Building Process Optimization with Supply Chain Management in the Manufactured Housing Industry

Makarand Hastak[1] and Matt Syal[23]

Abstract

Manufactured housing industry represents approximately 20 percent of the total housing market share. However, in the past years, the manufactured housing industry has faced many different types of problems including industry specific financial aspects to national economic recession. In order to overcome this situation, advanced technologies for building process optimization should be investigated and applied in this industry. This paper summarizes the current state of the art in the manufactured housing industry, describes major industry challenges and opportunities, and suggests future research direction that will contribute to increase the value and performance of manufactured housing. This paper is focused on three sub-areas: building process optimization, whole house redesign, and supply chain management for the manufactured housing industry which facilitates the industrialized housing construction process.

Keywords: Manufactured Housing (MH) Industry; Building Process Optimization, Whole House Redesign; Supply Chain Management (SCM); Industrialized Housing Construction Process.

Introduction

Manufactured housing (MH) industry is rapidly becoming an integral part of the national housing industry representing approximately 20 percent of the total housing market share (MHI 2003). Although, there has been a constant growth in the number of shipments of manufactured houses, the industry has faced many different problems over the past several years. These problems range from industry specific financial aspects to national economic recession. Specifically, problems of current MH industry are characterized by the following drawbacks: (i) adoption of a mixed model manufacturing process; (ii) unbalanced operations and potential process bottlenecks; (iii) inefficiency and rigid physical shapes and flow patterns prohibiting productivity and desired production levels. In addition, (iv) inflexibility to adapt to changing trends in the market demand (Abu Hammad 2003); and (v) poor supply chain management in: information technology, material handling, production planning, and controlling the supply chain parties (Jeong 2003).

[1] Assistant Professor, Division of Construction Engineering & Management, School of Civil Engineering, Purdue University, 550 Stadium Mall Dr. West Lafayette, IN 47907. Email: hastak@ecn.purdue.edu (CORRESPONDING AUTHOR)

[2] Professor, Division of Construction Management, Michigan State University, 203 Farrall Hall. East Lansing, MI 48824. Email: syalm@egr.msu.edu

[3] The material for this paper was contributed by the housing research team members who worked with the PIs on the NSF-PATH projects discussed here. Team members include: Ayman Abu Hammad, Edgar M. Barriga, Jae G. Jeong, Juan Pablo Garcia, Chris Ports, Omar Senghore, Namita Mehrotra, Deblina Banerjee, Abhishek Sabharwal, and Lori Swarup.

In order to resolve some of the problems mentioned above: (i) advanced layout designs are crucial in attaining higher productivity and improved performance; (ii) productivity improvement should be accomplished by balancing the system workloads and resources, thus eliminating potential bottlenecks in the production process and material flow; (iii) altering the design of new homes to appeal to more customers and (iv) a production planning system employing advanced supply chain management techniques, i.e., information technology is essential in achieving an efficient MH production process.

In such an environment, the future research discussed in this paper should be able to provide positive change for this industry. Current situation indicates the need for combing the three main parts which provide more efficiency in many ways for the manufactured housing industry. Production process optimization with whole house redesign that is supported by efficient supply chain management system will contribute to improve the overall competitive advantage of manufactured housing. Therefore, this paper is focused on three sub-areas: building process optimization, whole house redesign, and supply chain management for the manufactured housing industry which facilitates industrialized housing construction process.

Current State of the Art

Until now, limited research work has been done in the area of manufactured housing. Moreover, no research so far has encompassed MH production improvement and overall supply chain efficiency. However, through the NSF-PATH projects (Grant CMS-0080209: Modeling of Manufactured Housing Production and Material Utilization, Grant CMS-0229856: Manufactured Housing Production Process Analysis and Facility Layout) efficient production process and material flow management in the manufactured housing as well as innovative factory layouts were investigated and developed.

In terms of building process optimization, a simulation model was developed for a generic manufactured housing factory to identify process bottlenecks constraining productivity (Abu Hammad 2001). It was determined that the industry can benefit from the use of more modern equipment such as faster cranes and a less labor intensive way of moving materials from feeder to main stations (Senghore 2001). At the same time, production optimization was investigated considering factory layout optimization. As a result, space and proximity requirements in a production plant were developed as a process model and detailed steps involved in the layout design generation process were compiled (Mehrotra 2002, Banerjee 2003). Most recently, Abu Hammad (2003) developed an activity streamlining model (ASM) for MH operations using the critical path method (CPM) that was tested via simulation on four factory design alternatives such as, the spine, the J-shape, the central layout, and the U-shape. These alternative designs offer productivity improvement as much as two, three, and four times, respectively, when compared to the existing U-shape systems (Abu Hammad 2003).

Jeong (2003) analyzed the characteristics of the current supply chain in the manufactured housing industry at the macro level and identified significant process bottlenecks with regard to process time from order to installation of a manufactured housing unit. It was determined that streamlining the information flow plays an important part in the overall performance of the supply chain parties. Broad adoption of information technologies by the manufactured housing industry was also recommended (Jeong 2003). For example, during the late 80s and throughout the 90s information technology dramatically changed modern manufacturing organizations.

