Assessing the Efficiency and Effectiveness of MRP System in Manufacturing Industries of North India

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by

Ramanpreet Singh

Registration No. 801282015

to the

MECHANICAL ENGINEERING DEPARTMENT
THAPAR UNIVERSITY, PATIALA

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Certificate

I hereby declare that the thesis entitled "**Assessing the Efficiency and Effectiveness of MRP System in Manufacturing Industries of North India**" is an authentic record of my study carried out as requirements for the award of the degree of **Master of Engineering** in **Production Engineering** at **Thapar University**, **Patiala** under the supervision of **Mr. Supreet Bhullar,** Associate Professor, Mechanical Engineering Department, Thapar University, Patiala and **Dr. Dhanesh Garg,** Lecturer, School of Mathematics & Computer Application, Thapar University, Patiala during July, 2013 to July, 2014. The matter embodied in this report has not been submitted in partial or full to any other university or institute for the award of any degree.

Ramanpreet Singh

Date: 18-07-2014

Ramanpreet Singh

(Regd. No. 801282015)

It is certified that the above statement made by the student is correct to best of my/our knowledge and belief.

Mr. Supreet Bhullar
Associate Professor
Mechanical Engineering Department
Thapar University, Patiala – 147004

Dr. Dhanesh Garg
Lecturer
School of Mathematics &
Computer Application
Thapar University, Patiala - 147004

Countersigned by

Dr. Ajay Batish
Professor & Head
Mechanical Engineering Department
Thapar University, Patiala – 147004

Dr. S. K. Mohapatra
Dean of Academic Affairs
Thapar University, Patiala - 147004

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Ramanpreet Singh

Ramanpreet Singh

Abstract

In today's dynamic industrial environment, Inventory control is an important parameter in production systems. To guard against inventory shortages or surprises of stock, proper policy for inventory control should be utilized, which can overcome inventory shortage losses and lessens the capital assets. MRP techniques are widely used to control inventories and to avoid stock out while retaining a high level of service. There are a number of factors which influence the parameters of the MRP system. This study has concentrated to examine the implementation aspects (organizational and technological factors) of MRP system and their effect on the parameters of MRP system to assess the efficiency and effectiveness of MRP system in the northern industrial belt of India. On the basis of implementation aspects, six hypotheses have been assumed to validate the goal of this study. The design of the questionnaire was based on the success measure variables and determinant variables which affect the efficiency and effectiveness of MRP system. The success measurements and determinant variables have been adopted from the previous studies of Sum et al. (1993) and Cheng (1997). Thirty numbers of survey responses were analyzed and presented by using SPSS software. Survey summary showed the profiles of MRP user, average rating of system parameters, and the degree of computerization, benefits and implementation problems of the MRP system. Various responses of the survey concluded that the different organizational (top management support, user training level) and technological factors (software customization, degree of computerization, suitability of software) have a significant effect on the parameters (performance and accuracy) of MRP system on which the system efficiency and effectiveness depend. The other results of this study, help manufacturing companies to implement an MRP system to strategize their efforts and process to ensure successful implementation.

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List of Abbreviations

MRP	Materials Requirements Planning
BOM	Bills of Material
ROP	Re-order Point
MPS	Master Production Schedule
ERP	Enterprise Resource Planning
SAP	System, Application and Products in data processing
SPSS	Statistical Package for Social Sciences
ANOVA	Analysis of Variance

Chapter 1

Introduction

1.1 Introduction

Material requirements planning (MRP) is a software based production planning and stock control system. It's applied to control manufacturing operations by offering a coherent, easily understood method for determine the number of components, and materials required for the assembly of each end item. The MRP system is formed by a set of logically related procedures, decision rules, and records, which transform the master production schedule into time-phased net requirements and the planned coverage for each end item (Orlicky, 1975). MRP packages help manufacturer's to allocate precisely when and how much material to buy and process based upon master production schedule. The master production schedule is generates by analysis the demand level, inventories, lead times, production capacities, and costs to gives the production plan. The MRP software system is viewed as an instrument for raising the firm's overall capacity to keep under control the logistics system in conditions of higher item's traceability, carrying out re-scheduling of interventions, and making adjustments to production planning over time (Braglia and Petroni, 1999; Petroni and Rizzi, 2001;Dolgui and Prodhon, 2007).

1.2 Background

In the earliest industrial era, manufacturing planning and control arrangements were maintained by groups of plant foremen, everyone was responsible for the scheduling of production, ordering of materials, and dispatching of products within their assigned area. With the increasing complexity in the manufacturing processes of products, this system was gradually replaced by the highly specialized reorder point (ROP) system of production and inventory control. Under the ROP system, the reduction in the stockpile of each stock item is tracked and a renew order is issued whenever the stock level drops to some fixed quantity i.e. known as reorder point. This quantity is determined for each inventory item separately, based on the forecast demand during a replenishment lead time and on the probability of actual demand exceeding the forecast (Orlicky,

1975). This system suffered from the mighty task of creates schedules, maintain the information of large numbers of parts and components, and other changes. This system also has a lack of differentiation between independent demand such as end-items or finished goods and dependent demand such as raw materials, subassemblies, components (Stevenson, 2005). These limitations of ROP system were overcome in the mid-1960, when the computerized MRP system was gradually beginning to replace the ROP system as the choice of control manufacturing process. This approach is particularly match able for the management of inventories subject to dependent demand, as it does not based on any assumptions regarding patterns of demand and inventory depletion. MRP system offers a forward-looking, demand-based approach for planning to manufacture the products and bring off the inventory level (Orlicky, 1975; Rondeau and Litteral, 2001).

In today's dynamic industrial environment, Inventory control is an important parameter in production systems. To guard against inventory shortages or surprises of stock, proper policy for inventory control should be utilized, which can overcome inventory shortage losses and reduce the capital assets (Dolgui and Prodhon, 2007). Uncertainties make a crucial effect on the inventory control system. This has been classified into two main categories: input as external supply or demand reliability and process as machine breakdown, material shortage, rework, etc. (Koh et al., 2002). To diminish the effect of these uncertainties, need of safety stocks, but retaining stock is too expensive. The problem was to control inventories and to avoid stock out while retaining a high level of service, MRP techniques are widely used. There exist a number of software's in inventory control which give a just-in-time schedule to do the stock list.

In manufacturing industries, there are two types of system i.e. push system and pull system. In the push system, manufacturer produces products without considering the customer need and produces the quantity as much as can be managed. Whereas in pull system, production is based on customer demand and is produced that quantity of product what has been consumed (Gary and Christopher, 2008). MRP is a pull system tool which brought down the inventory level by eliminating the level of wastage in handling, storing and getting products delivered to the customer (Seyed, 2003). MRP ensured that firms would have sufficient stock to satisfy production needs, but not more than necessary at whatever dedicated time (Braglia and Petroni, 1999).

MRP is an approach based on information technology to seek problem of management control in repetitive discrete manufacturing (of cars, aero planes, and computers) due to uncertainty

and complexity in the manufacturing processes. MRP itself is not a planning technique, but it aids to planning because in the case of limited productive resources, it cannot generate, evaluate, and select scheduling alternatives by altering the existing processes. MRP acts as a simulation tool due to its information processing capability, which allows the managers to examine the sequel of their production planning decisions. In other words, MRP acts as a databank in spite of an act as a scheduler (Ho, 1996).

1.3 Motivation of Research

- What issues and problems have manufacturing companies faced in the process of MRP implementation and their remedies to overcome these problems?
- What issues should be kept in mind to ensure its effective integration with the processes of an organization?
- Which type of manufacturing companies are using MRP system in the industry and which specific operations are dominated by the MRP software?

1.4 Objective of MRP

The objective of the MRP system is receiving the correct materials on purchasing to the correct place at the correct time. The objectives of MRP should be placed with respect to inputs and outputs connected with it. Inputs are identified as the master production schedule and the bills of material. Distinct organizational objectives commonly connected with MRP design and execution may be distinguished between these three main dimensions, i.e. inventory, priorities and capacity (Moustakis, V., 2000).

Table 1.1: Objectives of MRP (Moustakis, V., 2000)

Dimensions	**Specific Objective**
Inventory	Place the order of right material Place the order of right amount Place the order with perfect timing
Priorities	Place the order within the due date Maintain the due date valid
Capacity	Planning for an absolute and accurate load Planning of proper time to see future load

1.5 Structure of MRP

1.5.1 Inputs to MRP Program

Master Production Schedule: Out of three inputs master production schedule is the main input to MRP system that gives the information about which component will be manufactured, at what time it will required and in what amounts. Normally, the master production schedule is obtained on the basis of customer orders, forecasts, and orders from warehouses to the formation of required seasonal inventories, the demand for each particular component within the groups is specified. The second source is predicting demand. Demand from known clients and demand forecast are combined to become the input to the master production schedule.

The master production schedule differentiate the planning horizon into number of time periods or time buckets, which are often expressed in weeks. Nevertheless, the time buckets are not always of equal time duration. It may be in weeks for the near-term portion of a master schedule, in months or quarters at the later portions of a master production schedule. Normally, plans for items which have large span of time periods are more tentative than the requirements of shorter span period (Stevenson, 2005).

Bills of Material File: The bills of Material file contain the full product description, a list of all of the assemblies, subassemblies, parts, and raw materials that are required to produce a finished goods. The bills of material file has frequently named the product structure tree because it exhibits how a product has been sequentially produced. It carries the data to determine each item and the quantity used per unit of the item of which it was a subpart. A product structure tree is helpful in illustrating how the bills of material is used to determine the quantities of each of the sub items required to produce a desired number of end items.

Inventory Records File: Inventory records file gives a computerized list of records of each material, physically held in system. Every item of a product in stock is run as a different file and the spectrum of information carried about an item has been unlimited. The MRP system accesses the status section of each file of inventory item according to their time periods. These files are accessed as required during the MRP system program run. This consists of gross requirements, scheduled receipts, and expected inventory in hand. It also contains other information for each component, like vendor lead time, and lot size policy (Stevenson, 2005).

1.5.2 MRP Processing

MRP system gets the information of each end item requirements from the master production schedule during its processing and explore these end item into time-phased net requirements for assemblies, subassemblies, components and raw materials using the bills of material offset by lead times.

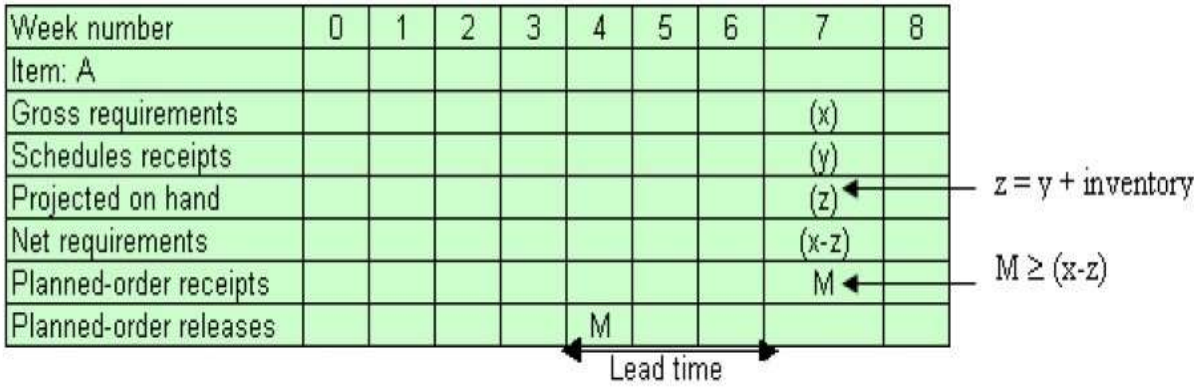


Figure 1.1: Processing of MRP system (Orlicky, 1975).

Gross requirements: It is the overall predicted demand for a component or raw material during every time bucket. This requirements is generated from the master production schedule or the planned order releases of their upper level components.

Scheduled receipts: Scheduled receipts are open orders and planned to attain from supplier or somewhere else in the pipeline by the starting of a time bucket.

Project on hand: Project on hand is the predicted quantities of stock that will be in hand at the starting of every time bucket. It is the total of scheduled receipts and balance inventory available from previous time bucket.

Net requirements: Net requirements is the quantity required in actual at every time bucket. It calculated by the subtraction of project on hand inventory from the gross requirement.

Planned-order receipts: These are the inventory of materials which are expected to be received at the staring of the time bucket.

Planned-order releases: It is the demand which is planned to order a particular item in a scheduled time bucket, offset by lead times. This demand produced gross requirements for the items which are used in the assembly or production chain. At a time when the particular order is placed, order will vanishes from planned order releases and comes under the scheduled receipts.

1.5.3 MRP Output

The MRP software has the tendency to furnish organizational operation by a wide spectrum of end items. MRP output is frequently classified as primary reports that are treated as a main outputs and secondary reports that gives the optional results.

Primary Reports: Primary reports are the prime or fundamental reports required for the control of stock and production processes. These reports contains

- Planned orders that are published in upcoming time period.
- Order discharge notification to implement the planned orders.
- Alteration in timing of due dates of open orders because of rescheduling.
- Invalidation or holding of open orders because of validation or holding of orders in master production schedule.
- Data records of stock quantity.

Secondary Reports: these are the optional reports of MRP software, which are used as to forecast inventory, performance level etc. These reports are categorize as follows:

- Planning reports to be employed in forecast stock and identifying requirements for upcoming time period.
- Performance reports for segregating the inactive items and determining the agreement between programs amount utilize and their prices.
- Exception reports that find out the incompatibility, such as faults, out of range conditions, overdue orders, over wastage, or non-existent items.

