ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

A Framework for a Decision Support Model for Supply Chain Management in a Small Scale Manufacturing Industry

Valasani Arundhati
M.Tech Student,
Dept of Mechanical Engineering,
JNTUA, Ananthaur.

Prof.Dr.B.Durgaprasad, M.E, Ph.D
Professor,
Dept of Mechanical Engineering,
JNTUA, Ananthaur.

Abstract:

Supply Chain Management is a major concern in all industries as Companies realize the importance of creating an integrated relationship with their suppliers and customers. Streamlining the supply chain has become an effective way of improving competitiveness by reducing uncertainty & improving service. One aspect of successfully managing the supply chain requires that Industries understand their logical strategies & practices. Materials are one of the areas that require very special attention while creating a project's master plan as well as during the daily manufacturing & fabrication process. The absence of materials when needed is one of the main causes of loss of productivity at a jobsite. Inefficient materials management can lead to an increase of 50% in work hours, financial losses and bad name to any industry. As a result, a detailed plan for the materials management of each Manufacturing industry is necessary.

A lot of material management solutions are available for big Manufacturing and fabrication industries; however same is not in case with small scale manufacturing and fabrication industry. Materials management problems have a great impact on general industries, but are more critical for small scale manufacturing & fabrication industry. Supply chain management concepts are applied to develop an integrated, effective system of decision framework for materials-management decisions of a small scale manufacturing & fabrication industry.

The framework developed is valuable in two fundamental ways. First, the framework identifies and describes all phases of materials management for an integrated, holistic view of all factors that affect the total cost of materials and material shortages.

The research created detailed mappings of the essential decisions, decision nodes that are required to support supply-chain activities of industry throughout a project life cycle. Second, the framework differentiates those steps in the materials management process that are straightforward applications of methods from those steps that are decisions. This phase of the research developed a structured systems design of distributed, integrated decision support systems for materials management of the industry. The research derives the optimal integration of people, decision processes, decision support systems and data that are required to support efficient and effective systems for acquisition, procurement, transport, storage and allocation of material in the small scale manufacturing and fabrication industry.Triveni Engineering &Industries Ltd, Bangalore are the client of SSA Industries, Requirement of Client are Nozzles for Boilers – material –SS301&SS304. Alternative are SS302&SS306.

1.INTRODUCTION

Supply chain management may be defined in terms of the managerial decisions that create and regulate the supply chain. Among these decisions are sourcing, forecasting, batch sizing, safety-stock setting, order timing and locating stock. During recent years, supply chain management (SCM) has emerged as a critically important aspect of the business viability of a small scale Industry.

Competitive advantage can be achieved through:

- Reducing or avoiding material shortages that delay projects and degrade the reputation of the industry.
- Reducing or avoiding excess material stock that is costly to store, transport and finance.

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

Although material management problems highly impact Big Players, they are more critical for specialty small scale industries including mechanical industries. Most mechanical fabrication & manufacturing Companies are small in size. Therefore, they have to efficiently manage their materials to lower cost in order to remain in business. Because of the risk that Mechanical contractors undertake in every construction job, they are constantly tracking their resources particularly their material. This tracking is useful to avoid losing material due to theft, misplacement or damage, to improve productivity, and to compare actual resource and labor usage against planned values. In addition, tracking allows materials for identifying when materials need to be ordered, based on actual usage of materials on site and progress of the work. Other challenges encountered include dealing with suppliers, on site materials handling, storage, and handling of material surplus.

1.2 PROBLEM STATEMENT:

Current materials management practices in the small scale industries are performed on a fragmented basis with unstructured communication and no clearly established responsibilities between the parties involved. This fragmentation creates gaps in information flow, which affects the decision making process and lead to delays in material ordering and receiving, among other problems. The material manager needs to realize that decisions taken at one stage in the process will certainly impact other activities and processes in the supply chain, a problem not realized due to this fragmentation.

The initial phase of this research investigated current material management practices in the Small Scale Manufacturing industry. The investigation considered the entire range of activities necessary for procuring the needed material, starting with the estimating process and ending with site delivery, distribution and storage logistics.Research outcomes included documenting the problem bottlenecks in the supply chain as well as identifying and classifying the various criteria that influence the decision process for procuring material. A comprehensive flowchart describing the material supply chain process was developed based on various discussions and interviews with several National Mechanical Contracting Association (NMCA) members.

The flowchart considered many decision alternatives including material type, supplier availability and relationship, procurement options and incentives, quantities needed, delivery dates, storage alternatives, and project schedules. The flowchart was developed through several interviews with office and site personnel of various mechanical contracting companies in the Degrading & Claque Industrial area. Flowcharts prepared for the companies, narratives and questionnaires used during the interviews and site visits. From the information acquired from these interviews, five distinct phases that comprise the process were identified:

1-Bidding Phase,
2-Sourcing Phase,
3-Materials Procurement,
4-Construction Phase,
5-Post-Construction Phase.

