Quickly Understanding of Lean Construction to Improve Project Cost Performance: A Literature Review

Gebriel Huda[1*] & Mohammed Ali Berawi[1]

[1]Department of Civil Engineering, Faculty of Engineering, Universitas Indonesia
Kampus UI Depok, Depok 16424, Indonesia
Email: gebriel.huda91@ui.ac.id

Abstract. The study focuses on understanding construction projects' waste and cost performance through a lean construction approach. Concentrate on the following lean construction literature proposes a framework text to explain construction waste activities that result in the need to optimize work breakdown structures to create good construction cost performance. This framework consists of a series of interrelated processes by describing construction waste activities that occur by identifying three stages: evaluation and elimination of wasteful activities, optimization of work breakdown structures, and improved cost performance. While acknowledging the existing literature, the paper focuses more on the lean thinking of such wasteful construction activities by emphasizing lean construction mechanisms that will positively impact project cost performance.

Keywords: *construction project; cost performance; high-rise building*; *lean construction; waste.*

1 Introduction

Construction services firms play a role in offering construction implementation services to owners (investors or developers). Construction service firms also play a part in realizing or manufacturing the end product in the shape of buildings or other physical forms, both in the form of facilities and infrastructure. The construction sector demands specialization in construction design and services against the emergence of new technologies, innovative systems, and the increasing complexity of structures [1]. Construction service firms have rules created and developed based on the company's expertise to achieve the required performance. The ability to minimize waste by eliminating non-essential value-adding operations; results in cost savings and performance improvement [2]. As in prefabricated wall panels, which are load-bearing construction parts that provide the primary role of sustaining and transmitting building loads, significantly impacting the structure's performance [3]. The degree of execution of the functions offered by the building and the requirements initially stated by the owner are then used to develop quality metrics [4].

Improving quality performance will significantly impact its aims because of the high compliance necessary to meet better cost-performance requirements [5]. Fourteen factors affect project cost performance, namely design changes, improper work methods, lack of supervision, work delays, overly busy schedules, additional work, lack of knowledge, equipment selection errors, labor shortages, specification changes, equipment shortages, late materials, extreme weather, slow decision making [6]. Project stakeholders should consider critical reworking factors during the planning stage and before project implementation to eliminate or mitigate the occurrence and impact of the cause of rework and to improve project performance [7]. Implementation issues can prove critical. Each cost-benefit evaluation should consider the actual date on which the various alternatives will be completed and the risk of cost overruns and poor performance [8].

The concept of an on-site factory is not new and has been used in various forms for a long time. One example is a state-owned company engaged in the construction and investment industry with experience building prestigious buildings, infrastructure, property, and EPC for more than 60 years. Recent examples can be found in construction automation applications in Japan, where they used "sky factories" to construct high-rise buildings in the 1990s [9]. In the context of high-rise buildings, the wall is 20-30 feet deep to the internal surface. It has a building width ranging from 40 to 60 feet for double-charged corridors [10].

High-rise building projects to manage interior building work can be attributed to floor level, decomposition of workspaces with elevation to plan and track how work will flow from one level to the following [11]. In China, energy units and emissions from high-rise building types are standard. Planning and operational stages necessitate attention and investment to identify that resource and energy usage in the tall building sector since construction has a considerable impact on energy consumption, carbon emissions, climate adaption, and resilience [12]. In particular, the primary development method uses mixed-use development projects of high-rise buildings. They are one of the urban strategies of the future [13]. Construction policy will support applying specific structures to high-rise buildings, offices, and housing (range determination, height under ceiling) to reduce environmental impact during construction and deconstruction for reuse [14].

Due to the distinctiveness and nature of the operations and complexity of the work environment, the development of high-rise buildings is a dangerous bet [15]. Construction of high-rise and complicated structures rose, as did the size of construction sites, the severity and frequency of accidents on construction sites, and financial losses on snowballs [16]. In implementing high-rise building construction projects, good scheduling and quality control play a critical role in the timeliness, cost, and overall quality of project completion. Project delays often occur in the process of implementing construction projects. This project results in poor quality that does not match the technical specifications. In the end, this leads to losses to a project [17].