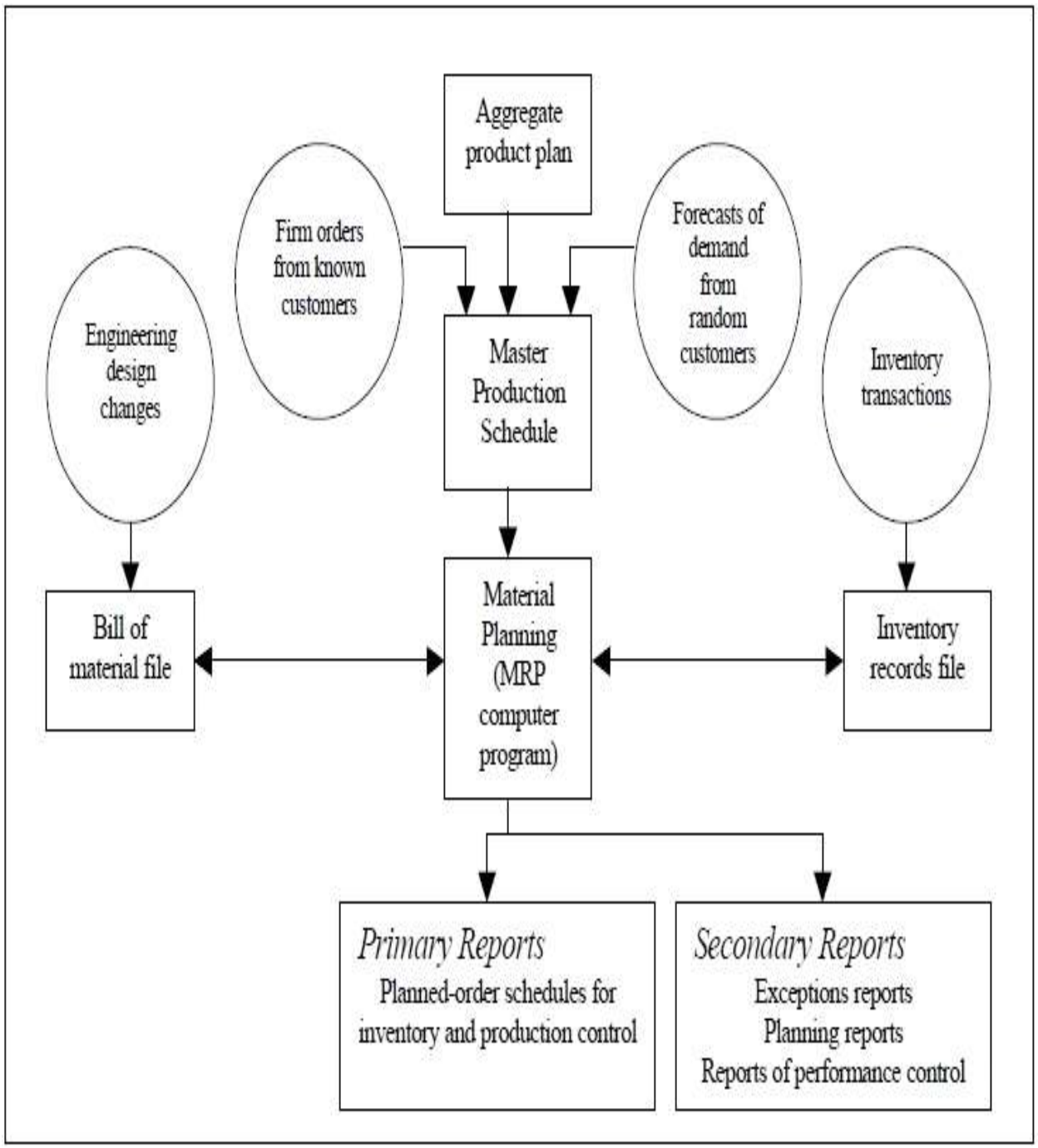


Figure 1.2: Structure of MRP System (Moustakis, V., 2000).

1.6 Benefits of MRP

Using MRP System can significantly benefit companies in manufacturing and service sector. Some of the benefits are as follows:

- Customer service is improved.
- Reduction in lead time, work in progress, past due orders.
- Elimination of annual inventory.
- Reduction in finished goods inventory, raw materials, and safety stock.
- Increase in productivity.
- Improvement in meeting of delivery promises.
- Better capacity planning.
- Improvement in production scheduling.

1.7 Types of Organizations used MRP

MRP is used in a wide range of industries with a job-shop environment. MRP software does not work well with companies in which the rate of production is minimum. Particularly for companies developing complex, expensive products requiring advanced research and design, lead times tend to be overly long and too unsettled, and the product configuration too complex for MRP to handle (Moustakis, V., 2000).

Table 1.2: Industrial Applications and range of MRP benefits (Moustakis, V., 2000)

Type of industry	Examples	Range of Benefits
Assemble-to-stock	Number of parts are combined to make a finished goods, and then stocks to fulfil the customer requirement. Examples: clocks, instruments, appliances.	High range
Fabricate-to-stock	In this type of industry finished goods are produced by using different manufacturing operation on machine. These are standard inventory items produced in anticipation of client needs. Examples: electrical switches, piston rings.	Low range
Assemble-to-order	A finished product is produce from the number of standard stock choices choose by the client. Examples: buses, invertor.	High range

Fabricate-to-order	Goods produced on the customer order by machine. These are rottenly industrial orders. Examples: keys, rivet, nut bolts.	Low range
Manufacture-to-order	In this category goods are fabricated or assembled completely to client operation system. Examples: turbine generators, heavy machine instruments.	High range
Processes	In this categories number of industries like foundries, rubber and plastics, specialty film, chemicals, paints, drugs, processors.	Medium range

1.8 Scope of MRP in Manufacturing

Manufacturing industries, facing the daily practical problems of customer needs of product availability in a shorter time than it takes to make them. To fulfil the customer demand, some level of preparation is needed. Need of controlling the types and quantities of material during the purchasing and planning for the production of each component. Ensured production level is compulsory to meet the current and future demands of the customer at the minimum possible cost. MRP system is helpful to taking a decision for better planning of production scheduling, otherwise any wrong decision, will company pay the fine in terms of loss of money. A few examples are given below:

- If insufficient quantities of material is purchased by the companies for the manufacturing or purchase the wrong item, then companies may be unable to produce required quantities of product to meet the purchasing order of customer in a time of due date.
- If excessive amounts of inventory is purchased, money is being wasted in terms of storing the excess amount of inventories and inventory carrying cost is applied. This problem is particularly occur in food manufacturers companies and the companies which have very short product life cycles.
- Beginning production of an order at the wrong time can cause customer deadlines to be missed.

1.9 Related Software

Since 1960s, many MRP software have been built up and traded by many software and consulting firms. There are number of software has been developed for the integration of the number of processes of organization.in the table 1.3, a list of MRP software developer is categorize according to their product name and description of software.

Table 1.3: List of MRP Software developer (Moustakis, V., 2000)

Product	**Vendor**	**Description**
MRP	INMASS	MRP
MRPlite: LS	DbM	MRP
Fourth Shift	Fourth Shift Inc.	MRP
Monitor Manufacturing Software	Monitor system of Toronto	MRP
Merlin MRP 2000 for Windows	Merlin	MRP
Manufacturing Spreadsheet Templates	User Solutions Inc.	MRP/Scheduling System
Resource Manager VBX	Initiative Manufacturing System Inc.	MRP/Scheduling System

Chapter 2

Literature Review

A lot of research work has been done for predicting the effect of different organizational and technological variables on the efficiency and effectiveness of MRP system. This chapter presents the literature review, which includes the factors that influence the problems in MRP implementation, the benefits of successful implementation, the conclusions of the literature survey, literature gap and objectives of current research.

2.1 Review of Literature

Sum et al. (1994) identified the variables like organizational, implementational and technological that made an impact on specific benefits of MRP software. This study has used Alternating Conditional Expectation (ACE) technique in which the optimal transformation of the dependent and independents variables increase the model fit. The major finding of this research showed the determinant variables like rate of data accuracy, customer involvement, level of computerization, and the scale of company makes effect on the benefits in nonlinear way. The rate of data accuracy built a critical effect on the functional efficiency, customer service and specific interdepartmental benefits. Partial integration of system does not have any significant improvements. The user's system should have an advanced level of computerize integration to attain overall potential of functional efficiency and specific benefits. This research also found that the pattern of technical complaints can be indicative of system usage and interdepartmental coordination.

Manthou et al. (1996) examined the organizational aspect of MRP execution, the basic tips for its successful execution, check the MRP usage level in the company, the problems occurred in the implementation process, and the resulting benefits. The research has principally concentrated on the interaction of managerial tasks with MRP and the ensuring impacts on its adoption and extract. A case study has been carried in Greece, findings of which showed that the MRP software reduces the inventory level, improves the shipments, and attains better planning and command. The study

exhibited that the effectiveness of MRP was heavily depends on the human factor, its specialist and strength to transfuse and interact with the system. Other insights have been gathered from the survey included personnel training is a deed, which has been expanded widely in bigger industries than smaller ones. The study highlighted that as wider the training level and technical knowledge of firm's management, faster it will returns its investment.

Cheng (1997) surveyed on MRP system of manufacturing companies to assess the function and functioning of computer schemes to support manufacturing applications. This work has been performed to explore the causes of why organizations choose these type of systems, the issues and benefits gained from the MRP system, and the features of the various types of industries that have been gained from the execution of MRP software. In this study survey participant evaluated the performance of their MRP system on the basis of rate of data accuracy, satisfaction of customer, satisfaction of system user, effectiveness of system, and the suitability of software. In addition, success factors related with organizational performance were analysed and evaluated. The finding of this study showed that top management involvement, the level of training and the level of software customization was significantly correlated with the perceived performance of MRP system.

Plenert (1998) studied at the successes and disappointments of MRP. This study has been done to identify the shortcomings of MRP system, to investigate the failures and to determine the consequences of not correcting these failures. This study indicated that the labour efficiency was the most often drawback in MRP utilization on which a need of high focus is essential. The study indicated that for rebuilding the routings, there is a need to decrease the routings, reduction in lead times as much as possible and rebuild the routings which should be focus on actual lead times instead of estimated and buffered lead times. By rebuilding the routings, total manufacturing lead times can reduce greatly. This study also suggested that the measurement system such as the job traveler was used to increase the morale of users. An inadequate measurement system will giving the habit to employees to work with the wrong instrument. Although, need of pivoting the users towards materials efficiency, and need of measurement system would reduce the level of inventory and reduce the rate of scrap, instead of labour efficiencies.

Salaheldin and Francis (1998) investigated MRP practices in Egypt to examine the cost and benefit accrued from the successful execution of MRP software. The findings of this study indicated that the inadequate information about the MRP system could be viewed as the critical barrier that impeded the execution of MRP system, while improper training, instruction and specialist about MRP system were specified as an unfavourable problem confronted in the process of execution. The other findings of the research indicated that top management involvement has a main effect on the span and rate of the adoption of MRP software's. Software/ hardware vendor played a critical part in the implementation of MRP system. A many of companies in Egypt having MRP system evaluated that the main reasons for executing the MRP system were tactical instead of strategic reasons like the lower stock cost and meeting scheduling times properly, indicating that MRP software has not been presumed as a competitive strategy weapon.

Braglia et al. (1999) studied the execution of MRP software in the industry of machinery building for packaging. The study is mainly, conveyed the subjects of management and employee reactions and the original against forecasted economic and logistic advantages. The major evidence of this study was that the adoption of MRP system depended upon the package that was acceded to be appropriate by the industry ourselves. There are various aspects which restricted the preference of installing the software. The availability of mightiness and a dedicated temperament towards creativity was considered as the factor, most affecting implementation. In successful implementation, supplier involvement and project planning were considered as important constituent of the effective management for the introduction of MRP packages.

Koh et al. (2000) performed a study for measuring uncertainties in MRP environments. On the basis of a survey results, it was analyzed that the suspicions in the cumulative, intermediate and functional levels affected the performance of client dispatching in the MRP climates. These suspicions have been measured and the relative significance of ability has been evaluated. A relative scale of match able suspicions to client dispatching ability has been produced. According to the study it was critical for an organization to develop the techniques to gain higher performance of client dispatching, without knowing which causes of suspicion have the critical effect on performance of client dispatching. Buffering, dampening and other techniques has been applied to increase the MRP system performance, and with respect to these extra time and multi skilled labour

has been also the predominant and most emphatically used techniques.

Petroni and Rizzi (2001) presented the MRP acceptance criteria by the help of classic adoption models for prediction. A statistical analysis on a sample of 109 SME's was carried out which revealed that these constructs played a substantial role in the decision making process. Four classical adoption models were used. The models have given the importance to an adoption process of software by predicting what stages, small and medium-sized firms are most likely to go through before they were ready for MRP adoption. This adoption process constituted three phases (i.e. cognitive stage, affective stage and behavior stage), which yielded a better reason for managers to engage the necessary strategies, to motivate their organization efficiency through the implementation of MRP system. The framework of research investigated the relationships between benefit analysis, feasibility studies, organizational willingness and the mediating construct, MRP positive evaluation. Result also showed that organizational willingness and positive evaluation of the technology were significant stages of the adoption process.

Petroni (2002) presented the implementation process of material requirements planning within small and medium-sized firms and studied the elements, which ensuring the successful MRP implementation. A number of elements of implementation were identified and subsequently grouped into a hierarchical social system consisting of eight broader elements (top management support, formal project planning, data accuracy, organizational arrangements, training, formal planning, control policies and procedures, software/hardware characteristics, employee's individual characteristics). The analysis revealed that only a few of the identified elements were indeed required for the successful implementation. Among these management support, level of functional integration and data accuracy were the elements that strongly affected the benefits. Significant benefits such as improved customer service, better production scheduling and reduced manufacturing costs could be obtained from the successful implementation of the MRP.