The flowchart identifies several decision nodes, in each phase, requiring alternative management actions to be taken. Decision nodes identified include supplier selection, material procurement (where to buy from, how much to buy, when to buy) and delivery options, and storage alternatives. Actions to be taken at every decision node are complex because of their dependency on many other factors that could represent constraints or alternatives distribution. Many challenges are encountered during the various phases of material management process including challenges with bid procurement, material procurement, material storage & distribution. Examples of challenges include:

1.3 OBJECTIVE

The objective of this research is to improve the decision making process for supply chain management in the Small scale Manufacturing industry. This objective can be broken down into the following components:

• Identify bottlenecks in the current decision making process for material management for the industry

• Develop responses to the bottlenecks in currents practices. This will require identifying in greater detail the decision nodes in the material supply chain for the firm.

• Apply knowledge-management and decision-modelling concepts to design an integrated, effective system of decision-support tools for the material supply chain of the industry.

• Identify all of the knowledge elements that constitute the alternatives, factors or parameters and performance measures for each decision node.

• Develop decision making flowcharts that describe the material management decision making process for the decision nodes considered in the study.

1.7 SCOPE AND LIMITATIONS

The proposed research will be limited to the following assumptions,
- The research only addresses or considers the small mechanical manufacturing & contracting industry.
- The research will not study the decision making process for the entire material management process as it will focus in the decision making process for material procurement (purchasing, delivery options and storage alternatives).
- The research will be focused on small size mechanical industry that specializes in commercial construction & erection.
- The research will intend to design a blueprint for a knowledge management system for supply chain and not the development of a computer application.

2.MATERIAL MANAGEMENT

2.1 INTRODUCTION:

Materials constitute a major cost component for any Industry. The total cost of installed materials (or Value of Materials) may be 60% or more of the total cost (Stukhart 2007, Bernold and Treseler 1991), even though the factory cost may be a minor part of the total, probably less than 20-30%. This is because the manufactured item must be stored, transported, and restored before it is put in place or "consumed" at the site. The total cost of materials will include, in addition to the manufacturer selling cost, the cost of procurement (cost of placing processing and paying the material, physical distribution, the distributor's cost, and the transportation of materials), and the site-handling costs (cost of receiving, storage, issuing, and disposal).

The efficient procurement and handling of material represent a key role in the successful completion of the work. It is important for the contractor to consider that there may be significant difference in the date that the material was requested or date when the purchase order was made and the time at which the material will be delivered. These delays can occur if the contractor needs a large quantity of material that the supplier is not able to produce at that time or by any other factors beyond his control. The contractor should always consider procurement of materials is a potential cause for delay (Willis, 2008). Poor planning and control of materials, lack of materials when needed, poor identification of materials, re-handling and inadequate storage cause losses in labor productivity and overall delays that can indirectly increase total project costs. Effective management of materials can reduce these costs and contribute significantly to the success of the project.

2.2 Importance of Materials for a Project

Problems related to managing the flow of materials can be found in every organization. The efficient management of materials plays a key role in the successful completion of a project. The control of materials is a very important and vital subject for every company and should be handled effectively for the successful completion of a project. Materials account for a big part of products and project costs. The cost represented by materials fluctuates and may comprise between 20-50% of the total project cost and sometimes more. Some studies concluded that materials account for around 50-60% of the project cost (Stukhart, 2007 and Bernold and Treseler, 1991).

Materials are critical in the operations in every industry since unavailability of materials can stop production. In addition, unavailability of materials when needed can affect productivity, cause delays and possible suspension of activities until the required material is available. It is important for a company to consider that even for standard materials, there may be significant difference in the date that the material was requested or date when the purchase order was made, and the time in which the material will be delivered. These delays can occur if the quantities needed are large and the supplier is not able to produce those materials at that time or by any other factors beyond the control of the company.

The company should always consider that purchase of materials is a potential cause for delay (Willis, 2008). Unavailability of materials is not the only aspect that can cause problems. Excessive quantities of materials could also create serious problems to managers. Storage of materials can increase the costs of production and the total cost of any project. When there are limited areas available for storage, the managers have to find other alternatives to store the materials until they are needed. Some of these alternatives might require re-handling of materials, which will increase the costs associated with them. Provisions should be taken to handle and store the materials adequately when they are received. Special attention should be given to the flow of materials once they are procured from suppliers.

It is obvious that materials should be obtained at the lowest cost possible to provide savings to the company (Damodara, 2008). In the late 1970's, construction companies experienced an increase in costs and a decrease in productivity. Owners of these companies thought that these increases in cost were due to inflation and economic problems. Further research concluded that these companies were not using their resources efficiently and that the decrease in productivity was also attributable to poor management (Stukhart, 2007). Material Management has been an issue of concern in the construction industry. 40% of the time lost on site can be attributed to bad management, lack of materials when needed, poor identification of materials and inadequate storage (Baldwin et al, 2004).

The need for an effective materials planning system becomes mandatory. Some companies have increased the efficiency of their activities in order to remain competitive and secure future work. Many other firms have reduced overheads and undertaken productivity improvement strategies. Considerable improvement and cost savings would seem possible through enhanced materials management. Timely availability of materials, systems, and assemblies are vital to successful construction. Materials management functions are often performed on a fragmented basis with minimal communication and no clearly established responsibilities assigned to the owner, engineer or contractor. Better material management practices could increase efficiency in operations and reduce overall cost.

