CHAPTER 9

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

9.1 SUMMARY

Throughout the study, material management for the small scale electrical industry has been analyzed and described. This study was done in an effort to improve the current material management practices for the construction industry.

Chapter 1 presented the research objective. This chapter presented a description of the problem statement, the objective of the research, the justification for the research, the methodology for the research work, relevance of this work to the small scale electrical industry and the limitations of this study.

Chapter 2 presented a general introduction to material management in small scale industry. This chapter defined what a material management system is, why is important to have a material management system and the advantages of having it.

Chapter 3 presented the current state of knowledge in material management for industry. This chapter described other research efforts that have been performed in material & supply chain management for construction &
manufacturing industry. These studies were classified into materials management and project management, benefits and costs of a materials management system, role of vendor/supplier and fabricator, models developed and studies of effectiveness of materials management, use of technology for materials management, other research related to materials management, cultural change in fabrication, supply chain management for the small scale manufacturing industry, and knowledge management.

Chapter 4 presented an overview of the electrical contracting & manufacturing industry including services provided by electrical industry, materials purchasing and typical products used by electrical units. In addition, this chapter described the current material management practices in the electrical contracting & manufacturing industry, the different phases: bidding, sourcing, material procurement, construction and post-construction. This chapter also described supplier/contractor arrangements such as partnering, among others.

Chapter 5 described the many challenges that are encountered during the five phases of the materials management process. These challenges were grouped into three categories: information technology, decision modeling and implementation management.

Chapter 6 presented the decision modeling approach used in the study. The chapter gave an introduction to decision modeling, described the modeling approach used and explained the decision making processes studied.

Chapter 7 presented the framework for a Decision Support System for material supply chain. The chapter provided a description of the decision making process for material supply chain for the decision nodes considered:
what material to buy decision node, how much to order decision node, when to buy material decision node, when to deliver material decision node, where to deliver material decision node, where to store on site decision node. In addition, the chapter provided a description of framework for decision models.

Chapter 8 provided a description of new concept of SPARCS - Supply-chain PARameters Classification System. The chapter describes the development of SPARCS, the data definition for SPARCS, and the application of SPARCS to all the decisions considered in the study.

9.2 CONCLUSIONS

Efficient 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 electrical industry current practices, 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 Electrical 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, 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 electrical 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 particularly an electrical 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 pre-fabrication phase. A fully integrated approach will better improve communication and minimize gaps in information flow among all the parties and departments involved.

9.3 CONTRIBUTIONS

The main objective of this research was to improve the decision making process for supply chain management in the small scale electrical 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 EC 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 electrical Industry. This was accomplished by the work presented in Chapter 7.
2. The identification of the current material management practices for the small scale electrical industry and the representation of these practices in Chapter 4.

3. The identification of decision nodes in the current material management practices for the electrical industry. More specifically, identifying which are the important questions and aspects related to decision making for material supply chain in the electrical 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. The data collection and description of current practices is explained in Chapter 4.

5. The development of SPARCS described in Chapter 8.

6. The design of the framework for material supply chain for the electrical industry described in Chapter 7.

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 electrical contracting industry in the design of the framework for implementing supply-chain practices.

9.4 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 electrical 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.

**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.

**Database 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.

**Expand SPARCS into a Knowledge Map**

SPARCS, as described in this document, is a system that allows categorizing parameters for material supply chain. By expanding SPARCS to be a knowledge map, it would define all of the knowledge elements of the decision support system including the decision variables, performance measures, formulas, optimization routines and human expert knowledge that are involved in the decisions.

**9.5 RECOMMENDATIONS**

The big manufacturing industry has successfully applied material management systems for the last decades and this has been possible by the enabling culture change that exists in this industry. There are movements in the manufacturing sector towards Just in Time (JIT), Total Quality Management (TQM) and enterprise resource planning (ERP), among others, that support the claim that there is an enabling cultural change. Unfortunately, the small scale industry is very resistant to change. The “if it is not broken, don't fix it" attitude is typical in this industry. Implementation of new innovative methods might be difficult in such an environment. However, the industry is being under huge pressure by competition, owners and the market to be more effective, responsive, flexible and to provide more value by reevaluating its methods and processes. Most small scale
industries are small business owners who cannot afford to design their own systems. In addition, if every industry is developing their system independently, this would produce many incompatible systems. Standardization and institutionalization of new methods and processes are especially important in the small scale Electrical industry.

It is clear that effective planning is required to keep costs to a minimum and to insure that the material is on site when needed. Poor planning of materials will increase indirect costs associated with delivery and use of materials. In addition, losses in productivity, delays, re-handling, and duplicate orders among other factors can be expected when there is a poor materials management system. The electrical industry need to realize that by improving their material management systems, improvements could be achieved in other areas such as in the effective optimization labor force. The effects of not having material available when needed are could be difficult to measure, but the impact in labor productivity could be noticed and quantified. Indirect labor cost due to absence of materials could be significant. Increases in idle time and/or unproductive time should be expected. Crew members will pretend to be busy even if there is no material to install, which increases the labor cost.

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.