PREFABRICATION OF SINGLE-FAMILY TIMBER HOUSES – PROBLEM AREAS AND WASTES

Djordje Popovic[1], Tobias Schauerte[2], and Jimmy Johansson[3]

1 Background and Identification of Problem /Knowledge Gap

Industrialization of house building is a process that shifts the activities traditionally done at building site to the off-site production. Off-site production has been claimed by various authors to increase the quality of buildings, decrease costs, and increase the efficiency and control of processes. The design, off-site production, and on-site assembly in industrialized house building are defined and documented to form a process platform, but these must be evaluated and improved to constantly develop better and more efficient practice. To set the foundation for improvements, the identification of the current state of value adding and non-value adding activities has shown to be a good starting point.

Prior work related to waste in off-site production of industrialized house building is already present in the literature. However, none of the waste categorisations and descriptions seem to address problem areas and occurrence of waste in prefabrication of single family timber houses.

2 Research Aim and Methodology

The research aim is to define problem areas that occur during the prefabrication of wall modules, associate them to eight types of waste and identify the key problem area for possible development and improvement.

In this study, five companies have been investigated through secondary data of five case studies conducted during 2014-2016. These are referred to as cases a, b, c, d, and e. All of them act on the same market, are direct competitors producing wooden single family-houses and are located in the province of Småland in Southern Sweden. The data is of qualitative manner and was, for the purpose of this study, analysed using workshop technique. The participants of the workshop were four academic researchers and two middle managers from one of the case companies. The first goal of the workshop was to discuss and make a consensus on which types of wastes that are related to each observation. The second goal of the workshop was to categorize observations into problem areas to enable easier representation of findings.

3 Research Findings

To fulfil the aim of this study, the authors have first categorized problem observations into four problem areas: material handling, internal logistics, assembly system, and work balancing. In the following section, the categorization of observations will be given together with the occurrence in case companies in parenthesis. The grouping of instances into problem areas and case companies is shown in Table 1.

[1] PhD Student, Department of Industrial engineering and management, Jönköping University, Jönköping, Sweden, djordje.popovic@ju.se
[2] Senior Lecturer, Department of Mechanical Engineering, Linnaeus University, Växjö, Sweden, tobias.schauerte@lnu.se
[3] Associate Professor, Department of Forestry and Wood Technology, Linnaeus University, Växjö, Sweden, jimmy.johansson@lnu.se

Table 1: Overview of the problem areas and their presence in the case companies in terms of number of problem observations.

Problem area	Case a	Case b	Case c	Case d	Case e
Material handling	4	2	2	1	1
Internal logistics	4	1	2	0	1
Assembly system	3	3	5	6	5
Work balancing	2	1	1	4	1

After the problem areas have been defined, the next goal of the workshop was to associate them to eight types of wastes. Problem observations on the other hand rarely related to only one type of waste. To give an overview and facilitate discussion, the occurrence in case studies was summed both per problem area and per type of waste (Table 2).

Table 2: Connection between problem areas and eight types of waste in case companies. Superscript is used to denote the number of waste observations per problem area if it is higher than one in a particular case.

	Over prod.	Wait.	Trans.	Inapp. proc.	Unn. inv.	Unn. mot.	Def.	Unus. h. p.	Σ
Material handling			a3, b, c2, d, e	a	a2, b, c	a3, b, c2, d, e		b	22
Internal logistics		a3, b, c2	a2, c, e	a, b, c, e	a2	c, e			18
Assembly system		a, c2, d2	b, c	a3, b3, c5, d6, e5	c	b, c, d	d	b, c	36
Work balancing		b, c, d3, e		a, d3,	a	a, e			13
Σ	0	17	14	31	8	15	1	3	

Although qualitative data was used, the findings to certain extent point out to what extent which wastes are present in the four problem areas. This, by relating to the number of waste observations that were made during the workshop. Considering observations from all case companies, the waste of inappropriate processing was the most significant one, notably in the assembly systems problem area. The wastes of waiting, transport and unnecessary motions were the second most significant ones. Furthermore, the problem area of assembly systems had the highest total number of waste observations. Therefore, the main conclusion is that future improvement efforts for the prefabrication of single family houses can be placed on developing the processes of the assembly system problem area.

Apart from the elimination of several types of wastes, improving one problem area can lead to changes in other problem areas as they are interrelated. Hence, a holistic approach should be used for the sake of avoiding sub-optimization. Therefore, the findings of this study can be a starting point for future work that aims at quantifying these problem areas.