Top management is paying more attention to material management because of material shortages, high interest rates, rising prices of materials, and competition. There is a growing awareness in the construction industry that material management needs to be addressed as a comprehensive integrated management activity.

2.3 What is Material Management?

Different researchers provide different definitions for material management, therefore different definitions can be found in different references. Basically, material management is concerned with the planning, identification, procuring, storage, receiving and distribution of materials. The purpose of material management is to assure that the right materials are in the right place, in the right quantities when needed. The responsibility of one department (i.e. material management department) for the flow of materials from the time the materials are ordered, received, and stored until they are used is the basis of material management.

• Ballot (2006) defines material management as the process of planning, acquiring, storing, moving, and controlling materials to effectively use facilities, personnel, resources and capital.

• Tersine and Campbell (2004) define material management as the process to provide the right materials at the right place at the right time in order to maintain a desired level of production at minimum cost. The purpose of material management is to control the flow of materials effectively.

• Beekman-Love (1998) states that a material management structure should be organized in such a way that it allows for integral planning and coordination of the flow of materials, in order to use the resources in an optimal way and to minimize costs.
• Chandler (2001) states that material management systems should be implemented to plan, order, check deliveries, warehousing, controlling the use of materials, and paying for materials. He adds that these activities should be interrelated.

• Ammer, Dean (1991) defines material management as the process in which a company acquires the materials that it needs to achieve their objectives.

This process usually begins with the requisition of materials from the supplier until the material is used or incorporated into a product.

• Bailey and Farmer (2009) define material management as a concept concerned with the management of materials until the materials have been used and converted into the final product. Activities include cooperation with designers, purchasing, receiving, storage, quality control, inventory control, and material control.

• Gossom (1999) indicates that a material management system should have standard procedures for planning, expediting, transportation, receipt, and storage to ensure and efficient system for materials control.

• Cavinato (1994) states that material management involves the control of the flow of goods in a firm. It is the combination of purchasing with production, distribution, marketing and finance.

• Arnold (2001) states that material management is a function responsible for planning and controlling of materials flow. He adds that a materials manager should maximize the use of resources of the company.

• Stukhart (2007) defines material management as the activities involved to plan, control, purchase, expedite, transport, storage, and issue in order to achieve an efficient flow of materials and that the required materials are bought in the required quantities, at the required time, with the required quality and at an acceptable price.

• Plemmons et al. (1995) define material management as the plan and control of all activities to ensure the correct quality and quantity of materials and equipment to be installed are specified in timely manner, obtained at reasonable cost and are available when needed.

• Dobler and Burt (2009) state that material management is designed to improve the activities related to the flow of materials. They add that material management should coordinate purchasing, inventory control, receiving, warehousing, materials handling, planning, and transportation. The role that a materials manager plays in an organization is strictly economical since the materials manager should keep the total cost of materials as low as possible. The person in charge of handling materials should keep in mind the goals of the company and insure that the company is not paying extra money for materials. The goal of every company is to make a profit. This is the basis for company's survival, costs should not exceed income, but keeping in mind customer's expectations.

The typical tasks associated with a material management system are
{(Tersine and Campbell (2004), Ammer (1999), Stukhart (2007)}:

• Procurement and purchasing
• Expediting
• Materials planning
• Materials handling
• Distribution
• Cost control
• Inventory management / Receiving/ Warehousing
• Transportation

Purchasing and procurement deals with the acquisition of materials to be used in the operations. The primary function of purchasing and procurement is to get the materials at the lowest cost possible, but keeping in mind quality requirements. Expediting is the continuous monitoring of suppliers to ensure on time deliveries of materials purchased. The purpose of materials planning is to procure the materials for the dates when they are needed, storage facilities, and handling requirements.

The primary function of materials handling is to manage the flow of materials in the organization. The manager has to assure that the costs associated with handling materials are kept to a minimum. In cost control, the manager has to insure that the costs to buy materials are kept to a minimum. In other words, the manager has to insure that he is buying the products at the lowest possible price.

The inventory management deals with the availability of materials.Transportation involves using the safest most economical means to transport the materials to the site where they are needed. Following fig depicts the different phases of the material management process including the relationship and interdependency between the different activities in each phase.

ISSN No: 2348-4845
International Journal & Magazine of Engineering,
Technology, Management and Research
A Peer Reviewed Open Access International Journal

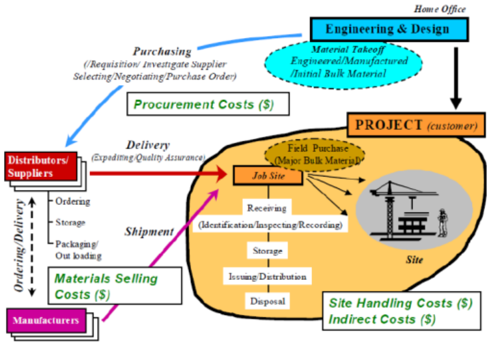

Fig:2.1. Typical Material Management

As a result, a successful implementation of a material management system needs to consider the different decisions made at various phases of the supply chain.

