

# A Critical Review of Lean Project Management and Its Application in Construction Project Management

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**Abstract**— there is a growing awareness of the importance of Lean project management within construction organizations. The main aim of Lean project management is helping organizations achieving the overall goals in a construction project lifecycle by adding end-to-end value. Lean project management is a production philosophy which has the potential of bringing innovative changes in the construction industry. The poor performances of construction projects in Saudi Arabia require proper management of the resources and the use of efficient managerial tools and techniques throughout the life of the project, from conception to completion. The Lean project management principles focus on the minimization of both material and process wastes, which in turn not only improve construction project performance and the entire construction process delivery but also can help in reducing the cost and delivery times. Hence, this study aims to explore the concept of Lean project management and examines how the approach can impact the construction industry in Saudi Arabia. The study will use literature review to achieve the stated aim. It is expected that the findings from this study will reveal the application of lean project management principle, tools and methods that have direct contributions to improving the throughput and reduce lead-time and cost within the construction industry in Saudi Arabia.

**Index Terms**— Lean manufacturing, waste, project management, construction projects.

## 1 INTRODUCTION

Generally, construction around the world is developing at a rapid rate both in terms of technology and organization. Apparently, the construction industry earns its reputation from its perceived performance in terms of the value it produces and plays a key role in the economy of any nation which is a vital contributor to the gross domestic product (GDP) growth and produces the built environment that supports other sectors of the economy in most part of the world [32; 33]. Going forward, the importance of effective project planning will be more important due to the new government regulations. For example, according to the “Construction 2025” vision, the UK construction industry should deliver projects at lower cost (33%), lower emissions (50%) and faster (50%) [30]. There are other numerous examples of poor project management, which caused delays and increased cost. This includes [31];

1. Euro tunnel between the UK and France (significantly higher than planned)
2. Cargo railway link between Netherland and Germany (four times higher than original)
3. Construction of Kuala Lumpur’s new international airport

Similarly, the construction industry in Saudi Arabia has been through significant changes stages and has been in fluctuation since the 1980s, due to large infrastructure projects and there has been a high level of competition between different contractors to win projects, even though profit margins are low. Moreover, there has been an increasing demand for construction projects of different types and this together with

tight budgets, has given the construction industry an extra challenge to reduce costs. There are other government regulations under the sustainability initiatives, which demands new improved approaches for construction project management. Apart from the problem of high costs in construction projects in Saudi Arabia, the results of Ibrahim’s [1] study found that the top contributors to project delay were poor communication and coordination between construction parties, poor site management, payment delay, poor labor productivity, rework and bid award for the lowest price. This suggests the reason why more attention is paid to the sector. The adoption of a sustainable approach was suggested to lead to important business benefits and address the shortcomings of the construction industry identified in the Rethinking Construction report. This reflects that becoming more sustainable could lead to efficiency, profit-orientated practice and achieving value for money, as it is about helping society and protecting the environment.

Lean construction is a new production philosophy which has the potential of bringing innovative changes in the construction industry. The concepts and principles of lean are to generally make the construction process leaner by removal of waste which is regarded as non-value generating activities [2]. Several studies regarding various stages/aspects of construction projects have confirmed that waste in construction can be reduced by improving the project management activities [31]. The removal of waste (Man, Machine, Method, Material, Measurement, and Mother Nature) and value generation in terms of adding value to the customer are the major contributions of lean construction to sustainable development [3]. This

can be achieved using lean principles and tools; such as – pull system, flow, value stream mapping, continuous improvement, visual management, simulation, causal analysis and involvement of employees.

The main aim of this research paper is to provide a critical review on the traditional and lean project management techniques. This study will further examine how the application of lean principles can impact on construction projects in Saudi Arabia. The literature for this study focuses on the construction industry in Saudi Arabia and lean project management. The paper is structured as follows; section II and III provides a critical review regarding the construction project management and Lean management techniques respectively. Section IV introduces the concept of Lean project management. Finally, Section V and VI provide the discussion and conclusion about the research paper respectively.