Ang et al. (2002) employed a multiple case design to examine MRP execution in Singapore. In this research, two-phased data collection approach has been used to generate a comprehensive and functionally acceptable standards of MRP success. The standards consisted of two linked components. They were a satisfaction score based on quantitative standard and a complementary

standard based on views from the interviewees regarding the level of utilization and adoption of the system. This research also extended and consolidated a seven-factor critical success factor (CSF) framework, which were upper management involvement, effective project management, education and training, data accuracy, company-wide support, suitability of hardware and software, software vendor support. CSF's have great importance, but knowing the linkages between CSF's were even more important, because these linkages explained which CSF's to emphasize at various stages of the project. The study also highlighted that the omission of any one of the CSF's factors would unbalance the entire network of coordination's, which would result in ineffective execution.

Olhager and Selldin (2003) studied ERP execution in Swedish manufacturing firms using survey as the data collection instruments, the pre-execution operation, execution experience, configuration of ERP system and its benefits. The survey reported that the 83.6% of Swedish companies adopted the ERP packages. The survey result showed that the ERP system was not considered to be an overwhelming investment for the enterprise because the implementing cost of ERP system ranged from an average of 0.5% of annual revenues of larger firms to an average of 3.5% for smaller orders. The study also concluded that ERP system have not merely cut down the information technology costs, but also improved the availability and quality of information by successful integration and interaction across the enterprise. The research also showed that in Swedish companies, ERP systems primarily supported the material and data flows and secondarily the financial flows.

Jonsson and Mattsson (2003) empirically explained the fit between the planning environment and material planning methods. A four planning method was used (detailed material planning, capacity planning, scheduling, sequencing) with respects to the different planning environments. Results showed the use of planning methods and their levels of user satisfaction in different planning environments like complex customer order production, configure to order the production, batch production of standardized products and repetitive mass production, in manufacturing companies. The rightness of manufacturing planning and control methods depends on the characteristics of the actual product, requirement and manufacturing operation. Each planning method is applicable in varying degrees to the various planning environments. Research indicated

that MRP was the most applicable planning method at a detailed material planning level. It is used as the main planning method in most companies, irrespective of the planning environment. This study also concluded that the general knowledge of planning and control methods in the industry was rather low, and that it most likely needed to be improved in order to achieve better use and performance of the planning methods.

Salaheldin (2004) explored the critical factors influencing the stage of implementation of MRP. The study includes empirical studies to explore the critical factors affecting the level of MRP implementation. On the basis of questionnaire data has been collected from production managers and materials managers in manufacturing companies. The results of this study indicated that the organizational desire to change was positively related with the successful implementation of MRP. The research also concluded that there was no correlation between vendor support and successful implementation of MRP and a significant correlation between the level of bills of material and the need and opportunity of the implementation of the advanced stage of MRP. This research highlighted the implications for practitioners to carry out relevant changes as a result of the successful execution of advanced level of MRP.

Adel et al. (2004) surveyed on the MRP software of aircraft maintenance and their stock control procedures. The study was meant to study the experience of companies using MRP. Survey results demonstrated an urge to sort out issues that originated from the use of MRP system into management associative and arising from expert authors. The research indicated that management cited for MRP system failure, could be rectified with adequate MRP education and training prior to and during execution. The technical sources of difficulty of executing MRP cited ranged from uncertain use of items, through unscheduled items requirements, to difficulty forecasting with uncertain items. This study tested that the MRP system failure due to lack of top management commitment to the project, lack of instruction/training in MRP for those who will have to use the system and unrealistic master schedule, BOM and inventory information. According to this study, it has been more challengeable to execute MRP in the aircraft maintenance climate as compare to commercial climate, where the unpredictable need for spare parts. But if the obstacles were understood and a sound plan was released, MRP could be successfully executed, with ample benefits.

Yu (2005) explored the chain of causal relations influencing the functional effectiveness of the executed ERP system. In this study process-oriented approach has been applied to identify, how the earliest step influences the coming step from pre-execution state, to in between execution state, and to after execution state. A questionnaire has been constructed on the basis of belief variables like (management culture, top and middle management commitment and involvement), attitude variables (implementing approach, degree of resistance to change), behaviour variables (integration of the ERP system, effectiveness of the training) and effective variables (degree of system stability, degree of data accuracy). A valuable concept studied from this research was that end-users across the organization must be educated from the onset of ERP execution. This study also suggested that adequate education has a milestone of ERP execution, the user training should be emphasized and the courses should be centred on computer/system operation rather than an understanding the ERP concept and spirit.

Lee et al. (2006) reported a survey study in the manufacturing industries of Korea. This study has conducted by using a questionnaire as a survey instrument to know about the acceptance level of ERP software in the manufacturing industries of Korea, their motivational aspect, execution techniques and benefits obtained, and to give a helpful data to show the similarities and differences among different countries using ERP software. This study indicated that as larger the size of an enterprise, contribution to the overall performance in the organization processes would be more by implemented ERP system. This study also showed that US companies used the formal evaluation analyses, while many of the manufacturing industries of Korea executed an ERP software without a formal evaluation analysis. The study also highlighted that those manufacturing industries of Korea used a formal evaluation analysis has adopted the return on investment method while the Swedish companies adopted a variety of evaluation techniques. This study reflected that by comparing with previous study, the estimated returns of Swedish firms were higher than other countries.

Jonsson (2008) explored the presence of several user environment issues and explained the effect of the user environment issues in the perceived performance of planning of various materials planning methods. Four different clusters of user environments were examined. The study

indicated the effect of how different materials planning methods works differently in various user environments. The study showed that focusing on the software support was not main concern while conducting planning of material. It also indicated that the giving to much preference to software focus might produce even larger problems compared to not giving too much importance on any of the proposed user environment features. The reason for low perceived performance between software relier might be because of not using analytical strategies during methods has been designed. Research also indicated that when analyzed individual user environment problems and their position in the materials planning process, lead-time precision and education and knowledge appeared to be the most important factors for attaining high perceived user friendliness.

Dezdar and Ainin (2011) examined the organizational aspects that may affect the success of ERP system implementation. The study suggested that upper management of companies must give a wide support and commitment to the project for the successful implementation of ERP system. In addition, management also verified that the plans would be communicated and understood by the entire company. The outcomes of the research also indicated positive correlation between training/education and satisfaction of software user, which consequentially influenced the organizational impression. Finally, the study also suggested that improper training and education related to the systems must be provide to all users to verify that the system would be operated effectively and efficiently.

Madapusi *et al.* (2012) looked into the changes in functional execution that resulted from an execution of enterprise resource planning system. A literature based and theory driven model was built up for recognize the correlation among the execution of enterprise resource planning systems and functional execution. Data were collected by the use of a survey study to evaluate the assumed correlations. The outcomes indicated that functional execution measures were differently affected by the implementation of each ERP system module. The outcomes spotlight the varying impact of the execution of the enterprise resource planning system, as a whole, on functional performance standards. The study suggested a good knowledge about the role of enterprise resource planning systems to functional execution could be produced if the developer and managers assessed variation in functional execution at both the modular and the system levels.

2.2 Summary of the Literature Review

Organizational and technological factors that are most important for a successful MRP software execution has been a main research objectives in earliest study. Implementation of an MRP system has been a complex process containing number of variables and working conditions which can potentially affect the execution of MRP software. These variables took positive effect on the project outcomes of MRP execution, whereas the lack of these conditions could impede the MRP implementation process. Some of the conclusions drawn from the revealed literature review are:

- The MRP software decrease the level of inventory, improved the rate of deliveries, and obtain better planning and control.
- The rate of return of investment on software was significantly depends on the firm's level of training and technical knowledge about the software.
- MRP vendor involvement and project planning for MRP implementation are important constituent of the effective management for the introduction of MRP packages.
- Materials Requirements Planning (MRP) implementation outcomes depended on critical factors such as top management support, effective project management, education and training, data accuracy, company-wide support, suitability of hardware and software, software vendor support.
- Organizational willingness to change has been positively correlated with the stage of successful implementation of MRP system.
- MRP has been more cumbersome to execute in the maintenance climate as compare to commercial climate.
- The rate of Implementation success was lower among the small and medium scale enterprises which have not using the full potential of MRP packages due to lack of effective integration.
- Organizational and technological aspects of implementation has a critical impact on the benefits of MRP system.

2.3 Gaps in Earlier Investigations

Previous studies conducted by Sum and Yang (1993) and Cheng (1997) indicated that the need for MRP system was well realized by production and inventory control departments of manufacturing companies. As MRP software became widely used, American Production and Inventory Control

Society (APICS) sponsored an extensive view of their members in various neighbourhoods of the United States to study MRP system (Anderson et al., 1981). This study was adapted and refined by Sum and Yang (1993) and Cheng (1997) in their survey to know demographic data which describes the characteristics of the companies that used MRP system and the factors influence the MRP system performance. The MRP computer system has shifted dramatically over the last 15 years from single user systems to client server system. The review of the literature revealed that no such type of study has been reported in north Indian manufacturing companies, so similar study has been carried out in manufacturing companies of the northern states of India like Punjab, Himachal Pradesh to evaluate the efficiency and effectiveness of MRP system by analyse the effect of organizational (management involvement, level of training) and technical (level of computerization, degree of customization, suitability of software) aspects of MRP implementation.

2.4 Objectives of the Study

The main objective of the research was to assess the effectiveness and efficiency of MRP system in manufacturing industries, providing factors associated with the success of MRP system. To achieve the goal of the study, the following objectives are taken:

1) Determine the effective utilization of software based on concepts related to MRP.
2) Determine the correlation between the parameters (performance and accuracy) of MRP system and organizational and technical variables.
3) Determine the dominant and trade off aspects of MRP system.
4) Determine the level of customization.
5) Determine the level of MRP implementation.
6) Determine the effectiveness and end user satisfaction.
7) Determine benefits of MRP.

Chapter 3

Research Methodology

This chapter presents the research methodology includes the research approach to carry out this study by assuming the research hypotheses, designing the questionnaire for implementing the survey and software used for survey analysis.

3.1 Research Approach

The efficiency and effectiveness of MRP system has been assessed by examining the organizational and technological aspects of MRP implementation through survey studied in various manufacturing firms implemented the MRP system. In this study used a survey methodology to gather data about the use of MRP system. This study used different types of medium like mail and email the survey to receive relevant, up-to-date information from a significant sample of manufacturing industries.

3.2 Research Hypothesis

For validating the research objectives, following assumed hypotheses were tested in this survey to recognize the relationship between parameters (performance, accuracy) of MRP system and the different aspects of MRP implementation to evaluate the efficiency and effectiveness of MRP.

1) There is a significant effect of top management involvement on the parameters of MRP system.
2) There is a significant effect of degree of computerization on the parameters of MRP system.
3) There is a significant effect of level of software customization on the parameters of MRP system.
4) There is a significant effect of the level of employee Training on the parameters of MRP system.
5) There is a significant effect of the suitability of the software on the parameters of MRP System.
6) There is a significant effect of the level of implementation on the parameters of MRP system.

3.3 Design Of Questionnaire

The development of the questionnaire was based on the success measure variables and determinant variables which affect the efficiency and effectiveness of MRP system. The success measurements and determinant variables have been adopted from the previous studies of Sum et al. (1993) and Cheng (1997).

Success Measure Variables: These are dependent variables to determine the efficiency and effectiveness of MRP system. The success measure variables used in the questionnaire were constructed from the listed variables in Table 3.1.

Determinant variables: These are independent variables on which the efficiency and effectiveness of the MRP system depend. Determinant variables are categorized into the organizational, implementation and technological variables, listed in Table 3.2.

The design of the questionnaire was divided into three parts. Starting part of the questionnaire describes the characteristics of the organization. Middle part addresses the characteristics of the MRP computer system and how it is used by the organization and the final part, determines to rate the accuracy of the data of the MRP system and the various aspects of the performance of MRP system.

Table 3.1: List of Success Measure Variables

Success Measure Variables
- Improvement in meeting of delivery date - Improved production scheduling - Better ability to meet volume/product changes - Improvement in the estimation of cost - Improvement in productivity - Decrease the inventory costs - Shorten delivery lead time - Increase the value of throughput - Reduction in safety stocks - Improved competitive position

Table 3.2: List of Determinant Variables

Determinant	Variables
Organizational	- Scale of company - Product Type - Number of Bills of material levels
Implementation	- Data accuracy - Initiative of MRP system - Implementation problem
Technological	- Source of system - Degree of computerization - Software suitability

3.4 Implementing the Survey

In order to collect the information about manufacturing companies using MRP system to check the system efficiency and effectiveness, survey methodology was used to reach out as many manufacturing companies as possible. A survey of people involved with the management of MRP system was conducted in order to collect relevant data for this study. Possible titles of survey respondents were Management information system Manager, Production and Inventory Control Manager, Master Scheduler, Materials Manager and Production Manager.

3.5 Software used for Analysis

SPSS (Statistical Package for the Social Sciences) is a software package used for statistical analysis. It was acquired by IBM in 2009. SPSS is a widely used program for statistical analysis in social science. It has been too employed by market researchers, health researchers, survey companies, government, training researchers, marketing arrangements, data miners and others. In this study, SPSS software of the 17.0 version has been used to statistically analyse the research hypotheses. By using this software, Pearson correlation coefficients, one-way ANOVA, linear regression analysis test has been carried out to analyse the effect of organizational and technological factors on the parameters of MRP system.