3. MATERIAL MANAGEMENT

3.1 MANAGEMENT FOR INDUSTRY

A successful construction company meets the customer's needs effectively and in the process makes a profit. Owners are looking for construction companies that can deliver the project at low cost, with the required standards of quality and in a reasonable time. Similar to other industries, the cost of materials in construction accounts for a considerable part of the project cost. Some studies concluded that materials account for around 50- 60% of the project cost {(Stukhart, 2007), Bernold and Treseler (1991)}. It is obvious that materials should be obtained at the lowest cost possible to provide savings to the company (Damodara,2008). In the late 1970's, construction companies experienced an increase in costs and a decrease in productivity. Owners of these companies thought that these increases in cost were due to inflation and economy problems.

Further research concluded that these companies were not using their resources efficiently and that the decrease in productivity was also attributable to poor management (Stukhart et al.1995). Materials management has been an issue of concern in the construction industry. In addition, 40% of the time lost on site can be attributed to bad management, lack of materials when needed, poor identification of materials and inadequate storage (Baldwin et al. 1994).In any construction project the cost of materials can exceed half the cost of construction.

Many researchers have indicated that in a typical industrial facility 50% to 60% of the total cost is for equipment and materials. The proportion in terms of cost of materials has increased more than labor. Bernold and Treseler (1991) stated that cost of materials escalated twice the cost of labor between 1975 and 1980 and 60% of costs of projects were materials and equipment. They also pointed out that the construction industry spends 0.15% in material management systems.

Some studies have shown that an effective material management system can produce 6% improvement in labor productivity and a computerized system can produce additional 4-6% in savings (Stukhart, 2007). There is a growing awareness in the industrial construction industry that materials management needs to be addressed as a comprehensive integrated management activity. Researchers have acknowledged the importance of materials and the impact that these have in the total project cost, plans and operations. This chapter presents an overview of some of the aspects considered in previous and ongoing research in materials management in small scale manufacturing & construction industry.

3.2. MATERIALS MANAGEMENT AND PROJECT MANAGEMENT

Different authors define the concept of materials management in different ways. However, all the researchers point out that materials management is extremely important for a successful project completion. The basic idea behind materials management is that the materials and/or equipment needed, in the quantities needed, meeting the standards of quality specified, are obtained at a reasonable cost and are available when needed on the construction site. The process of materials management should integrate purchasing, expediting, and inventory control.

The benefits of implementing a materials management system have not been recognized by senior management. A well managed materials management system can contribute to the cost effectiveness of a project. In order for a company to implement a successful materials management system, top management support is required. Damodara (2008) identifies seven stages in which the project management team must ensure a materials

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

management focus. These seven stages are: Planning, Preliminary design, Final design, Procurement, Vendor control, Construction, and Closeout. A description on the tasks of managers in each stage follows. In the Planning stage the project management team develops the materials management team and the functional relationships among members of the team in order to develop a team that is united and working towards the same goal. In this stage the materials management focus should be defined and adapted to the mission, which is to complete the project at the lowest cost possible. In the Preliminary design phase the materials to be used in the project are defined. This definition of materials should minimize the cost of the design, but assuring that the materials and equipment selected meet the owner's requirements. Once materials are defined, the project team starts to inquire suppliers for information about the materials needed and possible delivery dates.

In the Final design stage the team should develop specifications for equipment and materials to be used in order to request and obtain competitive proposals. In the Procurement stage the team should consider to use standard materials that meet the specifications and requirements. In addition, the submittals should be kept to minimum levels. This might ensure more reliable delivery dates. The team should not buy materials advance. Buying materials earlier than needed may require re-handling which will increase costs. When dealing with vendors, the team should review the drawings submitted by the vendor without delay, this will eliminate delays due to necessary changes. In addition, the team has to put in place a plan to expedite the orders so that the materials are delivered according to the schedule.

In the Construction stage the team should account for all materials and equipment received. This practice will be useful to avoid duplicated orders. These materials and equipment should be available when needed on site to avoid delays. In the Closeout stage the project team should dispose any surplus materials. The disposal process can be simplified if the team uses standard materials. The team can identify any pitfalls in the materials management process and identify areas of improvement. The success of a project depends greatly in the effective implementation of materials management system.

4.SMALL SCALE MANUFACTRING INDUSTRY

4.1 INTRODUCTION TO MANUFACTURING

Manufacturing is the backbone of any industrialized nation. Manufacturing and technical staff in industry must know the various manufacturing processes, materials being processed, tools and equipments for manufacturing different components or products with optimal process plan using proper precautions and specified safety rules to avoid accidents. Beside above, all kinds of the future engineers must know the basic requirements of workshop activities in term of man, machine, material, methods, money and other infrastructure facilities needed to be positioned properly for optimal shop layouts or plant layout and other support services effectively adjusted or located in the industry or plant within a well planned manufacturing organization.