Especially high-rise building projects implemented by large construction service companies in Indonesia wasted project costs in the last ten years. The construction industry has been accused of inefficiency and inefficiencies due to delays, cost overruns, and defects partly due to flaws in design [18]. Construction projects are often carried out in complex and dynamic contexts with numerous interconnected components, resulting in considerable uncertainty. Many variables can damage a construction project, resulting in project cost overruns [19].

The screen projects, many project owners and managers are expected to experience excessive cost overruns and anticipate budget losses during the bidding phase and before contracts are completed [20]. Many projects were delayed, financial overruns occurred, and large volumes of garbage were generated [21]. The performance of construction projects has been criticized over the years for low productivity levels, cost overruns, and significant delays [22]. The project defines poor productivity, time and expense overruns in inefficient management procedures, poor communication, and low automation [23].

Waste is a process barrier that gets in the way of providing value to customers. A significant problem often encountered by construction projects worldwide is the cost overrun and timing of construction activities. Prevention of time and cost overruns is essential for checking and observing progress at all levels of the project [24]. Inefficient time frames, project content, and additional costs can result in cost overruns [25]. Although many advanced tools and technologies are available for scheduling and planning, construction projects face time and cost overruns [26]. Reworking has adverse consequences on project performance, leading to time delays and cost overruns for any project [7].

Therefore, overcoming the project's waste requires a suitable concept and approach. Lean thinking identifies values determined according to the product, the flow of values, creating a product flow that aims for perfection [27]. The basic concept of lean thinking is the development of integrated management of workflow practices appears to improve the use of lean thinking to control variability in construction [28].

Lean thinking practices are also included in planning, design to cost, and standardization [29]. Standard work constitutes one of the most important aspects of lean thinking [30]. One of the primary causes in the construction sector is the successful application of lean thinking in the manufacturing industry and the benefits that result from its adoption [2]. Lean thinking in construction seeks to enhance employment through the building process [9]. Several definitions are presented for lean construction [31].

The approach that allows and conceptualizes the basis of lean thinking is to use a lean construction approach. Lean thinking was brought into construction and termed Lean construction [32]. Lean construction is a type of offshoot of the lean manufacturing philosophy [33]. Lean construction is a relatively recent idea in the building industry that aims to improve production efficiency [21]. Lean construction is a new practice that differentiates from traditional construction management approaches and leads to good transformation in the construction industry [27], [33]. Lean construction is a production system designed to minimize waste of materials, time, and effort to increase the maximum amount of value [2], [27], [34]–[36]. Lean construction is value generation for all building project stakeholders [37].

As lean construction develops and demonstrates effectiveness in several places worldwide, it is necessary to study the challenges facing its adoption, especially in countries where this philosophy is not well known or formally practiced [31]. This research focuses on giving a lean construction interpretation of waste to generate consistent project cost performance in the building project process. It focuses on the evaluation and elimination techniques from the work breakdown structure.

1.1 Waste of Construction Project

Waste of construction projects is everything that has no added value. Waste is wasted material and other resources at large, including time, energy, and work area. In general, a very high level of wastes/non-value added activities are assumed to exist in construction, and it is difficult to measure all waste in construction [34]. Because the construction business is essential, paying greater attention to safety measures is critical. Although work-related injuries represent a considerable waste in construction projects, little emphasis has been made to incorporating safety into a lean construction framework [38]. In the building industry, the idea of waste is continually evolving [21]. Typical waste categories in construction include, among others, finishing tasks ahead of or behind time, superfluous transit (double hanging), material stockpiles, and waste of untapped human potential [39].

