A FRAMEWORK FOR A DECISION SUPPORT MODEL FOR SUPPLY CHAIN MANAGEMENT IN A SMALL SCALE MANUFACTURING INDUSTRY

SUMMARY OF THE THESIS

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SUMMARY

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. Materials constitute a major cost component for any Industry. The total cost of materials (or Value of Materials) may be 60% or more of the total cost of the product/project.

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. The efficient procurement and handling of material represent a key role in the successful completion of the work. Although material management problems highly impact Big Players, they are more critical for specialty small scale industries including electrical industries. Most electrical fabrication & manufacturing Companies are small in size. Usually Electrical Industries comes into play at the end of the project, where there is pressure of cost reduction from the owner and also to speed up and complete the project on time, for which availability of Material in right quantity at proper place in proper time is essential and key element. Therefore, they have to efficiently manage their material procurement process along with timely delivery of raw material to site in order to remain in business. Because of the risk that electrical 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.

A lot of material management solutions are available for big Manufacturing and fabrication industries, however same is not the case with small scale manufacturing sector, Because of inherent characteristics of small scale sector.

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 study investigated current material management practices in the Small Scale Electrical Contracting & Manufacturing industry. The investigation considered the entire range of activities necessary for procuring the materials, 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. After study 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.
Several decision nodes were identified 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. Few Examples of challenges include:

**Bid procurement challenges**- During budget negotiation, the general contractor may be forced to cut costs to satisfy budget limits of owners while still committing to the same scope of work. The electrical job is usually one of the last trades to be procured in a project and in many times is asked by the General Contractor (GC), prior to finalizing the sub-contract, to absorb some of the cost reductions. This puts even more pressure on the electrical industry to complete the scope of work for a lower cost than what was initially budgeted.

**Supplier selection challenges**- The selection of a reputable supplier is critical for ensuring that materials are delivered in the quantities needed and at the dates specified.

**Material purchasing challenges**- Once a supplier is selected, the contractor has to systematically follow up the status of ordered material in order to assure that the material arrives to the job site in the right quantities and dates specified.
Jobsite storage and handling challenges- The majority of the problems faced by electrical contractors with respect to materials management are encountered at the job site and include tracking of material, storage issues, material distribution and re-handling.

The material procurement (ordering and delivery) phase is very critical to the successful execution and completion of any project. The person in charge of procuring materials or the purchasing department, in the case of a large/small scale company, needs to ensure that the correct materials in the correct quantities are ordered. They also need to verify the release dates at which the material is needed and clearly specify those delivery dates as well as the location of delivery to the supplier.

The focus of the procurement decision node includes how much material to buy, when to buy this material, which supplier to choose and where to deliver this material. The decision of how much to buy is very important to assure that material quantities needed are available on time and that there are no material shortages. From the interviews, it was found that most of the electrical contractors buy large amounts of their material very early based on field personnel purchase requests without planning which quantity is needed. This result in additional costs associated with storage fees, damage during storage, and re-handling due to space limitations. Electrical contractors believe that these costs are minor when compared to delays and labor costs if the material is not available when needed.

Material procurement problems greatly affect the construction stage and failure to manage this phase effectively could result in project disruption and possible delays due to late deliveries, stock outs due to small quantities bought, material delivered to the wrong locations, material backordered and
overall costs. The owner has to systematically follow up the status of ordered material to assure that the material arrives to the job site in the quantities and dates specified. Expediting is one control system necessary to assure a timely equipment and materials arrival to achieve a project completion on schedule. Expediting involves monitoring all steps in the procurement cycle, with special focus on those involving the vendor or subcontractor, to assure reliable, economical, on-schedule delivery.

Ensuring that material deliveries occur on a timely basis is a very difficult task. As revisions come through from material takeoff, it is all too easy for this to impact on material deliveries, resulting in them arriving late or in insufficient quantities. The impact of schedule changes can have a similar effect. While material may originally have been ordered in good time, this may no longer be the case. Design changes may result in a reduction in requirements for some material and an increase for others, which will also affect the delivery schedule. These changes can have a considerable impact on cost and evaluating the full impact of the changes is extremely important. Material may not arrive on time, work may have to begin out of sequence, or the fabrication process may be delayed.

Effective planning and communication is required to keep costs to a minimum, to minimize errors in ordering and to increase the probability that the material is on site when needed. Constant communication and clearly specifying, without ambiguities, the material needed could help to minimize errors in ordering.

After identification of bottlenecks in the supply chain management process for materials in small scale Electrical industry, Extensive study was done in developing a new decision framework for the Small Scale Electrical Contracting and 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 models and data that are required to support supply-chain activities of construction contractors 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 electrical contractor.

The research derives the most favorable 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 construction industry.

The development of **SPARCS**, Supply Chain **PARameter Classification System**, is a major contribution of this study. SPARCS is a hierarchical structure for classifying parameters for material supply chain, specifically for the electrical Manufacturing & contracting industry. Up to the development of SPARCS, there was no structured approach to categorize the parameters that need to be considered on the supply chain decision making process for the small scale electrical Industry.

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. The SPARCS hierarchy includes the informations that is related to all the decisions that are considered in this study. In this hierarchy the different categories, subcategories and parameters falling under each nodes are well defined.

SPARCS model is being developed for ‘How much to Buy’, ‘What Material to Buy’, ‘Where to Deliver’, ‘Where to store on Site’, ‘When to deliver’ and for ‘When to Buy’ situation. For Each situation guidelines are being developed so as to enable the small scale manufacturing and contracting industries to optimizes the resources and give them a efficient material management system. The development of SPARCS fills the need for a structured model to categorize the parameters that need to be considered on
the supply chain decision making process for the small scale manufacturing and fabricating industry.

With a well structured decision framework like SPARCS, the small scale industry can surly have greater flexibility in meeting out the various variables, constraints & challenges encountered during any project and have more responsive and efficient material management system with optimum integration of resources resulting in greater profit and increased productivity.

References