4.2 SCOPE OF STUDY

Today's competitive manufacturing era of high industrial development and research, is being called the age of mechanization, automation and computer integrated manufacturing. Due to new researches in the manufacturing field, the advancement has come to this extent that every different aspect of this technology has become a full-fledged fundamental and advanced study in itself. This has led to introduction of optimized design and manufacturing of new products. New developments in manufacturing areas are deciding to transfer more skill to the machines for considerably reduction of manual labor.

The scope of the subject of workshop technology and manufacturing practices is a extremely wide as it specifies the need of greater care for man, machine, material and other equipments involving higher initial investment by using proper safety rule and precautions. The through and deep knowledge in the course of study of this important subject is therefore becoming essential for all kinds of engineers to have sound foundation in their profession. Therefore the course of study of this subject provides a good theoretical background and a sound practical knowledge to the engineering students and workshop staff. One should also be aware of the following terms for better understanding of the scope of the study.

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

4.3 MANUFACTURING ENGINEERING

Manufacturing is derived from the Latin word manufactus, means made by hand. In modern context it involves making products from raw material by using various processes, by making use of hand tools, machinery or even computers. It is therefore a study of the processes required to make parts and to assemble them in machines. The study of manufacturing reveals those parameters which can be most efficiently being influenced to increase production and raise its accuracy.

Advance manufacturing engineering involves the following concepts—
1. Process planning.
2. Process sheets.
3. Route sheets.
4. Tooling.
5. Cutting tools, machine tools (traditional, numerical control (NC), and computerized numerical control (CNC).
6. Jigs and Fixtures.
7. Dies and Moulds.
8. Manufacturing Information Generation.
9. CNC part programs.
10. Robot programmers.
11. Flexible Manufacturing Systems (FMS), Group Technology (GT) and Computer integrated manufacturing (CIM).

PROCESS PLANNING

Process planning consists of selection of means of production (machine-tools, cutting tools, presses, jigs, fixtures, measuring tools etc.), establishing the efficient sequence of operation, determination of changes in form, dimension or finish of the machine tools in addition to the specification of the actions of the operator. It includes the calculation of the machining time, as well as the required skill of the operator. It also establishes an efficient sequence of manufacturing steps for minimizing material handling which ensures that the work will be done at the minimum cost and at maximum productivity.

PROCESS SHEETS:

Process sheets consist of the every detail about process of the WORK PIECE from starting stage to ending stage. It helps to operator how to operate the machine according to requirements.

ROUTE SHEET /JOB CARD:

Route sheet or Job card contains the information about work piece, its batch number and how many parts required manufacturing at one batch. Information detailing the method of manufacture of a particular item. It includes the operations to be performed, their sequence, the various work centres involved, and the standards for setup and run. In some companies, the routing also includes information on tooling, operator skill levels, inspection operations and testing requirements, and so on. Sync:

- bill of operations,
- instruction sheet,
- manufacturing data sheet,
- operation chart,
- operation list,
- operation sheet,
- bill of labor,
- bill of resources.

In information systems, the process of defining the path a message will take from one computer to another computer.

TOOLING:

Working or manufacturing aids such as cutting tools, dies, fixtures, gauges, jigs, molds, and patterns of a specialized nature which (unless substantially altered or modified) are limited in use to a specific production line or the performance of aspecific contract or job. The maintains of the tooling department is high risky job because the tools are not in working conduction, the total manufacturing process get slow done.
It effects the total companies manufacturing rate.

Fig 4.1 shows different types of Cutting tools, machine tools (traditional, numerical control (NC), and computerized numerical control (CNC)

These traditional tools are very useful to increase the star tinting manufacturing process, how means by using this tools only we can cut the raw material into required shapes, and required finishing operations. This process gives the good starting to finish the remaining manufacturing process.

Jigs and Fixtures

The successful running of any mass production depends upon the interchangeability to facilitate easy assembly and reduction of unit cost. Mass production methods demand a fast and easy method of positioning work for accurate operations on it. Jigs and fixtures are production tools used to accurately manufacture duplicate and interchangeable parts. Jigs and fixtures are specially designed so that large numbers of components can be machined or assembled identically, and to ensure interchangeability of components. It is a work holding device that holds, supports and locates the work piece and guides the cutting tool for a specific operation. Jigs are usually fitted with hardened steel bushings for guiding or other cutting tools. A jig is a type of tool used to control the location and/or motion of another tool. A jig's primary purpose is to provide repeatability, accuracy, and interchangeability in the manufacturing of products. A device that does both functions (holding the work and guiding a tool) is called a jig. An example of a jig is when a key is duplicated, the original is used as a jig so the new key can have the same path as the old one.

4.4 Manufacturing Information Generation

A new methodology is introduced for the automatic generation of manufacturing information. Intelligent CAD has an ability not only in assisting designer's design process, but also in providing essential information with the activities of manufacturing planning, which can greatly contribute to the realization of integration of CAD and CAM. The paper shows that the manufacturing information can be derived from the designer's intention described in the functional data and geometrical one, both of which are preserved in the result of design in intelligent CAD.