## 2 LITERATURE REVIEW

### 2.1 Project Management

The project plays an essential role in accomplishing and managing business activities. A project involves series of activities to achieve a specific objective. Resources are consumed to achieved the specific resources. Project must be completed within a set specification, having definite start and end dates. On the other hand, project management is considered as the process of controlling and achievement of project objectives [35]. Project management is considered as the ongoing phase of the process of implementation of a project that is responsible for monitoring the cost of a project, the duration and its people [4]. It is further reported that it involves the defining of tasks to control implementation, only when the different activities that are required then the scope of the project can be understood. Moreover, it involves controlling the work in increments of time and the establishment of agreed estimates. It is generally acknowledged that managements of projects must endeavor to achieve the goals of projects that were agreed upon before the start of the project [4 and 5].

According to PMBok Guide [5], “Project management is the application of knowledge, skills, tools and techniques to project activities to meet stakeholders’ needs and expectations of a project”.

There are numerous other definitions provided by different researchers. However, in a nutshell, project management focuses on three major phases’ i.e. planning, coordination and control, which forms the backbone of the project management. Project management consists of ten major functions: integration, scope, time (planning, scheduling, and controlling the project), cost, quality, human resource, communications, risk, procurement and stakeholders [5].

Two types of processes are involved in project as reported by the project management book of knowledge which is;

1. The processes that create the product, service or project results and
2. Managerial processes

As shown in Figure 1, the managerial processes include;

1. Initiating; The initiation process defines and authorizes the start of a project.
2. Planning; Project planning is the establishment of formal plans to accomplish the project's goals.
3. Execution; Execution is the method where a major portion of the project work is carried out both physically and mental.
4. Controlling; Project control is essential at the execution stage to make sure that the intended benefits are achieved.
5. Closing processes; The closing process finalizes all processes in overall Project Management Process Groups to complete the project, phase or contractual obligations.

Each process includes a series of activities, which generally have a sequential relationship. The process activities can be viewed as conversions of the inputs to outputs [6]. In any project environment, the definition of project success is that it

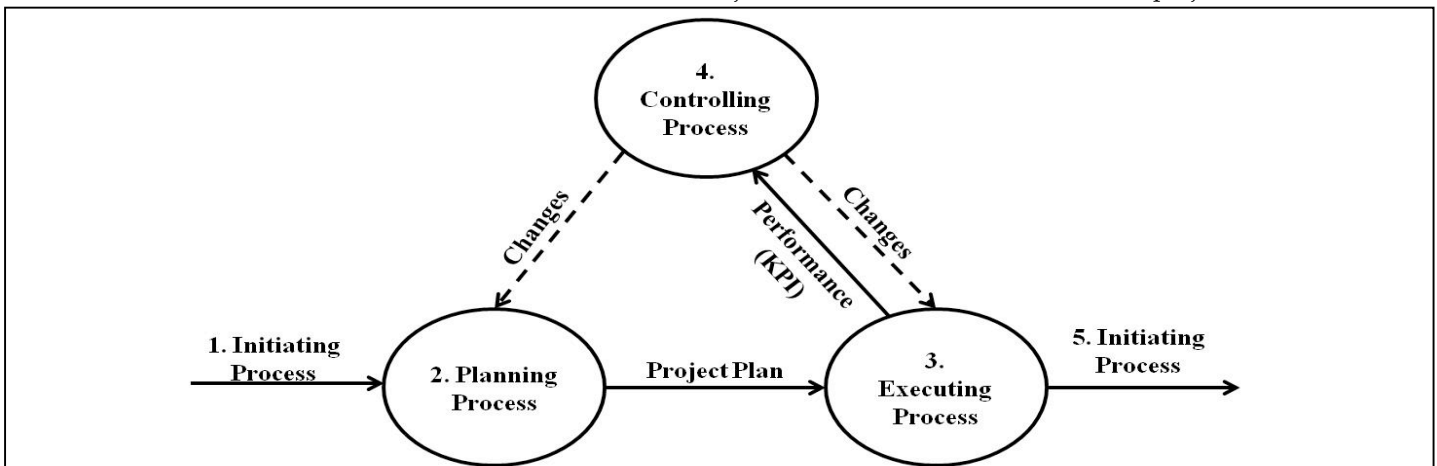


Fig.1. The closed loop of managerial processes in project management according to the PMBok Guide [5]

should be delivered on time, within the allocated budget and to technical specifications and that it should deliver customer satisfaction. Time, cost and quality are the fundamental objectives of project management. According to Serpell et al [8], the key to successful construction project performance is to manage the project efficiently, that is to do the work on time, within budget and according to quality standards.