Chapter 4

Results and Discussion

In this chapter responses of the survey have been analysed to present the results of survey study. This chapter presents the results and discussion on it which includes the responses of the survey, Cronbach's alpha test, data analysis of the survey report, hypothesis test and linear regression analysis.

4.1 Responses of Survey

Forty survey responses were collected of the hundred surveys distributed (40%), a reasonable response rate for an industry survey. Of the forty survey responses, thirty companies have an MRP system and ten were in the process of setting up the MRP system. The survey report showed that most of large firms have been using the internally developed software or SAP software's to implement the MRP packages. Some firms used Oracle, Baan, Ramco, and Movex software's to implement MRP packages because of the lower investment cost of purchasing these software's as compared to SAP software. The survey results represented the profiles of MRP user, average rating of MRP system parameters, the degree of computerization, benefits of MRP system, and system implementation problems.

4.1.1 Profiles of MRP User

The survey reports indicated that, out of thirty companies using MRP packages, there was a significant percentage of automotive companies having the MRP packages. The responses also indicated that MRP packages also true for companies that produced fabricated materials, machinery and transport equipment, pharmaceutical and chemical products, and textiles. Sum and Yang (1993) stated that in these industries, materials management and scheduling are the primary concerns. A variety of industries have been represented in the survey responses. Table 4.1 shows the type of industry, implementing the MRP packages.

Table 4.1: List of MRP User

Industry Type	No. of Companies	% of Survey Group
Automotive Components	10	33
Fabricated Industries	5	17
Machinery & Transport Equipment	5	17
Pharmaceutical and Chemical products	1	3
Textiles Industries	3	10
Others	6	20

4.1.2 Parameters of MRP System

In the survey report of different manufacturing companies, the average rating of parameters of MRP system was represented by using 5-point Likert scale. Score 1 showed little or no effect of system parameters and score 5 showed a very high amount of effect. The two main system characteristics considered which are performance and accuracy of the MRP system. The average rating of parameters of MRP system (in Table 4.2 and 4.3) showed that this system has high rating to give an information to make better decisions making to improve the job performance and to control the inventory level.

Table 4.2: Average rating of Performance of MRP System

Applicable	Average rating
MRP system relevant to Decision Making	4.53
How easy to collect information from the MRP	4.50
High reliability of your MRP Software	4.57
More effective job with MRP	4.47
Improves job performance with MRP	4.37
Improves performance of the organization with MRP	4.53
Your MRP software is not dependable	4.47
Improves control over inventory	4.37

Satisfaction of your customer	4.40
Your workability helped by MRP	4.27
Information to take better decisions	4.27
Overall satisfaction with MRP system	4.30

The average rating of accuracy of the system (in Table 4.3) results showed that the MRP packages have high accuracy to maintain the inventory and bills of material records. The result also showed that there was a high rate of accuracy for master production scheduling and capacity planning of the organizations. There was also a significant accuracy of market forecast, production lead time and shop floor control.

Table 4.3: Average rating of Accuracy of MRP System

Applicable	**Average rating**
Inventory Records	4.63
BOM Records	4.67
Market Forecast	3.83
MPS	4.33
Production Lead Time	3.90
Vendor Lead Time	3.37
Shop Floor Control	3.30
Capacity Planning	4.20

4.1.3 Degree of Computerization

Computerization of system function is essential for the successful MRP implementation. Companies will always want to implement only those set up that are essential for meeting their specific requirements. The degree of computerization of various functions of system, reported in this study was marginally greater than the studies of Cheng (1997). The average value of degree of integration between functions has been reported to be nearly 75%, which was 25% greater than the previous studies of Cheng (1997). Survey responses showed that there was a high degree of computerization of inventory management, bills of material, purchasing and receiving function of

the system. Table 4.4 has presented the degree of computerization.

Table 4.4: Average rating of Degree of Computerization

Applicable	**Average rating**
Inventory Management	4.63
Bills of Material	4.67
Purchasing and Receiving	4.47
MRP	4.23
Accounts payable/ receivable	4.07
Cost Accounting	4.03
Sales Analysis	3.90
Routing/Work canters	3.40
Payroll/Personnel	3.53
Master Production Schedule	4.20
Shop Floor control	3.33
Capacity Requirements Planning	3.53
Forecasting End Items	4.23
Product Data Management	3.83
Integration of Function	3.70

4.1.4 Benefits of MRP System

The major benefits of MRP system as a main reason for their implementation. Benefits such as better delivery, better production scheduling, better responses to changes, and reduced safety stocks are the main reasons for MRP implementation. This survey response was consistent with the outcomes of research conducted by Manthou et al. (1996). The benefits obtained from the MRP system were primarily operational in nature. It seems that companies want to initiate the MRP software as a technique for improving operational efficiency rather than as a means for increasing competitiveness. The average rating of MRP benefits from the survey responses has been presented in Table 4.5.

Table 4.5: Average rating of Benefits of MRP System

Applicable	Average rating
Improvement in meeting of delivery date	4.70
Improved production scheduling	4.20
Better ability to meet volume/product changes	3.97
Improvement in the estimation of cost	4.13
Improvement in productivity	4.17
Decrease the inventory costs	4.13
Shorten delivery lead time	3.93
Increase the value of throughput	4.00
Reduction in safety stocks	4.23
Improved competitive position	3.93

4.1.5 MRP Implementation Problems

The survey results indicated that problems occurred in the MRP system takes place due to some degree of organizational factors and technological factors. The survey responses indicated that the high cost of MRP packages have a strong effect on the system implementation. Due to the high cost of software, smaller firms could not afford the advanced MRP packages. The lack of top management support, software's suitability, and clears goals about the installed packages also have a significant effect on the MRP implementation. The average rating of MRP implementation problems due to various organizational factors (top management support, software literacy level, user training level, enterprise wide communication, vendor support) and technological factors (suitability of software, cost of software) have been shown in Table 4.6.

Table 4.6: Average rating of MRP Implementation Problems

Applicable	Average rating
Lack of top management involvement	2.27
Lack of software suitability	2.13
Lack of vendor support	2.13

Lack of knowledge about MRP	2.30
Lack of MRP expertise in company	2.33
Lack of level of MRP training/education	2.33
High initiation cost of MRP system	2.63
Communication barrier within organization	2.10
Lack of Information technology expert	2.37

4.2 Cronbach's Alpha Test

In 1951, Lee Cronbach was developed Alpha to give a criterion of the internal consistency of a test which was stated in a number between 0 and 1. Internal consistency of test gives the estimation to what extent, all the particulars in a test, measure the same concept and hence alpha test connect to the inter-relationship of the details within the test. The value of alpha is increased when the particulars in a test are correlated to each other. However, a higher alpha coefficient does not always imply a high quantity of internal consistency. This is because alpha is also impressed by the duration of the trial. The value of alpha is reduced when the length of the test is too short. Thus, to increase alpha value, same concept related items should be added to the test (Tavakol and Dennick, 2011).

In this study Cronbach's Alpha test has been applied to assess the reliability (internal consistency) of subscale of survey instrument. This test has been applied between all the subscale of performance, accuracy, benefits, degree of computerization and level of implementation of MRP system of survey instrument. The alpha coefficient for the fifty four subscale of survey questionnaire has recorded 0.9 (shown in Appendix A3) suggesting that the different subscale of survey questionnaire have relatively high internal consistency.

4.3 Data Analysis of Survey Reports

The survey reports of thirty manufacturing companies have been tested by using IBM Statistical Package for the Social Sciences (SPSS) tool to find:

1) One-way ANOVA
2) Pearson Correlation Coefficients
3) Linear Regression Analysis

One-way ANOVA test has been applied to analyse whether the different level of independent variables (top management support, software initiative, level of computer knowledge and level of training) were significantly different or not. Pearson Correlation Coefficients test has been used to find the correlation coefficients between the different parameters (performance and accuracy) of MRP system and the different factors (top management involvement, level of computerization, degree of customization, level of training, software suitability) of MRP implementation. Linear Regression analysis has been applied to predict how the different parameters of MRP were based upon the values of the independent variables (different organizational and technological factors). The data analysis of survey report has been shown in Table 4.7 to Table 4.22.

4.4 Hypothesis Tests and Discussion

Hypothesis 1: There is a significant effect of top management involvement on the parameters (performance and accuracy) of MRP System.

The effect of top management involvement has been tested using the following questions (Appendix A1) of the survey:

(A) Upper management initiation of MRP system.

(B) The level of management support.

Hypothesis 1A: There is a significant difference between the effects of upper management initiation and non-management initiation of the system on the parameters of MRP system.

H_0: There is no significant difference between the means of two group.

H_1: The parameters of MRP system initiated by upper management is better than other's initiative.

Decision Rule:

The null hypothesis (H_0) rejected if the calculated value of p is less than 0.05 or the calculated value of F ratio is greater than the tabulated value of F ratio.

One-way ANOVA has been applied to analyse the means of the initiative of independent variable (software initiative) were significantly different or not. The p-values (in Table 4.7) between levels of independent variable with respect to parameters of MRP system was less than the critical p-value i.e. 0.05, and the values of F ratio were greater than the tabulated values of F ratio. Hence, the null hypothesis (H_0) has been rejected. Therefore, there was a significant

difference between the means of the different software initiative.

Table 4.7: One-way ANOVA for Software Initiative

Source of Variation		Sum of Squares	df	Mean Square	F-ratio	Sig.(p)
Performance	Between Groups	.983	1	.983	14.634	.001
	Within Groups	1.880	28	.067		
	Total	2.863	29			
Accuracy	Between Groups	.329	1	.329	10.477	.003
	Within Groups	.880	28	.031		
	Total	1.210	29			

The mean value of different initiatives of MRP system in the organization with respect to the parameters of MRP system has been summarized in Table 4.8. Means plot graph (in Fig. 4.1) of the means of initiative and the performance of the system showed, which initiative system has a better performance. This graph showed that the performance rating of MRP system was higher in management initiative system compared to those initiated by others.

Table 4.8: Mean Value of Software Initiative

		N	Mean	Standard Deviation	Standard Error	Minimum	Maximum
Performance	Not initiated by Top management.	12	4.208	.3147	.0908	3.6	4.7
	Initiated by Top management	18	4.578	.2157	.0508	4.2	4.9
	Total	30	4.430	.3142	.0574	3.6	4.9
Accuracy	Not initiated by Top management.	12	3.908	.2151	.0621	3.5	4.3
	Initiated by Top management	18	4.122	.1478	.0348	3.8	4.4
	Total	30	4.037	.2042	.0373	3.5	4.4

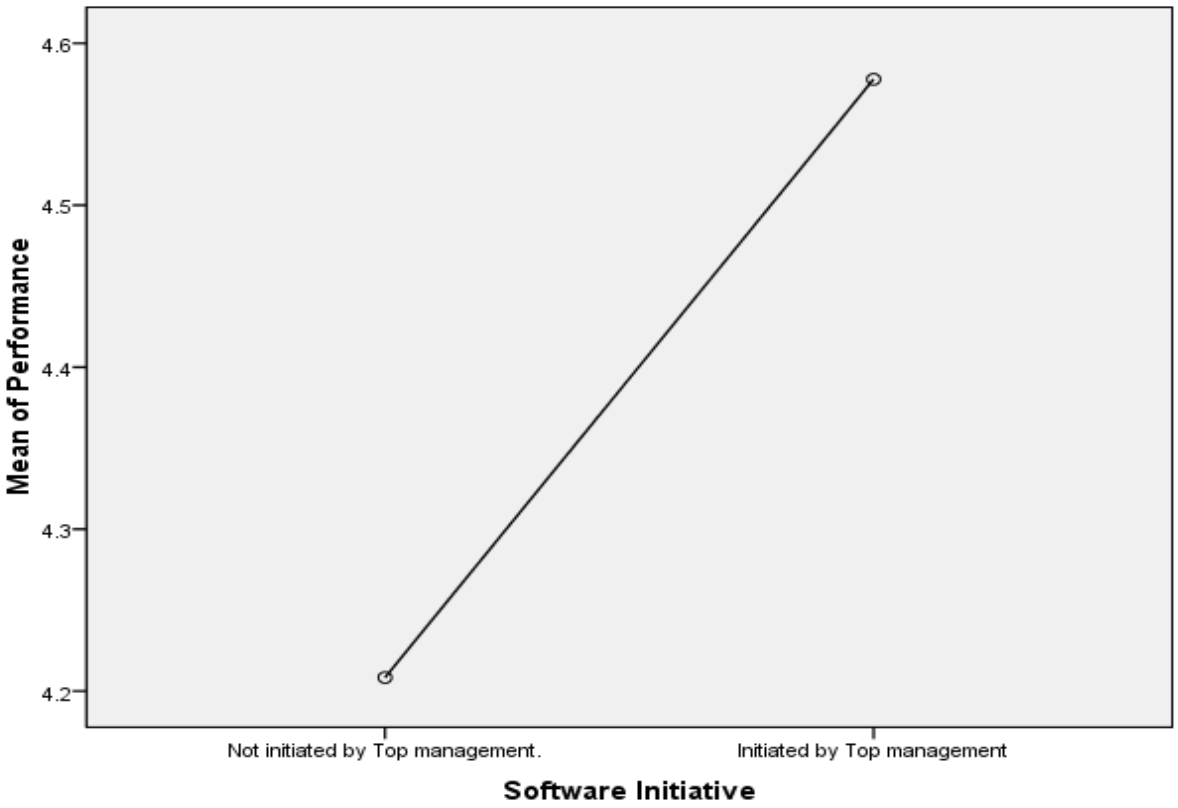


Figure 4.1: Means plot graph between the means of Software Initiative and Performance

Similarly, showed in the means plot graph of accuracy of the system (in Fig. 4.2). Therefore, the results concluded that the rating of MRP system parameters was higher in upper management initiated system as compare to those initiated by others.