In this, first we discuss the role of intelligent CAD in manufacturing, and propose a method to represent a design object for expressing the designer's intention fully, and describe about the generation of manufacturing information given as in the form of intermediate representation and the application of this representation to the tasks in process planning.

Fig: 4.3. Shows a CNC Machine

CNC part programs

Numerical control (NC) is the automation of machine tools that are operated by precisely programmed commands encoded on a storage medium, as opposed to controlled manually via hand wheels or levers, or mechanically automated via cams alone. Most NC today is computer numerical control (CNC), in which in modern CNC systems, end-to-end component design is highly automated using computer-aided design (CAD) and computer-aided manufacturing

(CAM) programs.

The programs produce a computer file that is interpreted to extract the commands needed to operate a particular machine via a post processor, and then loaded into the CNC machines for production. Since any particular component might require the use of a number of different tools – drills, saws, etc., modern machines often combine multiple tools into a single "cell". In other installations, a number of different machines are used with an external controller and human or robotic operators that move the component from machine to machine. In either case, the series of steps needed to produce any part is highly automated and produces a part that closely matches the original CAD design.

5. FRAMEWORK FOR A DECSION SUPPORT

5.1 CHALLENGES -- DECISION MODELING

There are a number of managerial decisions that create and regulate the supply chain and are embedded in the five-phase process for materials management that is described in the previous sections. In those junctures or nodes in the materials- management process that constitute decisions are identified. Table 5.1 offers a consolidated list of these decisions and the elements of each decision in terms of alternatives, parameters, and performance measures.

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

Table: 5.1 Bidding Phase Decision

Decision	Alternatives	Parameters	Performance Measures
What is the EC's bid price?	1 Contract bid price 2 Reject bid request	1.Project specifications 2.Project schedule	1.Expected contract profit 2.Financial risk

During the Bidding Phase various decisions need to be made regarding bidding and estimating the job. The first decision faced by the contract price to enter as a bid. The quantity takeoff and estimate need to be completed in order to prepare and submit a bid package to the owner. These data must be evaluated in light of the firm's commitments on existing contracts as well as the contractor's required profit margin and tolerance of financial risk. The tradeoff presented to the firm by this decision and the complex influences of numerous contract parameters makes the decision of how much to bid an overwhelming task without the aid of the quantitative analysis offered by a decision model.

DECISION MODELING APPROACH

Decision analysis can be defined as a methodical approach to decision making that allows managers to handle problems where different alternatives and/or a certain degree of uncertainty are involved. Decision analysis overlaps operations research and statistics that has the purpose to model and analyzing decisions made by decision makers. The objective purpose of decision analysis is to assist decision makers in making better decisions. Options are essential for decision analysis, because if only one option is available, there is no choice to make, thus no decision Cooke and Slack,(1984). Clemen (1996) argues that the steps in decision analysis are the following:-

Identification of the decision and objectives, identification of alternatives, modeling the problem structure, choosing the better alternative, sensitivity analysis, if further analysis is not needed, then implement the chosen idea. He states that the decision analysis process is iterative and what-if scenarios should be considered. Decision making is the process of making a selective judgment when presented with different alternatives consisting of several decision variables, and often defining a course of action. Decision making studies the identification and selection of alternatives based on the values and preferences of the decision maker. When a decision is made, it is implied that there are different alternative choices that are considered, and the decision maker wants to choose the one that best fits with his goals and objectives (Harris, 2008). Oglesby et al. (1989) and Heller (1998) state that decision making involves three different steps: identification of the decision to be made, seeking out feasible alternatives, and choosing the most suitable alternative.

Models are representations, with assumptions, of our interpretation of reality and not reality itself. This representation should include the relevant aspects of the process being modeled. Models therefore illustrate simplifications of more complex real situations and/or processes. Decision modeling attempts to develop a model of the decision process used to make important decisions. A decision model is a framework that assists a decision maker in estimating the outcomes of different alternatives and quantifying the tradeoffs inherent in choosing one alternative over another. This modeling approach presumes that a number of different factors are considered when comparing various alternatives. In addition, in such type of analysis, some of the factors could have more impact than others.

The decision maker weighs the effects of each parameter on the different alternatives. Based on the judging of the importance of the effect of the parameters, the decision maker chooses the "best" alternative (The Futures Group, 1994).Decision models are ever-present in the materials management processes of industries other than small scale segment and have proven their worth in improving productivity and profitability.

Fundamentally, a decision model describes quantitatively the cause-effect relationship between two sets of causative factors and the set of evaluative measures that the decision maker uses in order to judge the desirability of each alternative. The causative factors are divided into two sets. The controllable factors are those that constitute the alternatives or decision variables. The un- controllable factors are called parameters and must be measured, estimated or forecasted.

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

The evaluative measures are called performance measures because they quantify the "performance" of each decision alternative.

