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Process reengineering and improvement for building precast production

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ABSTRACT

Current production methods for the building of precast concrete elements are gradually becoming insufficient to meet industry demands. Most precast factories incorporate fixed molding production lines to produce building structural elements such as beams, trabeculae and pillars. Improvement of current production has reached its limits. The objective of this study is to perform process reengineering so as to create more efficient precast processes. The results of the literature review and advice from 16 experts suggest that the current process used to produce a precast element, which is comprised of 16 steps in a single module, should be redesigned to include 13 steps in 3 modules. Using historical data as input, the Arena software, Version 13, is adopted to simulate both the traditional and proposed methods, and then compare the results for practicability. An overall savings of production time of 24% can be reached by changing the current/traditional method to the flow-shop type production method.

1. Introduction

The main resources required by the building construction market are labor, equipment, and materials. In recent years, the costs of these resources have risen. To maintain their strength in a competitive market, construction companies need to re-examine their existing production procedures to ensure that resources can be efficiently used to produce desirable results. The precast construction process, for example, needs to be re-reviewed so as to control costs as well as to improve resource allocation, production, and quality control. Most precast plants currently implement the fixed production line method, which has several advantages for in-factory component production, where all phases in production can be controlled [1]. In the fixed production line method all the processes for the production of a product, for example a beam, are completed by a group of operators in a fixed position. The method means that a number of operators are working in a specific area, which can lead to congestion around the item being produced, in this case the beam. Operators are not able to simultaneously access the beam to finish their jobs. Moreover, some may be idle because the manpower-demand may be different in each process. This traditional mode may ultimately result in a waste of manpower [2]. In order to increase production efficiency and improve performance in precast plants, the main process examined in this study is based on specialization. With specialization, the production efficiency will increase because the workers have practiced the skill used in a particular process. The concepts of "process reengineering" and "lean production" are also combined to improve the production system. Davenport and Short examined how to improve the process reengineering system in 1990, suggesting that a given system workflow should first be analyzed and then amended or redesigned [3]. In 1988, an engineer in the Toyota Motor Corporation proposed streamlining as a design approach to avoid unnecessary relocation of labors and wasted waiting time as a way to minimize the loss of labor time, and thereby maximize the value of the total manufacturing process [4-6].

The objective of this study is to improve the overall production efficiency and performance of precast factories using the concepts of work based on specialization (flow-shop scheduling), process reengineering and production streamlining to develop a model. The proposed model is evaluated by using actual production cases from a precast company to examine if idle resources or waiting time can be reduced. The methodology is developed based on a literature review and concepts arising from both academic research and practical expertise. Basically the goal is to provide a method to improve the efficiency of the current processes and to develop a flow-shop production system model for precast factories. The production project simulation is conducted through the Arena program, with conclusions obtained from the analysis and comparison of the old and new methods used to develop recommendations for practitioners for productivity improvement.

2. Construction productivity

Most past studies in the literature dealing with the improvement of construction productivity have emphasized either process reengineering