Enterprise Resource Planning (ERP) systems became the major backbone technology for nearly every type of transaction (Mentzer 2002). ERP systems integrate many internal processes in an organization and provide a consistent database (Stadtler and Kilger 2002). The ERP systems approach has a strong potential to enhance the performance of the entire supply chain as well as the production efficiency of the manufactured housing and other factory-built components. Although, several large home building firms have implemented various forms of ERP systems, they tend to focus on procurement, scheduling, and accounting within the single organization. The ability of the ERP systems should be expanded further into the design or development stages and should include interaction with the information technology systems of vendors and others in the supply chain. Therefore, development of integrated ERP systems for the manufactured housing industry should be considered for future research in this area.

Some technological advances influence the concept of whole house redesign in the manufactured housing industry. According to the Foremost Insurance 2002 report, only six percent of owners surveyed have moved their home from one location to another. Manufacturers and dealers have responded to this by offering new technologies in home anchoring and foundation systems. There are several products in the market now that have addressed the issue of a manufactured home being a permanent facility on the site it is installed. New foundation systems such as those developed by Sure Safe provide affordable methods to fix a home on a site. With these HUD compliant foundations, owners can now take advantage of home equity loans and financing (SSII 2003).

Another type of technological advance found in the industry today is the ability to produce two story homes. This concept was preceded by the folding roof technology. Through folding the roof, manufacturers were able to bring a more spacious look to the home by being able to transport higher roofs that could be folded out into place during installation (NP 2003). Although not many manufacturers are producing the two-story home, this is definitely the trend for the future.

It is important to discuss material innovation with respect to the current technological advances. As an industrialized process, manufactured housing depends on many materials and their handling in the factory. Considering the manufacturing processes, it is obvious that less variation in material is desirable. The constructability and delivery time would be greatly improved if the home could be produced mainly out of very few materials (MHRA 2003). One such material that has multiple applications and is slowly being used in manufactured housing is the Oriented Strand Board (OSB). OSB is an engineered structural panel that could be used all the way from sheathing to shelving and cabinets (SBA 2003). Materials like OSB are improving the industrial processes and helping to develop a better quality product with less time.

Future Research Directions

From the previous research and current state of the art, it is evident that different and innovative approach are required at each category, i.e., building process optimization, whole house redesign, and supply chain management while realizing their impact on each other. Figure 1 illustrates the proposed direction for future research starting from the current state of the art to developing an ultimate new hybrid home with competitive advantage of factory built and site built homes.

In terms of building process optimization the following advances are important:

- Incorporating advanced technology and equipment with innovative factory layout in the logic of optimal production process
- Customizing MH systems for new building materials, which are an important variable influencing production line activities, manpower requirements, available technologies, and processing time
- Developing an efficient master production schedule (MPS) by utilizing the data from the simulation models that produce a more accurate production planning process for the industry
- Incorporating advanced material requirement planning databases with automated equipment and machinery (Barriga 2003).

Regarding whole house redesign, it is evident that there are two main objectives for manufactured home innovation. The first is improving the constructability of the home and the other is bringing the home closer to providing the amenities that site-built homes provide such as several stories and a more permanent design while maintaining the distinct benefits of a factory manufactured product such as quality and speed.

