



ORIGINAL ARTICLE

Applying lean thinking in construction and performance improvement

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Abstract The productivity of the construction industry worldwide has been declining over the past 40 years. One approach for improving the situation is using lean construction. Lean construction results from the application of a new form of production management to construction. Essential features of lean construction include a clear set of objectives for the delivery process, aimed at maximizing performance for the customer at the project level, concurrent design, construction, and the application of project control throughout the life cycle of the project from design to delivery. An increasing number of construction academics and professionals have been storming the ramparts of conventional construction management in an effort to deliver better value to owners while making real profits. As a result, lean-based tools have emerged and have been successfully applied to simple and complex construction projects. In general, lean construction projects are easier to manage, safer, completed sooner, and cost less and are of better quality. Significant research remains to complete the translation to construction of lean thinking in Egypt. This research will discuss principles, methods, and implementation phases of lean construction showing the waste in construction and how it could be minimized. The Last Planner System technique, which is an important application of the lean construction concepts and methodologies and is more prevalent, proved that it could enhance the construction management practices in various aspects. Also, it is intended to develop methodology for process evaluation and define areas for improvement based on lean approach principles.

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1. Introduction

Since the 1950s, lean production or Toyota production system principles have evolved and were successfully implemented by Toyota Motor Company. Toyota production system had two pillar concepts: (1) Just In Time flow (JIT) and (2) Autonomation (smart automation) as shown in more details in Fig. 1.

The term “lean” was coined by the research team working on international auto production to reflect both the waste

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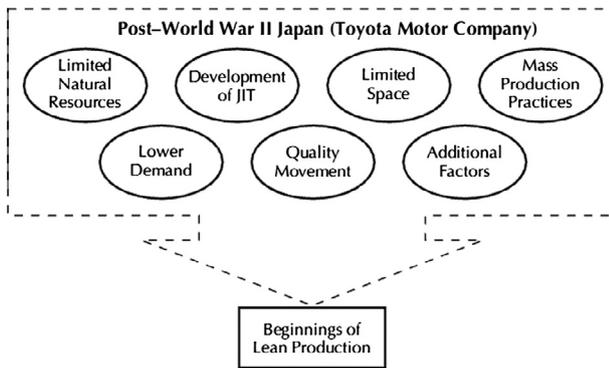


Figure 1 Beginning of lean production [1].

reduction nature of the Toyota production system and to contrast it with craft and mass forms of production [2]. Starting from efforts to reduce machine setup time and influenced by TQM, a simple set of objectives was developed for the design of the production system including to (1) Identify and deliver value to the customer value: eliminate anything that does not add value; (2) Organize production as a continuous flow; (3) Perfect the product and create reliable flow through distributing information and decision making; and (4) Pursue perfection: Deliver on order a product meeting customer requirements with nothing in inventory. Lean production aims to design and make things differentiated from mass and craft forms of production by the objectives and technique, and to optimize performance of the production system against a standard of perfection to meet unique customer requirements. In the beginning of the 1990s, the new production philosophy, which is known by several different names, is as follows: (1) world class manufacturing; (2) lean production; and (3) new production system. This philosophy is the emerging mainstream approach. It is practiced, at least partially, by major manufacturing companies in America and Europe. The new approach has also diffused to new fields, like customized production, services, administration, and product development. Since 1992, Koskela [3] has reported the adaptation of lean production concepts in the construction industry and presented a production management paradigm where production was conceptualized in three complementary ways, namely as (1) Transformation; (2) Flow; and (3) Value generation (TFV) theory of production. This tripartite view of production has led to the birth of lean construction as a discipline that subsumes the transformation-dominated contemporary construction management [4,5]. Managing construction under lean is different from typical contemporary practice because it (1) has a clear set of objectives for the delivery process; (2) is aimed at maximizing performance for the customer at the project level; (3) designs concurrently product and process; and (4) applies production control throughout the life of the project. The first goal of lean construction must be to fully understand the physics of production, the effects of dependence and variation along supply and assembly chains. In lean construction as in much of manufacturing, (1) *Planning*: defining criteria for success and producing strategies for achieving and (2) *Control*: causing events to conform to plan, and triggering learning and re-planning are two sides of a coin that keeps revolving throughout a project. In this research, princi-

ples, methods, and the implementation phases of lean construction will be discussed showing the waste in construction and how it could be minimized. The Last Planner System (LPS) technique, which is an important application of the lean construction concepts and methodologies and is more prevalent, proved that it could enhance the construction management practices in various aspects and bring numerous advantages, so that the construction projects will be more stable and less stressful for all involved stakeholders by reducing dependencies and variations to identify and eliminate waste (non-value adding activities).

2. Research background

Construction management and technology are the two key factors influencing the development of the construction industry. Over the past 40 years, although several new and advanced technologies have been applied to construction projects, the efficiency of the industry has remained quite low [6–8]. For example, the productivity of the USA construction industry has been declining since 1964 [9]. A similar decline in construction productivity has also occurred in other countries. Japan, for example, decreased from 3714 to 2731 Yen/Man/Hours over the period of 1990–2004. The main reason for this appears to be that the new technologies cannot effectively reduce the cost of design and construction while, at the same time, improving the management of the construction process. For example, although the Computer Aided Design (CAD) technology has improved the efficiency of drawing, it cannot reduce design errors and these, in turn, can cause the need for rework of construction making it difficult for construction managers to optimize the construction process to reduce cost [10,11]. This is a particularly relevant issue for Design/Build (D/B) projects, where the aim is to reduce cost and increase quality by an improved constructability of the building design. However, the new technologies cannot, as yet, effectively support the implementation of D/B projects. Therefore, the application of both appropriate new technology and contemporary management concepts is likely to be two effective approaches to improve construction industry efficiency. One of the new management philosophies that have been considered for the UK construction industry is that of lean thinking [12]. Lean construction, much like current practice, has the goal of better meeting customer needs while using less of everything, a term coined by the International Group for Lean Construction in 1993. Gleeson and Townend [13] had been investigated by many researchers in recent years. This refers to the application of lean production principles and practices in design–construction processes to maximize value and to reduce waste [14,15]. Some successful experience in implementing lean construction has been achieved. Conte and Gransberg [16], for example, examined the principles used in applying lean construction by over 20 construction companies in Brazil. Similarly, Wright [17] presented several cases involving the use of lean construction. However, the application of lean construction is still in its initial stages. In order to improve the implementation of lean construction, Miller et al. [18] proposed the harmonization between main contractors and subcontractors as a prerequisite, while Thomas et al. [19,20] proposed reducing variability to improve performance and improving labor flow reliability for better productivity as lean construction principles.

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