## 2.2 Construction Project Management

Construction project management inherits its vital importance from the strengthening of general management definitions described earlier regarding the project management. The CIOB [9] defines construction project management as "the overall planning, co-ordination and control of a project from inception to completion aimed at meeting a client's requirements to produce a functionally and financially viable project that will be completed on time within authorized cost and to the required quality standards".

Therefore, the object of construction project management is to produce a completed project that complies with the client's objectives. The implementation of this definition may take many forms in practice, depending on the nature of the project and the circumstances in which it is carried out [34]. It is generally acknowledged that managements of projects must endeavor to achieve the goals of projects that were agreed upon before the start of the project. Meeting or exceeding stakeholder needs and expectations invariably involve balancing competing demands among:

1. Scope, time, cost and quality
2. Stakeholders with differing needs and expectations
3. Identified requirements (needs) and unidentified requirements (expectations).

An efficient and effective construction project management involves utilization and deployment of tools, skills, techniques, budget and available resources to complete the various phases and activities on time.

## 3 LEAN PRINCIPLES AND WASTE

The application of lean thinking in construction was pioneered by Koskela [2] who suggested that construction production is a combination of conversion and flow processes for waste removal. The principle of lean is attributed to the manufacturing industry and was introduced to construction [2]. The concept of Lean management starts with five principles that when followed will reduce waste by eliminating the non-value-added activities [29];

1. Specify Value; precisely specify the value from the construction project management from the end customer aspect. Such as on time delivery, cost reduction, reduced carbon emissions, etc.
2. Value Stream Mapping; clearly identify all the steps in the processes that deliver exactly what the customer

values and remove everything that does not add value to the customer.

3. Flow; take actions that ensure continuous flow in the value stream.
4. Pull; produce only what the customer wants just in time.
5. Perfection; always strive for perfection by delivering what customer expects a continuous removal of waste.

Lean classifies the non-value-added activities into seven different types of waste. Like manufacturing, non-value-added activities can be associated with service sector and project management. Seven types of waste can be given as [29];

1. Overproduction; producing more than or earlier than required. Misalignment of project activities could lead towards acquiring excess resources before they required.
2. Waiting; process/activities waiting for resources, engineering, maintenance, designs, quality assurance results, material or information. During waiting products are not moved and hence can increase the lead time and overall project cost.
3. Transportation; the movement of materials or equipment within the site or across different construction sites.
4. Over-Processing; this term generally refers to unnecessary steps in planning, operations and execution phase; such as reprocessing, inspection, etc.
5. Excessive Inventory; excessive raw material, finished goods, redundant project plans and information are all examples of excessive inventory.
6. Excessive-Motion; moving information or projects plans between different departments to get approvals could lead towards excessive motion.
7. Defects; finished products are not up to the required quality standards. This includes project bids not accepted as bids failed to comply with the project requirements, unsuccessful project plans – failed to deliver the expected outcome in terms of cost, quality and time etc.

