6.7%	63.3%	26.7%
Vendor lead times	16.7%	6.7%	56.7%	20.0%
Shop Floor control data	0%	16.7%	46.7%	36.7%
Capacity Plan	0%	0%	36.7%	63.3%

The table 4.23 shows the response for the level of accuracy needed for the MRP type system for further improvement was mostly falls under the category of excellent and good.

From the above results based on the questionnaire it is concluded that there is a need of MRP system in the Production department of Sakthi Auto Component Limited particularly in knuckling line for the materials management and to keep the scheduling according to planned order release.

5. FINDINGS, SUGGESTIONS AND CONCLUSION

5.1 FINDINGS

- It is found that non-MRP approach recognizes neither the "time phasing" of requirements nor the possibility of subassembly quantity dependency on end-item quantities as shown in table 4.1.
- It is shown in the chart 4.1 the parts requirement of the final product which is to be manufactured is presented in the form of a Product Structure.
- It is clear that the Braking system has steering knuckle – left hand and right hand, Hub, Bolt, Circlip, Bearing, Brake Disc, Cylindrical housing and screw.
- Bill of materials is about listing of all components that go into the assembled item and it frequently includes the part number and quantity required per assembly and it is shown in table 4.2.
- The master production schedule is developed based on the demand forecasting. Here the demand of the braking system is forecasted based on the first three months form the known customers requirements as shown in table 4.3.
- The full capacity of the unit is 10,000 units.
- It is pointed that the master production schedule is developed for the three months period: March, April and May as shown in table 4.4.
- The master production schedule assumes that all the items are to be available the first week of the month i.e. week 9, 13 and 17.
- Inventory record file gives particulars about the on hand inventory at the start of the MRP program run, lead times of the components, shown in table 4.5.
- The 200 units of the Steering knuckle left hand and 200 units right hand on - hand inventory result in a net requirement of 3550 units of Steering knuckle left hand and right hand each (3750 units – 200 units=3550 units). To receive the product in week 9, the order must be placed in week 7 of March to account for the two week lead time.

- The gross requirements for Hub in week 7 are 3550 units, taking into account the 100 units on hand and the one week lead time, 3450 units of Hub must be ordered in week 6 of March.
- The planned order releases for the Hub become the gross requirement for the bolt for the same week. So the 3450 units of hub results in gross requirement of 13800 units for 8 units of bolt including both hand. Based on the on-hand inventory 200 units the no. of units ordered in the week 5 must be 13600 units considering one week lead time.
- The planned order releases of the steering knuckle of 3550 units become input for the Circlip gross requirement and on week 7. On-hand inventory of 150 units and one week lead time is considered for finding the net requirement of Circlip which is 3400 units and the order placed during the week 6 of March.
- The gross requirements for Bearing in week 7 are 3550 units, taking into account the 120 units on hand and the one week lead time, 3430 units of Bearing must be ordered in week 6 of March.
- The Brake Disc gross requirements are 3550 units on week 7, considering 100 units of on-hand inventory the net requirements are 3450 units and it is placed during week 5 with two week lead time.
- The gross requirements for Cylindrical housing in week 7 are 3550 units, taking into account the 80 units on hand and the one week lead time, 3470 units of Cylindrical housing must be ordered in week 6 of March.
- Based on the inventory record 4 units of Screw is required for each Steering knuckle hand, so total of 8 units. The 3470 units planned order release for Cylindrical housing in week 6 becomes the gross requirement for 13880 units in the same week. The net requirement based on the on-hand inventory 100 units is 13780 units and order in week 5 of March.
- The 200 units of the Steering knuckle left hand and 200 units right hand on - hand inventory result in a net requirement of 3800 units of Steering knuckle left hand and right hand each (4000 units – 200 units=3800 units). To receive the product in week 13, the order must be placed in week 11 of April to account for the two week lead time.