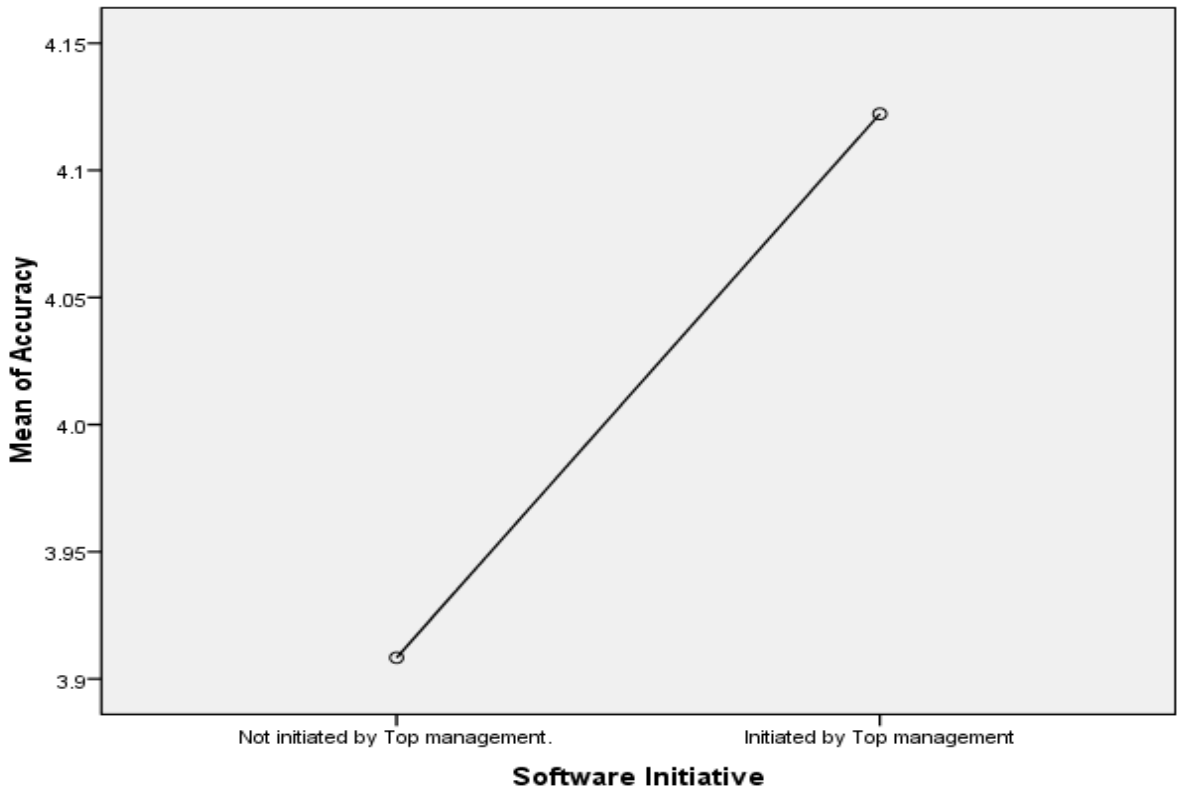


Figure 4.2: Means plot graph between the means of Software Initiative and Accuracy

Hypothesis 1B: There is a significant effect of the level of management support on parameters of MRP system.

Linear regression analysis has been applied to know the effect of top management support on the parameters of MRP System. First of all, One-way ANOVA and Pearson correlation coefficient test have been applied, after than applied the linear regression analysis. ANOVA test has been applied to check out whether the means of different levels of management support were significantly different or not. The p-values (in Table 4.9) between the levels of independent variable (top management support) and parameters of MRP system has been less than the critical p-value and values of F ratio were greater than the tabulated value of F ratio. Therefore, as in Hypothesis 1A, a null hypothesis has been rejected and there was a significant difference between the means of the levels of top management support

Table 4.9: One-way ANOVA for Management Support

		Sum of Squares	df	Mean Square	F-ratio	Sig.(p)
Performance	Between Groups	1.286	2	.643	11.010	.000
	Within Groups	1.577	27	.058		
	Total	2.863	29			
Accuracy	Between Groups	.488	2	.244	9.144	.001
	Within Groups	.721	27	.027		
	Total	1.210	29			

Pearson correlation coefficients and t-test have been applied between the top management support and the parameters of MRP System. The hypothesis $1B_1$ has been conducted to know the correlation between the parameters of MRP with level of top management support.

Hypothesis $1B_1$: There is a significant correlation between the parameters of MRP and the level of top management support.

H_0: There is no significant correlation between the parameters of MRP and top management support.

H_1: There is a significant correlation between the parameters of MRP and top management support.

Decision Rule:

The null hypothesis rejected, if the value of t calculated is greater than the value of t observed at $\alpha = 0.05$.

The Pearson correlation coefficients test under the given hypothesis $1B_1$ has shown that there was a significant correlation between the top management support and the parameters (performance and accuracy) of MRP System. The correlation coefficients between the top management support and the parameters of MRP System were summarized in Table 4.10. After calculating correlation coefficients, the t value has been calculated using the standard formula:

Calculated value of t = $|r|\sqrt{(n-2)/(1-r^2)}$

Where n = number of sample taken and

r = the value of correlation coefficient.

The calculated values of t-test (in Table 4.11) are greater than the tabulated values of t-test at (α = 0.05, $n - 2$ = 28) = 1.70, which showed that the hypothesis $1B_1$ has been accepted. These tests showed there was a significant correlation between the upper management support and parameters of MRP system.

Table 4.10: Pearson Correlation Coefficients

		Management Support	Level of Customization	Degree of Computerize	Software Suitability	Level of Training	Implementation Level
Performance	Correlation	.670**	.513**	.419*	.484**	.424*	.755**
	Sig. (1-tailed)	.000	.004	.021	.007	.020	.000
Accuracy	Correlation	.632**	.496**	.495**	.496**	.516**	.637**
	Sig. (1-tailed)	.000	.005	.005	.005	.004	.000

*. Correlation is significant at the 0.05 level (1-tailed).
**. Correlation is significant at the 0.01 level (1-tailed).

Table 4.11: t-test value for Pearson Correlation Coefficients

	Management Support	Level of Customization	Degree of Computerize	Level of Training	Software Suitability	Level of implementation
Performance	4.77	2.44	3.16	2.47	2.92	6.09
Accuracy	4.31	3.01	3.02	3.18	3.02	4.37

Under linear regression analysis summarized in Table 4.12, the unstandardized coefficients Beta (β) values (in table 4.13) showed that there was a significant effect of level of top management support on the parameters (performance and accuracy) of MRP system. The result of Hypothesis 1A and Hypothesis 1B concluded that there was a significant effect of top management involvement on the parameters of MRP System. This result was similar with Petroni (2002) and Salaheldin (2004) study, which indicated that there was a strong relationship between the inclination of top management and the stage of MRP implementation.

Table 4.12: Regression Analysis for Parameters of MRP system

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
Performance	.836	.700	.621	.1934
Accuracy	.823	.677	.593	.1303

Table 4.13: Regression Analysis Coefficients for Parameters of MRP system

Model		Unstandardized Coefficients		Standardized Coefficients	t	Significant
		β	Std. Error	Beta		
Performance	(Constant)	3.166	.213		14.876	.000
	Management Support	.044	.071	.107	.615	.545
	Level of Customization	.045	.047	.135	.963	.346
	Degree of Computerization	.077	.060	.169	1.278	.214
	Software Suitability	.073	.057	.171	1.278	.214
	Level of Training	.041	.044	.123	.928	.363
	Implementation Level	.153	.055	.468	2.788	.010
Accuracy	(Constant)	3.131	.143		21.843	.000
	Management Support	.030	.048	.113	.628	.536
	Level of Customization	.024	.032	.110	.758	.456
	Degree of Computerization	.089	.041	.301	2.192	.039
	Software Suitability	.049	.039	.176	1.275	.215
	Level of Training	.061	.030	.280	2.047	.052
	Implementation Level	.057	.037	.268	1.537	.138

Hypothesis 2: There is a significant effect of the computerization level on the parameters of MRP System.

The effect of degree of computerization has been tested using the following questions of the survey:

(A) What is the level of managerial knowledge about computer system?

(B) What degree is your organization computerized to support functions of MRP system?

Hypothesis 2A: There is a significant effect of managerial knowledge about computer system on parameters of MRP system.

H_0: There is no significant difference between the means of the levels of computer knowledge.

H_1: The value of MRP system parameters is greater having a higher level of computer knowledge than those having lower level of computer knowledge.

Decision Rule:

The null hypothesis (H_0) rejected if the calculated value of p is less than 0.05 or the calculated value of F ratio is greater than the tabulated value of F ratio.

One-way ANOVA test showed that the p-values (in Table 4.14) between the levels of independent variable (computer knowledge) with respect to parameters of MRP system are less than the critical p-value and values of F ratio are greater than the critical values of F ratio. Hence, there was a significant difference between the means of the levels of computer knowledge.

Table 4.14: One-way ANOVA for the Levels of Computer Knowledge

Source of Variation		Sum of Squares	df	Mean Square	F-ratio	Sig.(p)
Performance	Between Groups	1.219	2	.610	10.012	.001
	Within Groups	1.644	27	.061		
	Total	2.863	29			
Accuracy	Between Groups	.512	2	.256	9.893	.001
	Within Groups	.698	27	.026		
	Total	1.210	29			

The mean value of the levels of computer knowledge with respect to the parameters of MRP system has been summarized in Table 4.15. Means plot graph (in Fig. 4.3) between means of the level of computer knowledge and performance showed that as the level of computer knowledge increases, the performance of a system has also increased.

Table 4.15: Mean Value of the Levels of Computer Knowledge with Parameters of MRP System

		N	Mean	Standard Deviation	Standard Error	Minimum	Maximum
Performance	Fair knowledge	6	4.100	.1414	.0577	3.9	4.3
	Good knowledge	17	4.429	.2823	.0685	3.6	4.8
	Excellent knowledge	7	4.714	.2116	.0800	4.3	4.9
	Total	30	4.430	.3142	.0574	3.6	4.9
Accuracy	Fair knowledge	6	3.817	.1602	.0654	3.5	3.9
	Good knowledge	17	4.041	.1661	.0403	3.6	4.3
	Excellent knowledge	7	4.214	.1464	.0553	4.0	4.4
	Total	30	4.037	.2042	.0373	3.5	4.4

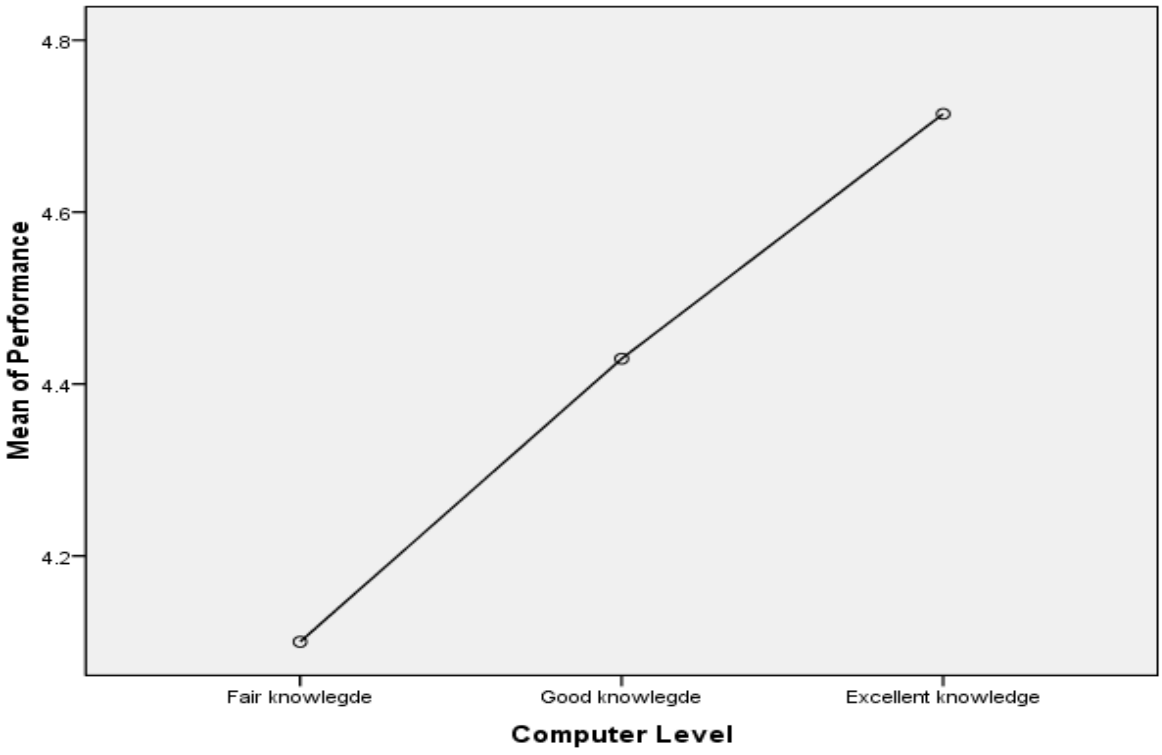


Figure 4.3: Means plot graph between the means of the Level of Computer Knowledge and Performance

Similarly, in the means plot graph of accuracy of the system (in Fig. 4.4). Therefore, the value of MRP system parameters was better having a higher level of computer knowledge than those having lower level of computer knowledge. This result supports the literature review concerning the need to have a high level of knowledge and experience with automated information systems prior to the implementation of the highest advanced level of MRP system (Petroni and Rizzi, 2001).