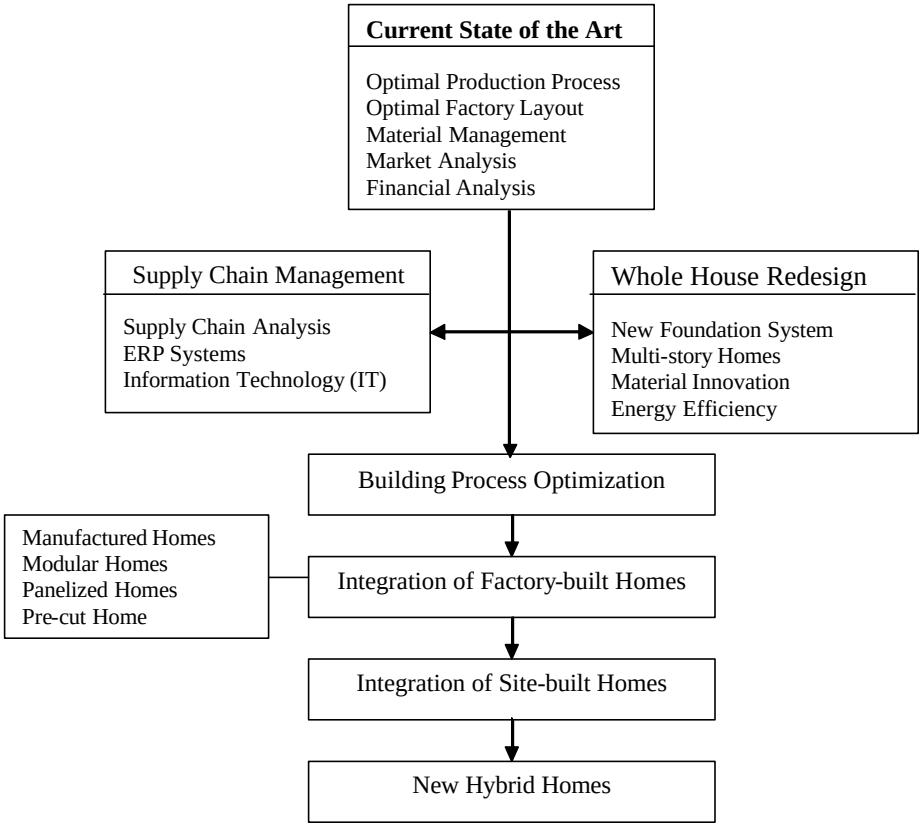

Figure 1: Future Research Direction in Manufactured Housing

To tackle the issue of constructability it is important to consider total redesign of the home. As it was expressed in PATH's Whole House Roadmap (NP 2003), homebuilders need to disentangle the systems. To do this, research should be focused on the home as a total system and analyzing how every subsystem contributes to the home and to one another. By doing this, possible problems like redundancies could be found and more effective system designs would be created. Better system integration leads directly to better assembly and better productivity. The second issue of increasing amenities should be addressed by simulating the various system possibilities to understand their advantages and drawbacks. The two-story home is a feasible solution. With a two-story home the house stops being a "trailer" and becomes a permanent facility for the owner. Another consideration that could be analyzed is the possibility of reducing factory completion and taking things like the exterior finishing to the site of placement where a more permanent finish can be given to the home. These innovations could convince the public that manufactured housing although an ancestor of mobile homes is just like and better than any home in the market.

At the same time, future research direction should be directed towards streamlining the information flow in the manufactured housing industry to improve the supply chain management. Timely and accurate sharing of information will help all related parties accommodate customer needs more quickly and at lower total cost. This can be achieved by the following activities:

- First, by defining current practices of information flow and identifying typical systems.
- Second, by identifying Information Technology (IT) tools or advanced systems already applied in other industries for sharing information. Through supply chain analysis information bottlenecks should be identified to streamline the information flow.
- Third, by implementing selected IT tools or systems in MH and assessing their effectiveness in the industry.

In conclusion, manufacturers must adopt innovations that maximize corporate resources. Such that they contribute towards improved efficiency in the management of overall home building process through whole house redesign combined with advanced information technology. As long as the manufactured homes are able to maintain their affordability, the technological innovations will only help the industry thrive. In the long run, innovation in the building process, supply chain management, as well as whole house redesign would integrate the best qualities of factory-built and site built homes, eventually leading towards hybrid factory-built homes.

References

Abu Hammad, A. (2003). "DSS for Manufactured Housing Production Process and Facility Design", *PhD Thesis, University of Cincinnati*. Cincinnati, OH.

Abu Hammad, A. (2001). "Simulation Modeling for Manufactured Housing Processes." *Master's Thesis, University of Cincinnati*. Cincinnati, OH.

Banerjee, Deblina. (2003). "Material Flow based Analysis of Manufactured Housing Production Plant Facility Layout," *Master's Thesis, Michigan State University*. East Lansing, MI.

Barriga, M. Edgar. (2003) "Manufactured Housing Industry: Material Flow and Management." *Thesis, Purdue University*. West Lafayette, IN.

Foremost Insurance Group. (2002). "Manufactured Homes: The Market Facts 2002 Report" http://63.94.12.219/market_facts_2002/ (July10.2003)

Jeong, Jae G. (2003). "Supply Chain Analysis and Simulation Modeling for the Manufactured Housing Industry." *Master's Thesis, Purdue University*. West Lafayette, IN.

Manufactured Housing Institute. (2003). "Quick Fact." www.manufacturedhousing.org (May.4.2003)

Mentzer, T. John (2002). "Supply Chain Management." Sage Publication, Thousand Oaks, CA.

Manufactured Housing Research Alliance. (2003). "Technology Roadmapping for Manufactured Housing." New York, NY

Mehrotra, N. (May 2002). "Facilities Design Process of a Manufactured Housing Production Plant**."** *Master's Thesis, Michigan State University.* East Lansing, MI.

Newport Partners L.L.C. (2003). "Whole House and Building Process Redesign." Davidsonville, MD.

O'Brien, Michael, Wakefield, Ron and Beliveau, Yvan. (2000). "Industrializing the Residential Construction Site." *Virginia Polytechnic Institute and State University*, Blacksburg, VA.

Senghore, O. (May 2001). "Production and Material Flow Process Model for Manufactured Housing", *Master's Thesis, Michigan State University.* East Lansing, MI.

Stadtler, Hartmut and Kilger, Christoph. (2002). "Supply chain management and advanced planning: concepts, models, software and case studies." 2nd Ed., Springer, Heidelberg.

Structural Board Association. (2003). "About OSB fast fact" http://www.osbguide.com/osb.html (Nov. 23, 2003)

Sure Safe Industries International (2003). "How sure safe steel buttress system permanent foundations work." http://www.suresafe.com/ (Nov.24, 2003)