- The gross requirements for Hub in week 11 are 3800 units, taking into account the 100 units on hand and the one week lead time, 3700 units of Hub must be ordered in week 10 of April.
- The planned order releases for the Hub become the gross requirement for the bolt for the same week. So the 3700 units of hub results in gross requirement of 14800 units for 8 units of bolt including both hand. Based on the on-hand inventory 200 units the no. of units ordered in the week 5 must be 14600 units considering one week lead time.
- The planned order releases of the steering knuckle of 3800 units become input for the Circlip gross requirement and on week 11. On-hand inventory of 150 units and one week lead time is considered for finding the net requirement of Circlip which is 3650 units and the order placed during the week 10 of April.
- The gross requirements for Bearing in week 11 are 3800 units, taking into account the 120 units on hand and the one week lead time, 3680 units of Bearing must be ordered in week 10 of April.
- The Brake Disc gross requirements are 3800 units on week 11, considering 100 units of on-hand inventory the net requirements are 3700 units and it is placed during week 9 with two week lead time.
- The gross requirements for Cylindrical housing in week 11 are 3800 units, taking into account the 80 units on hand and the one week lead time, 3720 units of Cylindrical housing must be ordered in week 10 of April.
- Based on the inventory record 4 units of Screw is required for each Steering knuckle hand, so total of 8 units. The 3720 units planned order release for Cylindrical housing in week 6 becomes the gross requirement for 14880 units in the same week. The net requirement based on the on-hand inventory 100 units is 14780 units and order in week 9 of April.
- The 200 units of the Steering knuckle left hand and 200 units right hand on - hand inventory result in a net requirement of 5000 units of Steering knuckle left hand and right hand each (5000 units – 200 units=4800 units). To receive the product in week 9, the order must be placed in week 15 of May to account for the two week lead time.

- It is pinpointed that a moderate level of accuracy exists for all categories of data used in the firm's commercial activities of the responding firm and highest mean value of 4.30 exists for Capacity plan as shown in table 4.19.
- It is indicated in table 4.20 the predominant reason for not utilizing an MRP system in a unit was "A better system is currently in place" with mean value of 4.13.
- It is found that the most influencing attributes of material procurement is for "Advance material buys" with mean value of 5.73 as shown in table 4.21.
- It is found from the table 4.22, the utilization of an MRP system will significantly improved customer satisfaction with mean value of 6.43.
- It is pointed in table 4.23; the response for the level of accuracy needed for the MRP type system for further improvement was mostly falls under the category of excellent and good.

5.2 SUGGESTIONS

- The current system for planning material procurement can be improved by implementing Material Requirements Planning system.
- The existing system gives only moderate level of accuracy and it can be improved by proper planning with MRP.
- For proper materials utilization the MRP program can be integrated with IT system.
- The inventory cost can be reduced by effective utilization of MRP system.
- Material procurement is done based on the manual tools and processes; it is time to go for introducing the MRP system.
- Better lot sizing methods can be followed for material order quantity.
- Material Requirements Planning applies mainly for dependent products which help to order right quantity of materials at right time and it will suits for entire knuckling line of Sakthi Auto Components Limited.

- The gross requirements for Hub in week 15 are 4800 units, taking into account the 100 units on hand and the one week lead time, 4700 units of Hub must be ordered in week 14 of May.
- The planned order releases for the Hub become the gross requirement for the bolt for the same week. So the 4700 units of hub results in gross requirement of 18800 units for 8 units of bolt including both hand. Based on the on-hand inventory 200 units the no. of units ordered in the week 13 must be 18600 units considering one week lead time.
- The planned order releases of the steering knuckle of 4800 units become input for the Circlip gross requirement and on week 15. On-hand inventory of 150 units and one week lead time is considered for finding the net requirement of Circlip which is 4650 units and the order placed during the week 14 of May.
- The gross requirements for Bearing in week 15 are 4800 units, taking into account the 120 units on hand and the one week lead time, 4680 units of Bearing must be ordered in week 14 of May.
- The Brake Disc gross requirements are 4800 units on week 15, considering 100 units of on-hand inventory the net requirements are 4700 units and it is placed during week 13 with two week lead time.
- The gross requirements for Cylindrical housing in week 15 are 4800 units, taking into account the 80 units on hand and the one week lead time, 4720 units of Cylindrical housing must be ordered in week 14 of May.
- Based on the inventory record 4 units of Screw is required for each Steering knuckle hand, so total of 8 units. The 4720 units planned order release for Cylindrical housing in week 14 becomes the gross requirement for 18880 units in the same week. The net requirement based on the on-hand inventory 100 units is 18780 units and order in week 13 of May.
- It is found that the lot order based on EOQ are 182 units for steering knuckle left hand and right hand separately, 95 units of Hub, 135 units of Bolt, 141 units of Circlip, 113 units of Bearing, 94 units of Brake Disc, 80 units of Cylindrical housing and 94 units of screw.