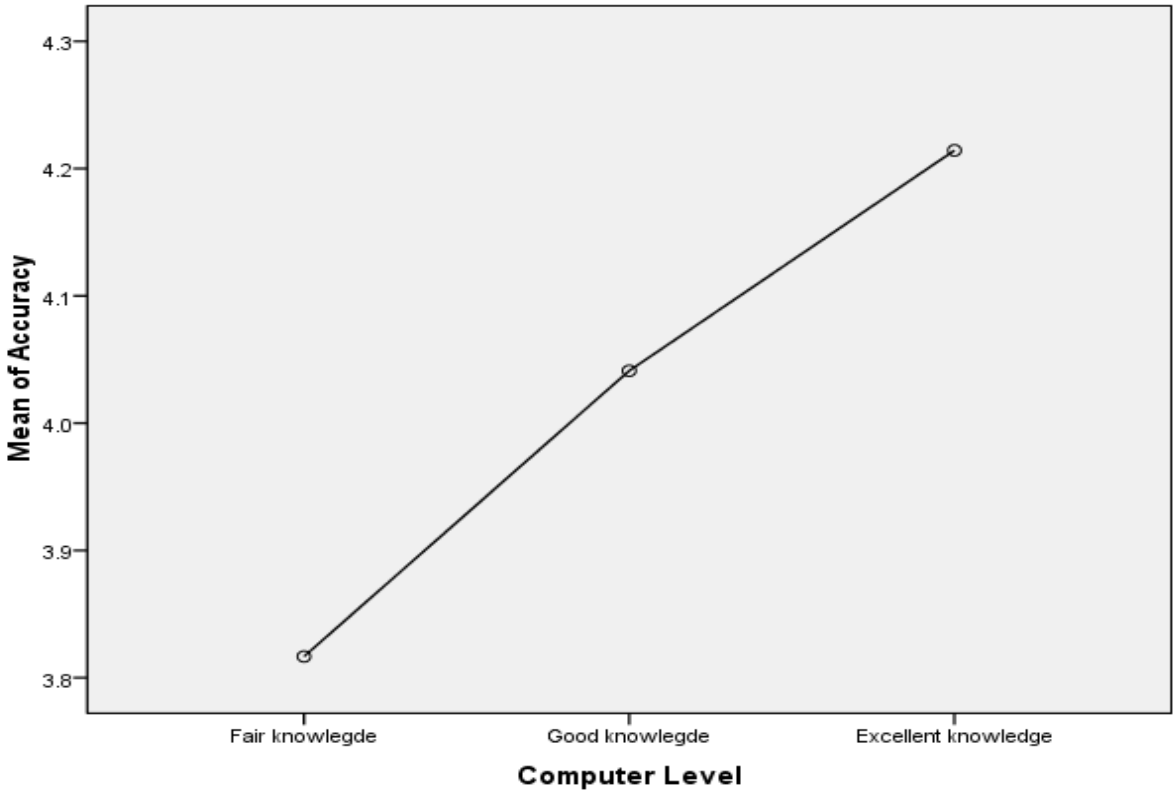


Figure 4.4: Means plot graph between the means of the Level of Computer Knowledge and Accuracy

Hypothesis 2B: There is a significant effect of degree of computerization on the parameters of MRP System.

In the Pearson correlation coefficient test, the correlation coefficients (in Table 4.10) between the degree of computerization and the parameters of MRP system were significantly correlated. The calculated values of t-test (in table 4.11) under Pearson correlation coefficients were greater than

the tabulated values of t-test, which showed the significant correlation between the degree of computerization and parameters of MRP system.

Under regression analysis, the β values showed that there was a significant effect of degree of computerization on the parameters of MRP system. Therefore, result concluded that the MRP parameters were significantly affected in the firms where the degree of computerization was significantly higher than the firms having a lower degree of computerization. The result of Hypothesis 2A and Hypothesis 2B concluded that there was a significant effect of level of computerization on the parameters of MRP System.

Hypothesis 3: There is a significant effect of the level of software customization on the parameters of MRP System.

One-way ANOVA test (in Table 4.16) showed that there was a significant difference between the means of the levels of software customization. The mean value of the levels of software customization with respect to the parameters of MRP system has been summarized in Table 4.17. Means plot graph (in Fig. 4.5) between the means of the levels of software customization and performance showed that as the level of customization increases, the performance of a system has been also increased.

Table 4.16: One way ANOVA for the Levels of Software Customization

Source of Variation		Sum of Squares	df	Mean Square	F	Sig.
Performance	Between Groups	.926	3	.309	4.142	.016
	Within Groups	1.937	26	.075		
	Total	2.863	29			
Accuracy	Between Groups	.370	3	.123	3.821	.022
	Within Groups	.839	26	.032		
	Total	1.210	29			

Table 4.17: Mean Value of the Levels of Software Customization with Parameters of MRP

		N	Mean	Standard Deviation	Standard Error	Minimum	Maximum
Performance	Little or no modification	5	4.240	.3975	.1778	3.9	4.9
	Some modification	6	4.183	.3545	.1447	3.6	4.7
	Large modification	15	4.527	.1870	.0483	4.2	4.9
	Internally developed	4	4.675	.2500	.1250	4.3	4.8
	Total	30	4.430	.3142	.0574	3.6	4.9
Accuracy	Little or no modification	5	3.880	.2864	.1281	3.5	4.3
	Some modification	6	3.900	.2280	.0931	3.6	4.3
	Large modification	15	4.120	.1207	.0312	4.0	4.4
	Internally developed	4	4.125	.1258	.0629	4.0	4.3
	Total	30	4.037	.2042	.0373	3.5	4.4

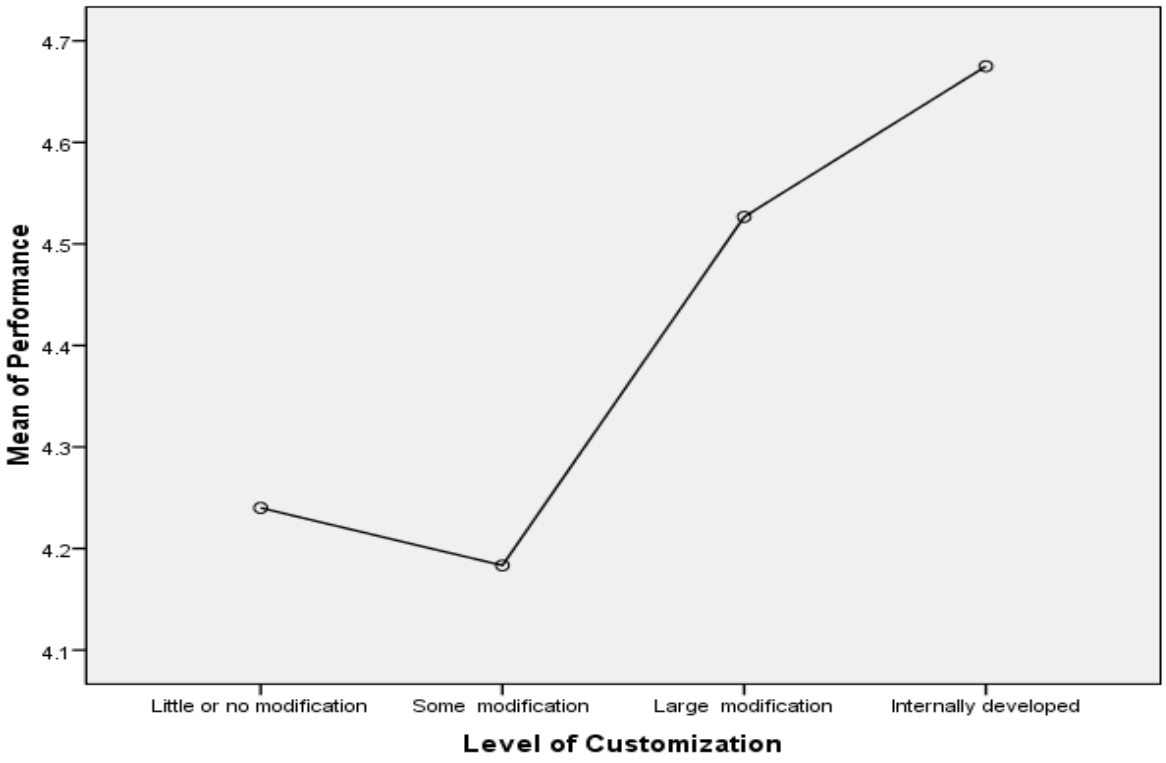


Figure 4.5: Means plot graph between the means of the Level of Customization and Performance

Similarly, in the means plot graph of accuracy (in Fig. 4.6) of the system showed that as the level of customization increases, the performance of a system has been also increased.

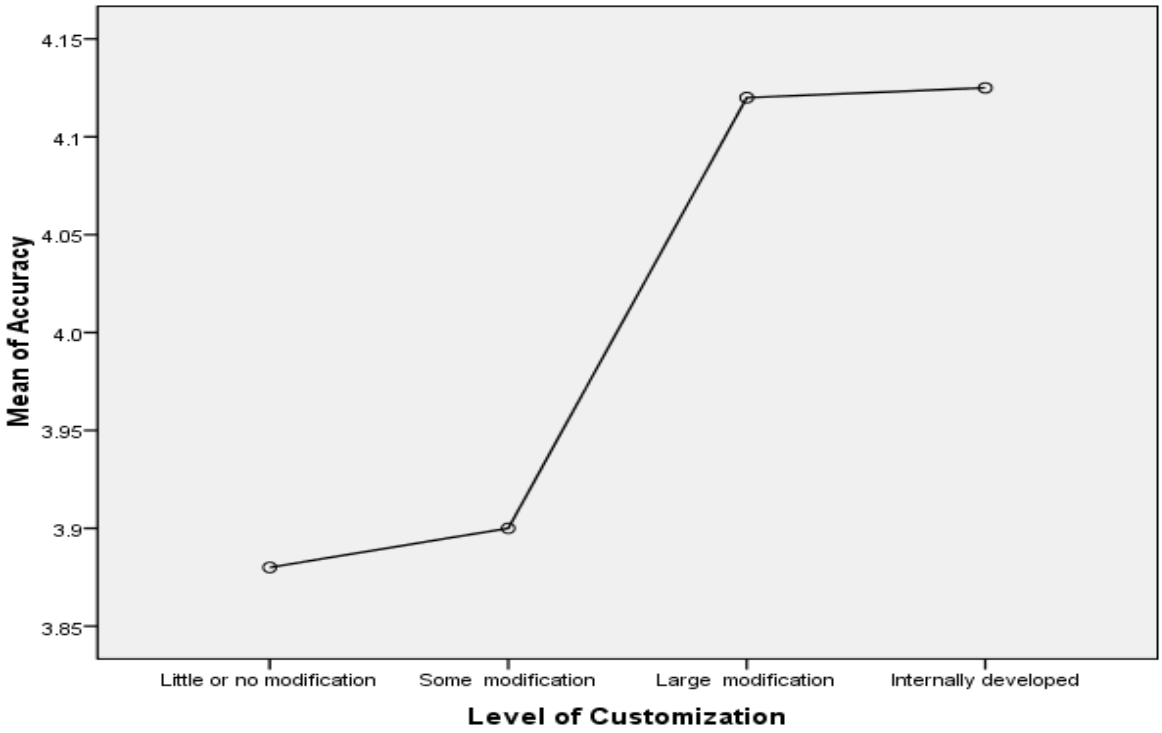


Figure 4.6: Means plot graph between the means of the Level of Customization and Accuracy

Pearson correlation coefficient test (in table 4.10) between the level of software customization of employees and the parameters of MRP System and the corresponding t-test values (in table 4.11) showed a significant correlation between the level of software customization and the parameters of MRP system.

The β values (in table 4.12) showed that there was a significant effect of software customization on the performance and strong effect on the accuracy of MRP system. The result of hypothesis 3 concluded that the efficiency and effectiveness of MRP system companies were significantly lower in vendor supplied software without modification as compared to the MRP system having modified packages. These modified packages were customized according to the processes and environmental condition of the manufacturing firms.

Hypothesis 4: There is a significant effect of the different modes of software training on the parameters of MRP System.

One-way ANOVA test (in table 4.18) showed that the p-value between the different modes of software training and the performance of MRP system was greater than the critical p-value. Therefore, there was no significant difference between the different modes of software training with respect to performance and for accuracy of MRP system, p-value between the different modes of software training and the accuracy of MRP system was less than the critical p-value. Therefore, there was a significant difference between the different modes of software training with respect to accuracy.

Table 4.18: One-way ANOVA test for the Levels of Training

		Sum of Squares	df	Mean Square	F-ratio	Sig.(p)
Performance	Between Groups	.532	3	.177	1.978	.142
	Within Groups	2.331	26	.090		
	Total	2.863	29			
Accuracy	Between Groups	.326	3	.109	3.193	.040
	Within Groups	.884	26	.034		
	Total	1.210	29			

Pearson correlation coefficient test (in table 4.10) between the different modes of software training and the parameters of MRP System and the corresponding t-test values (in table 4.11) showed a significant correlation between different modes of software training and parameters of MRP system. The β values (in table 4.12) showed that there was a significant effect of the different modes of software training on the parameters of MRP system. The results of hypothesis 4 concluded that the firms having a formal training program have a better result of system parameters. Therefore, formal training to the MRP user about installed software has been of great importance to know the how and the why of the software packages.

Hypothesis 5: There is a significant effect of the suitability of the software on the parameters of MRP System.