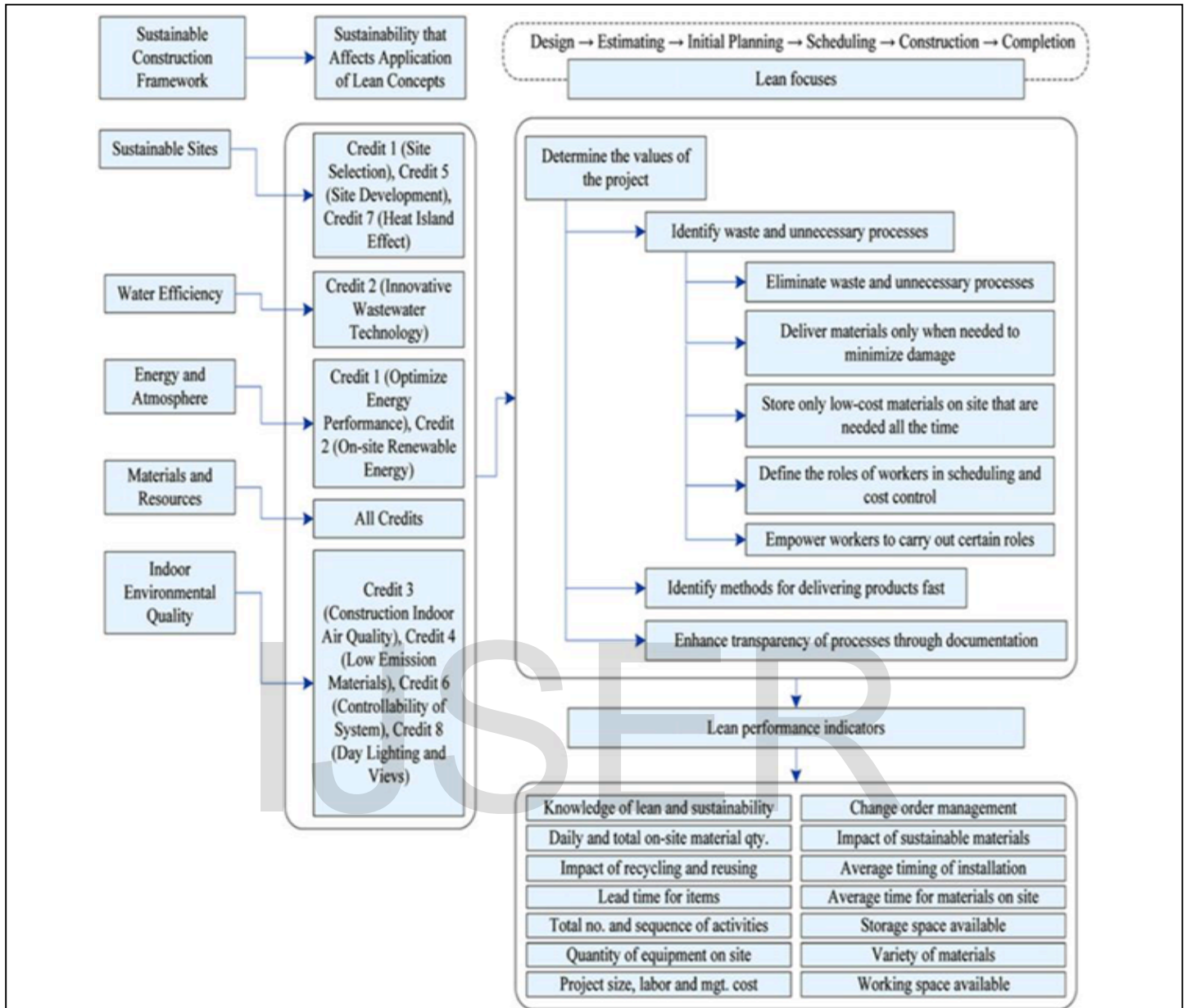


Fig. 2. Framework for implementing lean techniques in construction projects - Source: Koranda et al [27].

The application of the lean principles has been advocated around the world, and several seminars and initiatives have been undertaken to encourage its uptake. The Construction Industry Research and Information Association (CIRIA), Construction Productivity Network (CPN), Construction Lean Improvement Programme (CLIP) and the Lean Construction Institute UK (LCI-UK) are some of the examples of institutions established. Seminars and conferences have been organized to tease out the main issues in the development and awareness of lean project management principles with real life case studies of some construction organizations presented [10]. Despite these efforts, there seem to be some barriers to the successful implementation of lean project management. Generally, the rate of lean implementation within the Saudi Arabian construction industry is relatively low and the application of lean

The understanding of lean project management priorities among all stakeholders in the construction industry is essential to derive maximum benefit from lean project management implementation. Aside these, the dynamic, complex, and fragmented nature of the construction industry call for a clear focus, and a resolution of the differing priorities of lean project management. The absence of a clearly defined priority of lean construction might affect many consequences for potential lean implementers, organizations, as well as researchers trying to explore the essence of the concept.