5.3 Framework for a Decision Support System for Supply Chain Management

As discussed above, materials management problems, highly impact small scale industry, but are more critical for specialty industries including small scale mechanical industries The mechanical industry needs to establish an effective materials management system to minimize problems that might arise if the activities related to materials management are not handled properly. Among these problems, the following are encountered: material shortages, misplacements, loss, and theft, which might result in increases in crew idle times, loss of productivity and delay of activities. The industry should implement an efficient material management system due to the fact that in most of the cases they are asked to squeeze their bids in order to keep the costs of project under budget. In such a case, failure to effectively manage materials could result in decrease in profit or even a monetary loss.

6. SYSTEM FOR SMALL SCALE INDUSTRY

6.1 DEVELOPMENT OF SPARCS

The performance of the material-procurement decisions is heavily dependent on the combination of the different alternatives associated with every phase of the materials management process and the factors or parameters that influence the selection among the different alternatives for each particular decision. These parameters need to be extracted on a regular basis as decisions related to material management are ever present in a construction project. The identification of parameters is a task that requires more attention, since parameters related to different areas, such as schedule, suppliers, among others, need to be considered.

These parameters can be acquired from different sources such as historical databases, the internet, and suppliers, among others.The identification and extraction process for the parameters could be tedious and time consuming because the decision maker could be extracting the information from unstructured records that contain vast amounts of data.

In addition, important parameters that relate to different categories such as schedule, storage, cost, among others, need to be extracted and sorted. This chapter describes a framework/structured approach developed for parameter classification.

6.2 SPARCS

Currently, there is no structured model to categorize the parameters that need to be considered on the supply chain decision making process particularly for small scale industry. The small scale industry needs a structured database design that can allow decision makers to review and categorize these parameters. This categorization could facilitate the storage and classification of the parameter information for future extraction and use.

As part of this research, a structured approach was defined for parameter classification only. For a more complete system design and model specification, a similar approach needs to be developed for alternatives and performance measures. This development could be the basis for future research.

Based on the information gathered through interviews with the industry personnel and through extensive literature reviews, a system for classifying parameters for material supply chain was developed. SPARCS, an acronym for Supply-Chain PARameter Classification System, is a classification structure for supply chain parameters.

The development of SPARCS begins with a hierarchical framework. This approach conforms to generally accepted methods of structured systems development. SPARCS will be the basis for future development of a relational database to share and organize parameter information.

In addition, the development of SPARCS could help industry in understanding how some of the particular database applications work. For example, SPARCS could give the firm an idea of how an Enterprise resource Planning (ERP) system was set up and the data that could be part of that system.

In future research efforts, this hierarchical framework could be developed into a relational database design.

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

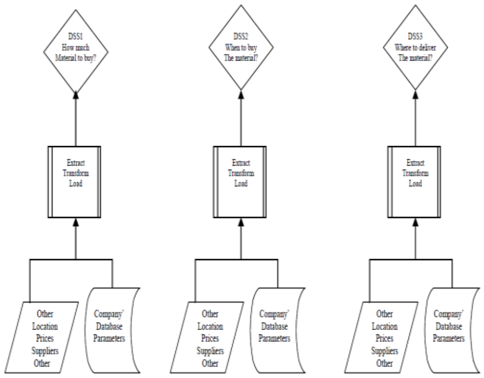

Figure 6.1 : Description of Structure of the Decision Support Systems

Figure 6.2 also depicts the activities that SPARCS addresses in the database development activities. SPARCS covers the first two activities and a very small part of the third activity. The information requirements for the application to be developed are defined, the contents of the overall database of parameters are described within SPARCS, the overall data needs for the material supply chain process are defined and detailed models that identify the data needed for the decision support system are identified.

There are several points that need to be addressed with respect to the development of SPARCS and the model:

1. Decision models are never perfect and are always being updated and enhanced. The hierarchical definition of SPARCS allows updating the parameter classification and structure of the system easily.

2. The data requirements of a decision usually change when the decision model is changed. SPARCS allows extracting data to be used as inputs in accordance with the decision to be analyzed.

3. Database design and data collection take a long time to complete. The database development process was presented in Figure 8.2. 4. The facts mentioned in points 1 to 3 imply that, in order to have the data available whenever a decision model is changed, the database must be built in

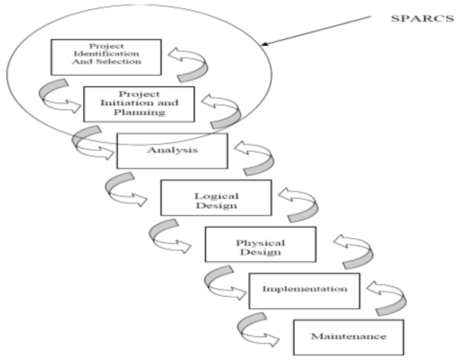

Figure 6.2: Database Development Activities

anticipation of future decision-model developments. In other words, the database must be defined comprehensively with all possible decision models in mind. This is the approach taken in designing and investing in ERP systems and data warehouses.