The results of the Pearson correlation coefficient test between the suitability of the software and

the parameters of MRP System and the corresponding t-test values showed a significant correlation between the suitability of the software and parameters of MRP system. The β values showed that there was a significant effect on the suitability of the software on the performance and strong effect on the accuracy of MRP system. Therefore, suitability of software is most important level of implementation of proper suitability of software technology with the complexity of the manufacturing processes.

Hypothesis 6: There is a significant effect of the level of implementation on the parameters of MRP System.

The level of implementation depends on the combined effect of the level of management support, level of computerization, level of software customization, level of employee training and software of suitability. The final hypothesis of the level of implementation results showed that there was a significant correlation between the implementation of MRP and the parameters of MRP system. The B values showed that there was a significant effect of successful software implementation on the parameters of MRP system.

4.5 Regression Analysis

The Regression analysis result showed (in Table 4.12) that the linear regression values (R) between all the independent variables and parameters (performance and accuracy) were 0.836 and 0.823 respectively. The output of a regression values predicted that the parameters of MRP has been significantly based upon the values of the independent variables (top management involvement, level of computerization, degree of customization, software suitability, level of training, level of implementation). The corresponding R square values were 0.700, 0.677 respectively, showed that 70% of the total variation in performance parameters could be explained by the linear relationship between the performance and independent variables and the other 30% of total variation in performance remains unexplained. Similarly, 67.7% of the total variation in accuracy parameter could be explained by the linear relationship between the accuracy and independent variables. Under regression analysis, the β values showed the effect of implementation aspects on MRP parameter and the benefits of the MRP system.

4.5.1 Effect on Performance of MRP System

The effect of the implementation aspects (organizational and technological factors) on the performance of MRP system has been shown by the β values (in Table 4.12) of regression analysis. The B values of performance of MRP corresponds to the different factors of implementation aspects has been presented by the use of pie chart. This pie chart (in Fig. 4.7) showed the percentage of different factors of implementation aspects that affected the performance of MRP system. The statistical analysis of survey report concluded that successful implementation and suitability of MRP system has a significant effect on the performance of MRP system.

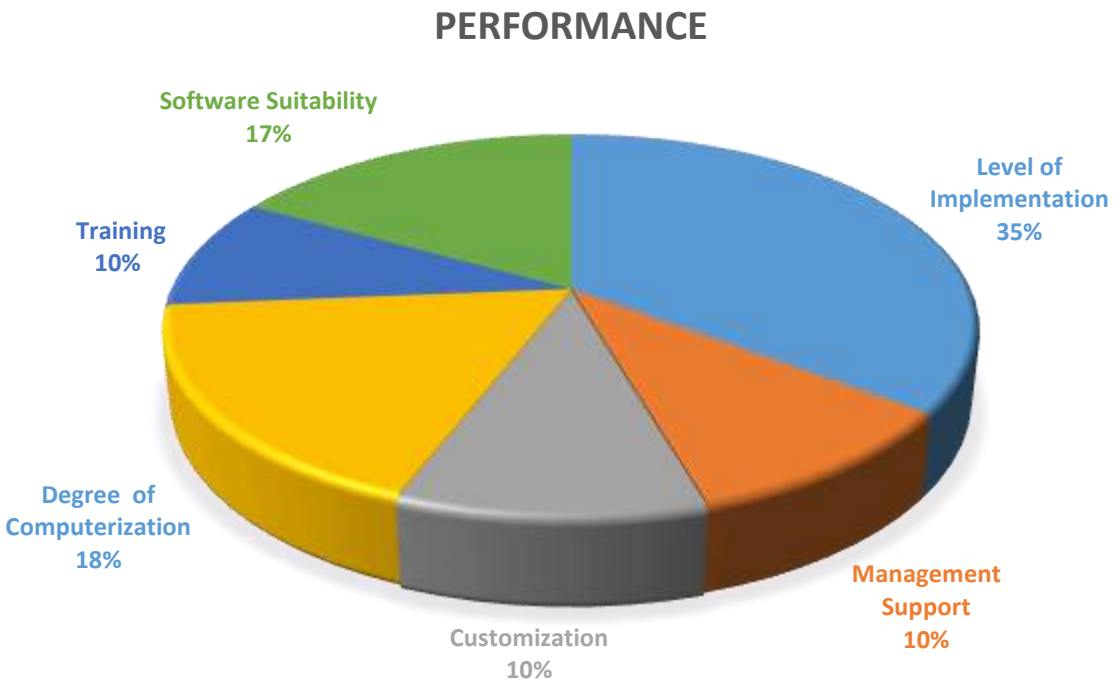


Figure 4.7: Effect of Implementation aspects on the Performance of MRP system

4.5.2 Effect on Accuracy of MRP System

The analysis report of the survey concluded that suitability of the software and degree of software customization has a significant effect on the accuracy of the system. Degree of computerization, management support and level of implementation also has a significant effect on the accuracy of the system. The pie chart (in Fig. 4.8) of accuracy, represented the percentage of different factors of implementation aspects that affected the accuracy of MRP system

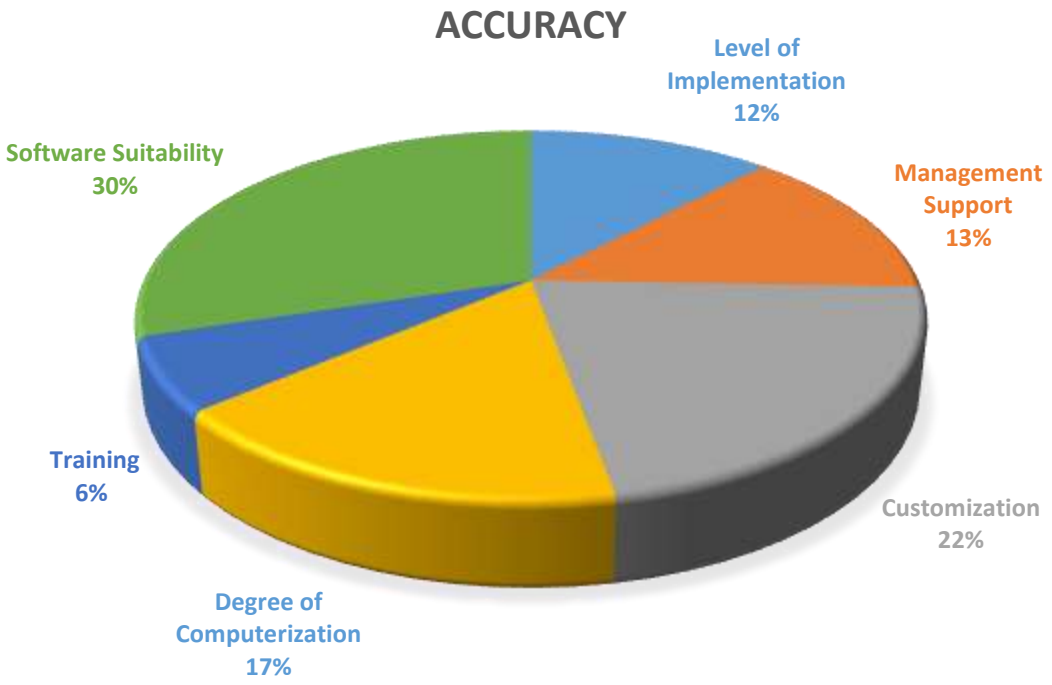


Figure 4.8: Effect of Implementation aspects on the Accuracy of MRP system

4.5.3 Effect on Benefits of MRP System

The Regression analysis result showed (in Table 4.19) that the regression values (R) between all the independent variables and the benefits of MRP system was 0.845. The output of a regression values predicted that the parameters of MRP has been significantly based upon the values of the independent variables. The β values summarized in table 4.20 showed the effect of implementation aspects on the benefits of MRP system.

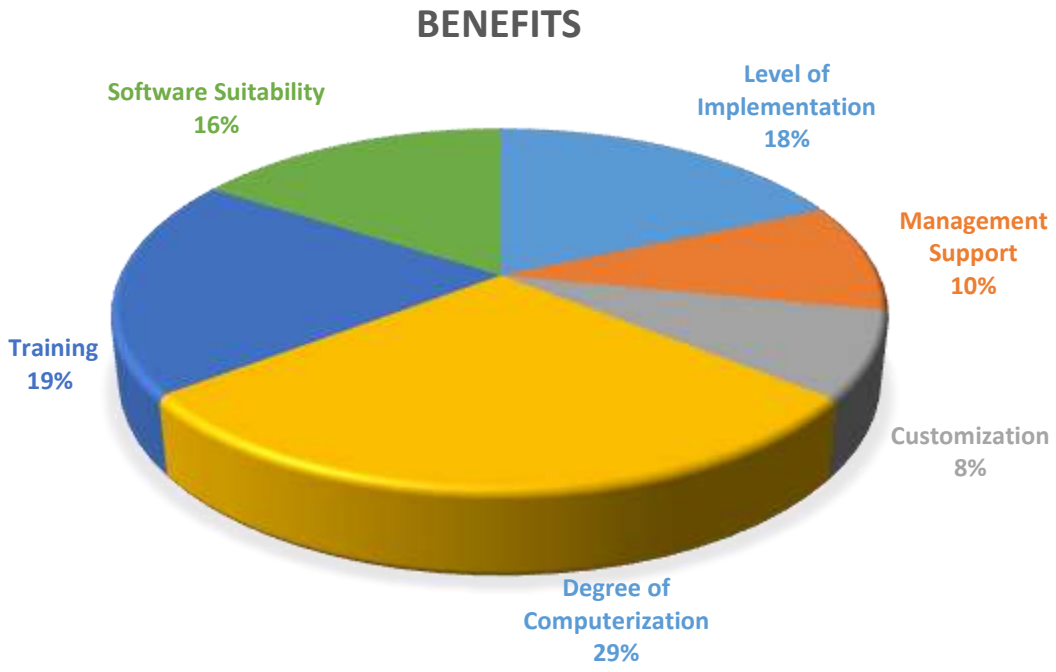
Table 4.19: Regression Analysis for Parameters of MRP system

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
Benefits	.845	.714	.639	.2184

Table 4.20: Regression Analysis Coefficients for Benefits of MRP System

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		β	Std. Error	Beta		
Benefits	(Constant)	2.534	.240		10.545	.000
	Management Support	.076	.081	.159	.939	.358
	Level of Customization	.121	.053	.310	2.262	.033
	Degree of Computerization	.093	.068	.178	1.376	.182
	Software Suitability	.167	.065	.335	2.571	.017
	Level of Training	.036	.050	.092	.715	.482
	Implementation Level	.067	.062	.177	1.081	.291

The analysis report of the survey concluded that the Degree of computerization has a significant effect on the benefits obtained from the MRP system. Training on software, level of implementation and suitability of the software has also significantly affected the benefits obtained from the MRP system. The pie chart (in Figure 4.9) of benefits, represented the percentage of different factors of implementation aspects that affected the benefits of MRP system.



Chapter 5

Summary and Conclusions

This chapter presents the summary of the industrial survey and the corresponding conclusions of the study, and scope of further research.

5.1 Summary

The study has provides a strong sense of the identification of significant factors that affect the MRP parameters on which the efficiency and effectiveness of the system within the manufacturing companies. The efficiency and effectiveness depend on the different parameters of MRP system. These parameters were affected by the different aspects of implementation. This study, however, examined the organizational factors (i.e. top management support, training level of user) and technological factors (i.e. customization of software, degree of computerization and suitability of software) among MRP user. Thirty survey responses have been analysed and presented by using SPSS software. On the basis implementation aspects, six hypotheses have been tested by using the various statistical test like Pearson correlation Coefficients, Linear Regression Model, t-test and ANOVA to analyse the survey report. Survey report showed the profiles of MRP user, average rating of system parameters, and degree of computerization, benefits and implementation problems of the MRP system. The statistical analysis of the various responses of the survey showed that the different organizational and technological factors have a significant effect on the parameters of MRP system on which the system efficiency and effectiveness depend. The other results of this study, help manufacturing companies to execute an MRP software to strategize their working conditions and processes to assure successful execution.

5.2 Conclusions

The conclusions drawn from these industrial surveys are represented as follows:

1) The level of top management support has significant effects on the parameters of MRP system. Level of upper management involvement constituted a critical factor to boost up the

performance of MRP system by establishing a better organizational environment and facilitate the learning process that has been essential for the execution of the new technology. The study of Manthou et al. (1996) indicated the effectiveness of MRP was heavily depends on the human factor, its specialist and strength to transfuse and interact with the system. The finding of the study resonate with that carried out by Petroni (2002) and Salaheldin (2004), Dezdar and Ainin, (2011) in terms of the Management commitment to its own involvement and willingness.

2) The degree of computerization and software suitability of the user environment has a significant effect on the parameters and the benefits of MRP system to increase the efficiency of the system. In contrast, this finding is dissimilar with the findings of Petroni (2002) study, which concluded that the problems with computerization of modules was not make any effect on the success rate of MRP implementation. The present study provides a strong evidence that as the degree of computerization would be better, easy to operate the automated information system and the opportunity of the implementation of more advanced stage of MRP system appears to increase.

3) The adequate and complete training on MRP to increase the knowledge of users giving a significant effect on the accuracy of the software by working with an efficient way to MRP packages. Dezdar and Ainin (2011) stated that training should be initiate with the knowledge of the project members in the system, line, and project management, and ends with the system's users. This finding is similar to those in Petroni (2002), Nah et al. (2003) and Salaheldin (2004) in terms of adequate training could boost the success rate of system execution while the improper training could impede the execution. The users must be prepared to take total advantage of the system's capabilities by learning those system functions that are connected to their businesses. Moreover, adequate training may also support the organization to construct up a positive feeling towards the system.