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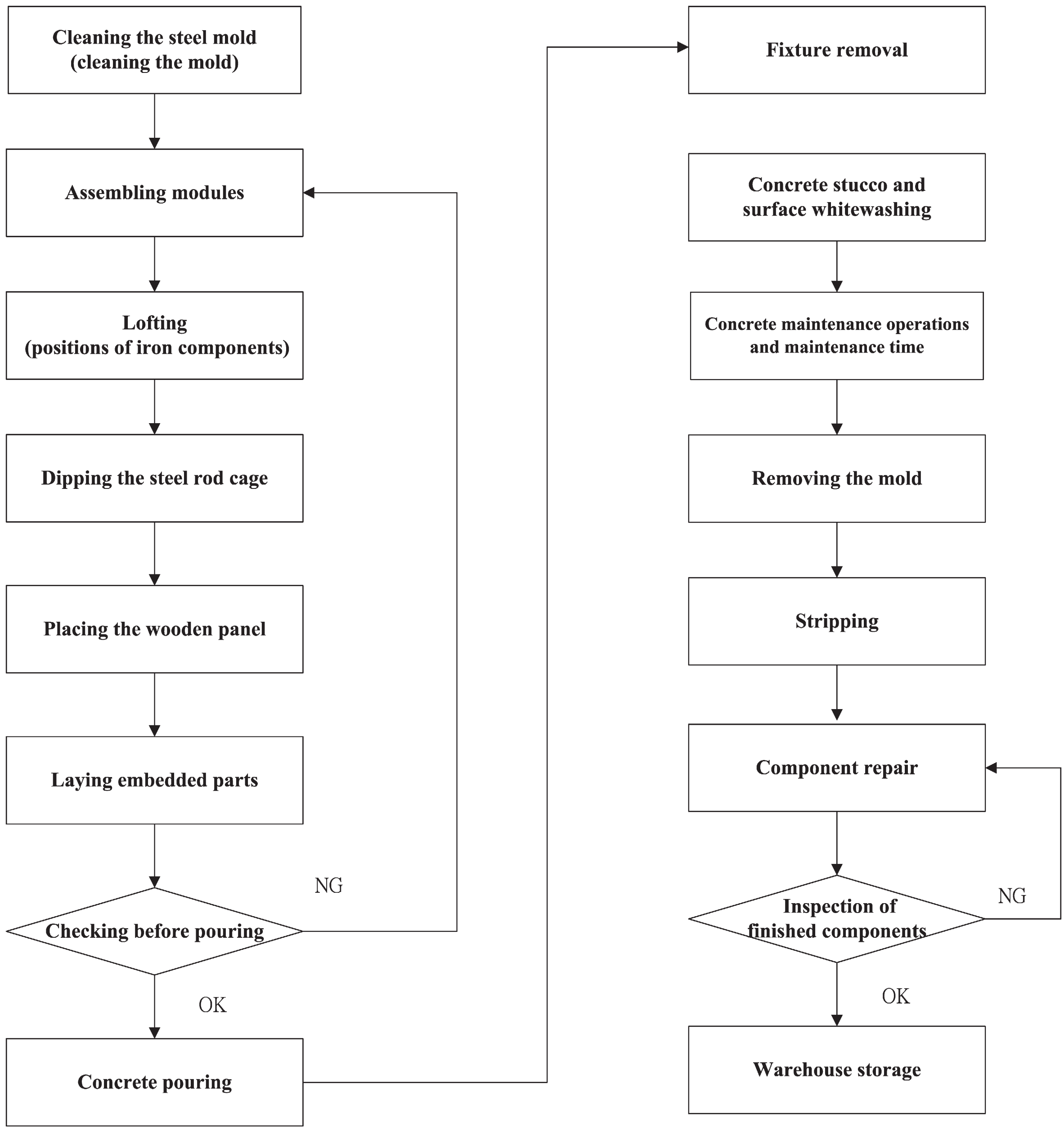

Fig. 1. Traditional procedure for production of precast components.

or process streamlining. In 1993, Hammer and Champy discussed process reengineering as a fundamental rethinking of system workflow and a radical redesign of the processes involved, which could result in a significant improvement in overall system performance [7]. In their breakthrough work they advocated thoroughly analyzing and modifying process and design to achieve maximum simplification, cost reduction, and efficiency improvement [7–12]. Production streamlining, also known as lean production, is mainly based on the management theory developed. The concept switched the industry viewpoint from focusing on artificial/machinery production capacity to total improvement of the production architecture, utilizing Just-in-time (JIT) and Total Quality Management (TQM) approaches to improve quality and to reduce processing time. Taking into consideration all of the above in an effort to maximize the value of production, the aim is to minimize loss of materials and time while pursuing the goal of transformation, flow, and value [13]. Other studies on the effect of construction streamlining have demonstrated a 5% increase per year in productivity for the construction industry, an equivalent of a 10%–15% increase per year in construction project productivity in the United Kingdom and United States [14,15]. Process reengineering and lean production are similar so have been combined to produce theories and concepts designed to eliminate wastage of time and materials. These include: (1) waste from relocation: any labor relocation without increasing the value of production; and (2) waste from waiting time: spare time caused by waiting for materials, machinery, inspection or labor [4]. Time waste includes both unnecessary waste and waste of accompanying operations, which have substantial differences in the engineering context. For example, Studies show that 35% to 60% of work time could be wasted in non-managed construction sites while 30% to 50% of work time could be wasted even in better managed construction sites [16,17]. It has been proposed that precast production could be divided into two major types: (1) a comprehensive-method production model with fixed production locations; and (2) a process-oriented or “Flow-Shop” production model [6]. The former is the current production method typically

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