5.3 CONCLUSION

Based on the observations made there is a need for Material Requirements Planning (MRP) in the firm for the dependent items. The existing system for material planning and procurement does not add any value in terms of effective material utilization which is shown by the accuracy of the data for their commercial activities. Thus the implementation of Material Requirements Planning system will help the company to determine precisely when and how much material to purchase and process based upon a time phased analysis of sales orders, production orders, current inventory and forecasts. They also ensure that firms will always have sufficient inventory to meet production demands, but not more than necessary at any given time. MRP will even schedule purchase orders and production orders for Just in time receipt.

5.4 SCOPE FOR FURTHER STUDY

This study on Material Requirements Planning is conducted to know the MRP benefits in the assembly line by comparing it with the existing non-MRP approach and the components taken for the study are from braking system assembly. The study could be extended further by increasing the planning horizon as this covers only three months and by including other assembly components with dependent item characteristics. This study conducted only for few sections of the knuckling line and it could be done in other sections to cover various models.

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APPENDIX -1

MATERIAL REQUIRMENTS PLANNING PRACTICE IN ORGANISATION

Dear Respondent,

A study is carried out to know about the Material Requirement Planning utilisation in the organisation. Please tick or circle the number which indicates your opinion.

1. Which of the following most nearly describes your area of responsibility within the firm?

- a. Production (Manufacturing)/Operations Management
- b. Financial Management
- c. Engineering/Research and Development
- d. Inventory Management
- e. Materials/Subcontract Management
- f. Other _____ (please specify)

2. Which of the following best describes your position within the firm?

- a. Executive Management
- b. Middle Management
- c. Foreman/Line Supervisor
- d. Non-supervisory/Worker
- e. Other _____ (please specify)

3. How many years have you been employed by your firm?

- a. Less than 1 year
- b. More than 1 year but less than 3 years
- c. More than 3 years but less than 5 years
- d. More than 5 years but less than 7 years
- e. More than 7 years but less than 10 years
- f. Over 10 years

4. Your total (overall) company consists of

- a. Single Plant
- b. Multiple Plants
- c. Other _____

5. Type of production at your facility or division

- a. Make-to-order
- b. Make-to-stock
- c. Both
- d. None

6. Type of Manufacturing at your facility or division

- a. Assembly
- b. Fabrication
- c. Both
- d. None

7. Type of production process at your facility or division:

- a. Job-shop
- b. Continuous-process
- c. Assembly-line

8. Number of employees at your facility or division? _____

9. Does your firm utilize an MRP system for the management of material and material-related costs?

- a. Yes
- b. No

10. How is the term "MRP" used in your company?

- a. In the "broad" sense, as a closed-loop manufacturing control system
- b. In the "narrow" sense, as parts explosion and order launching
- c. Other _____ (specify)

11. What is the accuracy of the following types of data used in your firm's commercial business (circle the most appropriate response)?

	Poor	-----	Excellent	Unknown				
a. Inventory Records	1	2	3	4	5	6	7	x
b. Bill of Materials	1	2	3	4	5	6	7	x
c. Market Forecasts	1	2	3	4	5	6	7	x
d. Master Production Schedule	1	2	3	4	5	6	7	x
e. Production Lead Times	1	2	3	4	5	6	7	x
f. Vendor Lead Times	1	2	3	4	5	6	7	x
g. Shop Floor Control Data	1	2	3	4	5	6	7	x
h. Capacity Plan	1	2	3	4	5	6	7	x