4) The level of customization of MRP system has a significant effect on the on the parameters of MRP system. Applicability of materials planning methods has been frequently differing in different types of industries and it is based on the requirement, component, and process features (Berry and Hill, 1992; Jonsson and Mattsson, 2003). The survey responses concluded that due

to software's suitability with the complex manufacturing processes, most of the large firms have internally developed their software or largely customize their software packages. The results also indicated that level of customization increases the level of data accuracy by giving the most precise result of scheduling, lead time, inventory level and purchasing order. The finding of the study resonate with that carried out by Olhager and Selldin (2003) and Umble et al. (2003) in terms of implementing a system may require the customization of software database to developing the new database which support the organization's processes.

5) The suitability of the software has a significant effect on the on the parameters of MRP system. The performance of planning does not depend on the method and planning conditions, but it is depends upon the user climate, i.e. the suitability of software existing in the ERP system to support the planning function (Jonsson, 2008). This finding is contradicts the finding of Petroni (2002), in terms of problems with the lack of suitability of software was not make any effect on the success rate of MRP implementation. MRP software's suitability has been a crucial factor to adopt the organization and its processes to exploit the system's capabilities.

6) The results of unstandardized coefficients (β) indicated that the level of implementation level has a significant effect on the performance of MRP system. The survey responses indicated that the high cost of MRP packages has a significant effect on the system implementation. Due to the high cost of software, smaller firms cannot afford the advanced packages of MRP. The lack of top management support, software's suitability, and clear goals about the installed packages have produced a significant effect on the MRP implementation.

7) The degree of computerization, suitability of software had a significant effect on the benefits obtained from the MRP system. Valuable benefits like better customer service, improved production scheduling and reduction in the cost of manufacturing can obtain by the successful implementation of MRP system (Braglia and Petroni, 1999; Petroni, 2002).

8) The average value of degree of integration between different functions has been reported to be approximately 75%. This level of integration between different function of MRP system reported in this survey was considerably higher than the previous studies of Cheng (1997).

5.3 Scope of Further Research

The results of this study, help manufacturing companies to execute an MRP software to strategize their working conditions and processes to assure successful execution. There are numerous research areas where the critical factors affecting the stage of MRP efficiency and effectiveness can be expanded. By assessing the degree of impact of computerization and the integration among MRP system by expanding industry sector instead of manufacturing companies. Further, it could be achieve similar beneficial to organize comparative studies among various types of industries and among various types of information system. The current study calls for undertaking case studies to present more details concerning the critical factors affecting the efficiency and effectiveness of MRP in the manufacturing companies. Finally, this study provides the opportunity for other researchers to execute more research in this field and to merge with disciplines such as marketing and finance.

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Appendix A1

Survey Questionnaire

The questions in this survey are designed to be answered by the MIS Manager, Materials Manager, Master Scheduler, Production and Inventory Control Manager, or another person who is most familiar with the MRP or manufacturing related computer system in your company. Answer the remaining questions by filling in the blank, or circling or checking the most appropriate response.

Part I

Organizational Characteristics

1. In which industry would you classify your organization? (Check one)
( ) Automotive products and components
( ) Fabricated metal products
( ) Machinery and Transport Equipment
( ) Pharmaceutical
( ) Textile
( ) Other _____

2. What is your job responsibility? (Check one)
( ) Production Planning
( ) Inventory Control Management
( ) Scheduling (Master Schedule)
( ) MIS Management
( ) Production Management
( ) Other _____

3. The facility described in the remainder of this questionnaire is:

a) A single plant

b) Part of a company with several plants

c) Other (describe) _____

4. What is the scale of your industry?

a) Small scale

b) Medium scale

c) Large scale

Appendix A1

5. Does your company currently have or is your company currently implementing a MRP?

a) Yes

b) No

If the answer to question number 5 is "No" then please stop here and return this questionnaire. Thank you for your participation.

6. What was the level of your software customization?

a) Vendor supplied with little or no modifications

b) Vendor supplied with some modifications

c) Vendor supplied with major modifications

d) Developed internally within your organization

7. Who initiated MRP development in your company?

a) Top management

b) Production and inventory control management

c) Both top management and production and inventory control management

d) Information systems

e) Software and hardware vendors

f) Other (describe) _____

8. What is the level of managerial knowledge about computer systems?

a) Not at all

b) Slightly knowledgeable

c) Moderately knowledgeable

d) Highly knowledgeable

9. What is the level of top management support to the implementation and project management of the MRP computer system?

a) Very little or Not at all

b) Limited support

c) High level of support

d) Entirely support

10. What is the mode of training on the existing MRP system?

a) External consultants, MRP computer systems specialists

b) In-house experts, employees involved with implementation

c) Both internal and external experts

d) Training is done on-the job with experienced employees

Part II

Usage of MRP System

A. MRP system features

1. How many levels are used in your computerized Bills of Material? (On average)
_____

2. How is your MRP system updated?

a) Net change
b) Regenerative (e.g. weekly re-planning cycles)
c) Both
d) Other _____

3. How often is your Master Production Schedule updated?

a) Weekly

b) Daily

c) Other _____

B. To what degree is your organization currently computerized to support these functions? Answer the following group of questions by circling the number at the right of each question, using the scale below:

1 = 0 - 20 % **4 = 60 - 80 %**

2 = 21 - 40 % **5 = 81 - 100 %**

3 = 41 - 60 %

		0-20%	21-40%	41-60%	61-80%	81-100%
1	Inventory Management	1	2	3	4	5
2	Bills of Material	1	2	3	4	5
3	Purchasing and Receiving	1	2	3	4	5
4	MRP	1	2	3	4	5
5	Accounts payable/ receivable	1	2	3	4	5
6	Cost Accounting	1	2	3	4	5
7	Sales Analysis	1	2	3	4	5
8	Routing/Work canters	1	2	3	4	5
9	Payroll/Personnel	1	2	3	4	5
10	Master Production Schedule	1	2	3	4	5
11	Shop Floor control	1	2	3	4	5
12	Capacity Requirements Planning	1	2	3	4	5
13	Forecasting End Items	1	2	3	4	5
14	Product Data Management	1	2	3	4	5
15	Integration of Function	1	2	3	4	5

C. From the experience your organization has had with MRP systems, rate the following benefits of MRP systems using the following scale:

1 = Poor **2 = Fair**

3 or 4 = Good **5 = Excellent**

		Poor	Fair	Good	Excellent

1	Improvement in meeting of delivery date	1	2	3	4	5
2	Improved production scheduling	1	2	3	4	5
3	Better ability to meet volume/product changes	1	2	3	4	5
4	Improvement in the estimation of cost	1	2	3	4	5
5	Improvement in productivity	1	2	3	4	5
6	Decrease the inventory costs	1	2	3	4	5
7	Shorten delivery lead time	1	2	3	4	5
8	Increase the value of throughput	1	2	3	4	5
9	Reduction in safety stocks	1	2	3	4	5
10	Improved competitive position	1	2	3	4	5
11	Other	1	2	3	4	5

D. From the experience your organization has had with MRP systems, rate the following *implementation problems* using the following scale:

0 = No Affect, Not Applicable (N/A)

1 = Small Problem

2 or 3 = Moderate Problem

4 = Large Problem

		N/A	**Small**	**Moderate**		**Large**
1	Lack of top management involvement	0	1	2	3	4
2	Lack of software suitability	0	1	2	3	4
3	Lack of vendor support	0	1	2	3	4
4	Lack of knowledge about MRP	0	1	2	3	4
5	Lack of MRP expertise in company	0	1	2	3	4
6	Lack of level of MRP training/education	0	1	2	3	4
7	High initiation cost of MRP system	0	1	2	3	4
8	Communication barrier within organization	0	1	2	3	4
9	Lack of Information technology expert	0	1	2	3	4
10	Other	0	1	2	3	4

Part III

Appendix A1

System Effectiveness and User Satisfaction

A. What is the accuracy of the following types of data in your MRP system?

	Applicable	Worst (0-50%)	Poor (50-80%)	Fair (81-90%)	Good (91-95%)	Excellent (96-100%)
1	Inventory Records	1	2	3	4	5
2	BOM Records	1	2	3	4	5
3	Market Forecast	1	2	3	4	5
4	MPS	1	2	3	4	5
5	Production Lead Time	1	2	3	4	5
6	Vendor Lead Time	1	2	3	4	5
7	Shop Floor Control	1	2	3	4	5
8	Capacity Planning	1	2	3	4	5

B. What is the level of user satisfaction regarding performance of your MRP system?
Please answer the following group of questions by circling the number at the right of each question, using the scale below:

1 = Strongly Agree (SA) **4 = Disagree Somewhat (DS)**

2 = Agree Somewhat (AS) **5 = Strongly Disagree (SD)**

3 = Average (A)

		SA	AS	A	DS	SD
1	MRP system relevant to Decision Making	1	2	3	4	5
2	How easy to collect information from the MRP	1	2	3	4	5
3	High reliability of your MRP Software	1	2	3	4	5
4	More effective job with MRP	1	2	3	4	5
5	Improves job performance with MRP	1	2	3	4	5
6	Improves performance of the organization with MRP	1	2	3	4	5

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7	Your MRP software is not dependable	1	2	3	4	5
8	Improves control over inventory	1	2	3	4	5
9	Satisfaction of your customer	1	2	3	4	5
10	Your workability helped by MRP	1	2	3	4	5
11	Information to take better decisions	1	2	3	4	5
12	Overall satisfaction with MRP system	1	2	3	4	5

Thank you for your help

Manager Name: _____

Designation: _____

Contact: _____

Email Address: _____

Company Address: _____

_____

_____

Appendix A2

List of Manufacturing Companies

1) SML-ISUZU Limited
2) Faviely Transport India Limited
3) International Tractors Limited
4) Gates India Private Limited
5) Claas India Private Limited
6) Honda Car India Limited
7) Emmbros Auto Component Limited
8) Metlonics Industries Private Limited
9) Eastman Industries Limited
10) JCT Limited
11) Max India Limited
12) Coatec India Private Limited
13) DSM Sinochem Pharmaceuticals Limited
14) DCM Engineering Limited
15) Vardhman Spinning & General Mills
16) Shiva Texfabs Limited
17) Kartar Agro Industries Private Limited
18) Punjab Tractors Limited
19) Swaraj Automotives Limited
20) Micro Turner Private Limited
21) Indo Farm Equipment Limited
22) Tokai Imperial Rubber India Private Limited
23) Spray Engineering Devices Limited
24) Bhushan Power & Steel Limited
25) PAPP Automotive Limited
26) Schneider Electric India Private Limited
27) Suvidha Engineers India Private Limited
28) Luminous Power Technologies Private Limited
29) NHK Spring India Limited

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30) Indo Autotech Limited
31) Durha Industry Private Limited
32) Yamada Automation Private Limited
33) Indopol Food Processing Machinery Private. Ltd.
34) Atop Products Private Limited
35) Shivai Enterprises Private Limited
36) APS Auto Limited
37) Agri King Tractors & Equipment Private. Ltd
38) Gutsy India Private Limited
39) Amtek India Limited
40) Supermax Industries Limited

Appendix A3

Chronbach's Alpha Results

```
RELIABILITY

  /VARIABLES=c1 c2 c3 c4 c5 c6 c7 c8 c9 c10 c11 c12 c13 c14 c15 a1 a2 a3 a4
            a5 a6 a7 a8 p1 p2 p3 p4 p5 p6 p7 p8 p9 p10 p11 p12 b1 b2 b3 b4
            b5 b6 b7 b8 b9 b10 i1 i2 i3 i4 i5 i6 i7 i8 i9
  /SCALE ('ALL VARIABLES') ALL
  /MODEL=ALPHA
  /STATISTICS=DESCRIPTIVE SCALE CORR
  /SUMMARY=MEANS.
```

Reliability

```
[DataSet1] C:\Users\raman\Desktop\crombac.sav
```

Scale: ALL VARIABLES

Case Processing Summary

		N	%
Cases	Valid	30	76.9
	Excluded[a]	9	23.1
	Total	39	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.900	.906	54

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Item Statistics

	Mean	Std. Deviation	N
c1	4.63	.490	30
c2	4.67	.479	30
c3	4.47	.507	30
c4	4.23	.626	30
c5	4.07	.640	30
c6	4.03	.556	30
c7	3.90	.607	30
c8	3.40	.724	30
c9	3.53	.730	30
c10	3.33	.758	30
c11	4.20	.610	30
c12	3.53	.629	30
c13	4.23	.679	30
c14	3.83	.747	30
c15	3.70	.466	30
a1	4.63	.490	30
a2	4.67	.479	30
a3	3.83	.699	30
a4	4.33	.547	30
a5	3.90	.548	30
a6	3.37	.615	30
a7	3.30	.750	30
a8	3.43	.568	30
p1	4.53	.507	30
p2	4.50	.509	30
p3	4.57	.504	30
p4	4.47	.507	30
p5	4.37	.669	30
p6	4.53	.571	30
p7	4.47	.507	30
p8	4.37	.490	30

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p9	4.40	.563	30
p10	4.27	.521	30
p11	4.27	.583	30
p12	4.30	.535	30
b1	4.70	.466	30
b2	4.20	.664	30
b3	3.97	.669	30
b4	4.13	.571	30
b5	4.17	.531	30
b6	4.13	.434	30
b7	3.93	.583	30
b8	4.00	.587	30
b9	4.23	.728	30
b10	3.93	.583	30
i1	3.73	.521	30
i2	3.87	.730	30
i3	3.87	.434	30
i4	3.70	.596	30
i5	3.67	.547	30
i6	3.67	.479	30
i7	3.37	.490	30
i8	3.90	.548	30
i9	3.63	.490	30

Summary Item Statistics

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Item Means	4.057	3.300	4.700	1.400	1.424	.160	54

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
219.07	157.375	12.545	54