6.3 DEVELOPMENT OF SPARCS

SPARCS allows classifying and organizing supply chain related parameter information into various categories. This classification can be used as the structure to create the database that will store the parameter information. Parameters needed by the decision maker at any instant can then be extracted from the respective category in the database under the SPARCS classification.The first step in the development of the system was to gather information from interviews with companies and literature review. Once the information was gathered, the decision nodes for material supply chain were identified, and the data needed as inputs (i.e. parameters) and the data generated as outputs (optimal decision variables and performance measures) for all the decision nodes were also identified.

Once the data were identified, categories under which the parameters could be classified were defined for each decision. Examples of the categories include cost, schedule and storage. Categories could also contain sub-categories. For example, the cost category can be subdivided into direct and indirect cost. The parameters are then classified into the respective category and subcategory, if applicable. Each category is comprised of parameters that can directly influence that category. For example, some parameters that are included in the storage category are capacity, cost, etc.

It could be argued that ERP databases that are currently available were designed to address decision support in all aspects of a business enterprise. However, the development of SPARCS presents the following research contributions:

1) It defines the database that would be extracted from ERP databases or other company data sources in order to support specific decisions.

2) It defines data that may have to be extracted from different corporate entities and different corporate databases (general contractor, sub contractor, suppliers, and owner).

3) It assists in the development of small-scale decision support that a sub-contractor may utilize in the absence of an ERP system.

7. CONCLUSIONS

Mechanical material & supply chain management is crucial for the success of any small scale manufacturing & fabrication project and can be the deciding factor between a successful project and a project full of delays and claims. Better material management methods and decision models are needed to improve the industry, thus increasing efficiency and minimizing costs. An effective supply management system is essential for managing efficient material management to avoid material shortages, misplacements, loss, and theft which might result in increases in crew idle times, loss of productivity and delay of activities.

Small scale mechanical industry should implement an mechanical material management system due to the fact that in most of the cases they are asked to squeeze their bids in order to keep the costs of project under budget. In such a case, failures to effectively manage materials could result in decreases in profit or even a loss. The primary goal is to have the material needed, in the amounts needed, with the quality required, and the time that they are needed.

Most mechanical companies have a material management system that serves their needs, although it could be improved. Standardization of the material management system could be a step forward in improving the system and eliminating some of the bottlenecks.The research presented in this document aimed at designing an integrated system of decision-support tools for material procurement for the small scale industry. An integrated approach for material procurement provides better decisions on what to order, how much to order and where to deliver. Future research will be needed to develop a more complete framework integrating other decisions needed in areas such as supplier selection and preliminary material scheduling during the prefabrication phase. A fully integrated approach will better improve communication and minimize gaps in information flow among all the parties and departments involved.

7.2 CONTRIBUTIONS

The main objective of this research was to improve the decision making process for supply chain management in the small scale mechanical manufacturing & contracting industry. The work presented in this document, constitutes a contribution to the body of knowledge. This was accomplished by the identification of bottlenecks in the supply chain management process and the development of a new decision Concept SPARCS for the industry.

The contribution presented in the study is comprised by the following components:

1. The development of structured systems design of distributed, integrated decision support systems for supply chain management for the mechanical Industry.

2. The identification of the current material management practices for the small scale mechanical industry.

3. The identification of decision nodes in the current material management practices for the mechanical industry. More specifically, identifying which are the important questions and aspects related to decision making for material supply chain in the mechanical Manufacturing & contracting industry.

4. The definition of the data, models, decision makers and procedures that make up the knowledge and a mapping of their relationships is another contribution of this study.

5. The development of SPARCS.

6. The design of the framework for material supply chain for the mechanical industry .

7. This research breached some of the barriers to the adaptation of methods and technologies that are emerging in other industries by working with companies from the mechanical contracting industry in the design of the framework for implementing supply-chain practices.

7.3 DIRECTIONS FOR FUTURE RESEARCH

This research established the knowledge and bases that allow re-engineering the current practices for material supply chain management for the mechanical fabrication industry. The research provides a framework for the design of a decision support system to assist the decision maker in the construction phase of the project. The implementation of the framework will allow making better decisions on what material to buy, when to buy, where to deliver, where to store. This section presents research directions and issues that could be the basis for future research efforts.

7.3.1 Expand the Framework to Include Other Phases of the Material Management Process

The framework developed, at part of the research, is limited to addressing the decision models for material ordering and delivery options during the construction phase. The framework could be expanded to consider and include other phases of the construction process such as material estimating and preparation of the material requisition projection, supplier selection and material surplus handling. The consideration of all the phases of the material management system will allow a more integrated and holistic approach to the material related activities in a manufacturing process.

7.3.2Database Design and Development for the Knowledge Elements

The decision nodes identified in this research are considered as independent decision systems, therefore the data required by every decision system was identified independently from the other systems. However, most of the knowledge elements are common data used across the different systems. Future research should combine the results of this research and design a database for all the knowledge elements required for material supply chain. This development should consider the design features of existing software and databases that are used in other industries for supply chain management in order to specify the better adaptation of this information technology to supply chain management for contractors. This design should include the application of standard methods for data definition and the construction of entity-relationship diagrams (ERD). Finally, the decision support systems specified for SCM in the construction industry should be able to integrate with ERP systems, thus allowing the extraction of data for each decision model from the system.