## 4 LEAN PROJECT MANAGEMENT

Lean implementation success is evident from the several performance improvement accomplishments in the manufacturing and sector through increased productivity, reduced waste and increased profit margins. Among the Lean project management techniques, this research has adopted Last Planner System (LPS) because it has been tested in the field and refined over last decade, with the achievement of great benefits. The Last Planner System (LPS), which has been demonstrated as a very useful tool for the management of the construction process and the continuous monitoring of planning efficiency through percent plan complete (PPC) gives rise to an ongoing improvement, which often ensures a stabilizing of the workflow and an improvement in productivity [23; 24]. LPS has five main integrated elements [24; 11]: master planning, phase planning, look ahead planning, weekly work planning and calculating the percentage of the plan completed.

Literature of Lean Project Management and Last Planner System shows no evidence of its practical application within construction industries in Saudi Arabia as well as the chosen case organization. Therefore, to the researcher's best knowledge, the research reported here is the first comprehensive study of the application of Lean Construction in Saudi Arabia. It aims to improve construction planning and control practice and overcome causes of waiting time waste or delay.

Last Planner System has been chosen for two reasons. First, it has proven to be a powerful tool for construction project management in many countries where its implementation addressed the root causes of delay, aiming to overcome them and thus to improve construction planning practice. Secondly, the implementation of this technique for the first time in Saudi Arabia seeks to launch the development thereof research into Lean Project Management and LPS. This may help construction organizations to establish new strategies and policies to improve their managerial practice. When documented and disseminated in local journals and construction magazines, the results of the implementation process, including benefits and barriers, can be used as a reference for organizations, which seek to improve their project management practice.

## 5 DISCUSSIONS

Lean project management is one of the strategies for improving construction performance. The Lean approach in construction project management focuses on the removal of all forms of wastes from construction processes to allow more efficiency.

Existing studies have suggested theories which reinforce lean as a method for optimizing resources, improving safety, productivity, working conditions and overall, the social, environmental, and the economic bottom line [25]. The principles of lean project management focus on creating a sustainable change by stressing on efficient, waste-free and safe flow, storage and handling of materials to minimize cost, energy

and resource consumption, and provide value for clients and end users [25]. Consequently, it is reported by Mossman [11], that some of the benefits of implementing lean in a construction project are:

1. More satisfied clients
2. Productivity gains
3. Greater predictability
4. Shorter construction periods
5. Operatives able to make better money
6. Sub-contractors able to make better money
7. Improved design
8. Reduced cost, less waste
9. Improved health and safety
10. Improved quality, fewer defects

Accordingly, Koranda et al [26] developed a framework for implementing lean techniques and in a construction project as shown in Figure 2.0. Lean can be positively applied to any aspect of an organization's and provides a method for achieving organizational goals [27]. These goals may be related to cost reduction, quality improvement, reduction of environmental impact, and improvement in safety.

It is also important to note that there is a need for leadership participation in the quest for attaining a more construction performance in projects as the leadership role in construction organization is one of the paramount factors that can provide an overall vision, direction, and vision towards the attainment of successful construction projects. Therefore, it is highly essential that leaders have full knowledge of the concept of lean project management to be able to guide their organizations effectively [28]. This suggests that thorough understanding of lean project management concepts as well as principles is necessary for proper application on a construction project.

## 6 CONCLUSION AND FUTURE WORK

The main aim of this research project is to provide a systematic approach to construction project management that could deal with both complex aspects of the problem and uncertainties at different levels of project management. It is evident from the literature that the employed or existing project management methods have not been able to deliver the projects on time and within given resource and budget constraints. Further, this study has drawn from the literature on lean project management reflecting the principles of lean, seven wastes and how these impacts the construction projects. A better understanding of lean concepts by the construction industry can contribute to improvement in all aspect of construction projects in Saudi Arabia. The concept of lean project management seeks to minimize waste, but this is achieved through different approaches. There is a need for construction stakeholders to set their priorities before the start of a project for better integration. More emphasis should be laid on lean approach in a construction framework. There should be more level of commitment and knowledge by construction organizations in Saudi Arabia to successfully implement and derive maximum benefits from the concept of lean project management. However, the application of lean in construction project

management is not only possible on the operational level; it could also be applied at the strategic level. Therefore, this study will go on to further present the application of lean project management at the strategic level and explore the benefits that can be achieved.

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