The principal purpose of Lean is to remove waste during the production process. Thus we must first define waste. Here is the category of waste in the construction project: Defects are products or services that do not match the required specifications and will cause rework or rework. This activity does not add value. Over-production, waste result in products exceeding demand or being ahead of schedule. Waiting, waste includes, among others, the activity of waiting for an automatic machine, waiting for goods to come, waiting for approval. Non-Utilized employees waste also provides for the addition of 7 wastes that were first known—putting employees who are not directly involved in the process in useless jobs. Transportation waste consists of unnecessary transfers or transportation, such as temporary placement, re-build up, and transfer of goods. Inventory, waste including supplies, excessive stock or inventory, or unprocessed materials. Motion and energy are used because of movements that do not provide added value, such as seeing ergonomic movements that are inefficient and unhealthy. Waste motion can come from humans or machines; Extra processing, which is the addition of processes that are not needed for products, will only increase production costs.

1.2 Lean Construction View on Cost Performance Improvements

Lean construction is most often used in the construction phase and is beneficial to client satisfaction [21]. Lean construction is concerned with the quantity of waste material in place and all sorts of waste related to specific operations. Overproduction, waiting time, material handling, processing, inventory, and labor movement are only a few examples of factors that substantially impact cost performance [17], [40]. The concept of sleek construction reduces material constraints, resources, time, and cost [25].

2 Conceptual Framework

2.1 From waste to Optimize Work Breakdown Structure

The wastes in construction projects include materials, time, resources, and achieving customer [40]. Highly inefficient construction services strategies usually develop project design drawings to a level of completeness, estimate their costs, and then change them to fit the project budget. Basically, in this process, the costs of the design elements are summed up, which defines how much the project will cost [41]. Failure to review quality assurance practices regularly can be considered a wasted opportunity because new technologies can be introduced that can conduct rapid data collection making old methods wasteful [42]. Participants in the construction sector investigate novel techniques, strategies, and processes to reduce waste in the business [2].

Critical competencies at critical points need to be mapped for high-performance building projects to understand where to leverage the most significant influence and avoid wasteful activities [36]. The efficiency of architectural elements (floor materials, walls, work aids/cutting instruments) should have been planned and projected from the beginning of the design process. So that problems like these do not result in wasted expenses during the building phase [43]. Adopting many optimization strategies is inefficient in terms of both money and time. As a result, efficient design methodologies and the ability to save time for optimization are critical [44]. Rework is wasteful and presents an obvious target for improvement [45]. Material wastage occurs more in architectural work than structure works, evidenced by the wasteful materials [46]. There are possibly several alternative ways to complete project construction. Reducing downtime can be an instructive measure to reach the most effective and least wasteful [47].

Construction of complex systems requires requirements, design, work breakdown structure, and schedule [48]. A construction project's project management procedures often begin with identifying the structure of the project job specifics [49]. Work Breakdown Structure is a results-oriented analysis of the work covered in a project called the total scope of the project [50]. The structure of work details is the details of efforts into smaller components and better manages them. Although each project has its uniqueness, most buildings can be standardized in each activity and provide more substantial estimates in project management [51], [52]. A comprehensively efficient work breakdown structure can prove critical in the project management planning process by dividing the project into stages, deliverables, and work packages [53]. The project is separated by work breakdown structure into small sections to be more easily managed [54].

The tasks are more managed, and the work detail structure separates the project into portions. Because each part is considered a product, these pieces may be used for planning, cost estimation, observation, and control. It is the foundation for project planning, budgeting, resource scheduling, allocation, and risk management [55]. Creating detailed models with detailed work structures requires many resources, including the working time of highly qualified design engineers [56]. The most complex levels of the work details structure contain work packages used to group activities for scheduling, estimation, monitoring, and management [57]. An organization's budgeting system is positively influenced by the organization's willingness to enable innovation, which can improve the structure of work details and reduce construction waste [25], [58]. Lean construction is defined as the continuous elimination of waste by meeting every customer's needs while focusing entirely on the flow of value and the pursuit of perfection in completing construction projects [59].

Therefore, in the short and medium-term, multiple intervention states are simulated to suggest improvement by gradually eliminating inefficient processes in the value chain using lean construction concepts and technologies. The standard process is essential for waste reduction, and the evaluation of the costs and benefits of activities will further reduce construction waste.

Proposition 1. Evaluating waste construction projects affect the definition of an optimized work breakdown structure, which, through the eliminating process, can reduce waste and support the optimization of work breakdown structure.

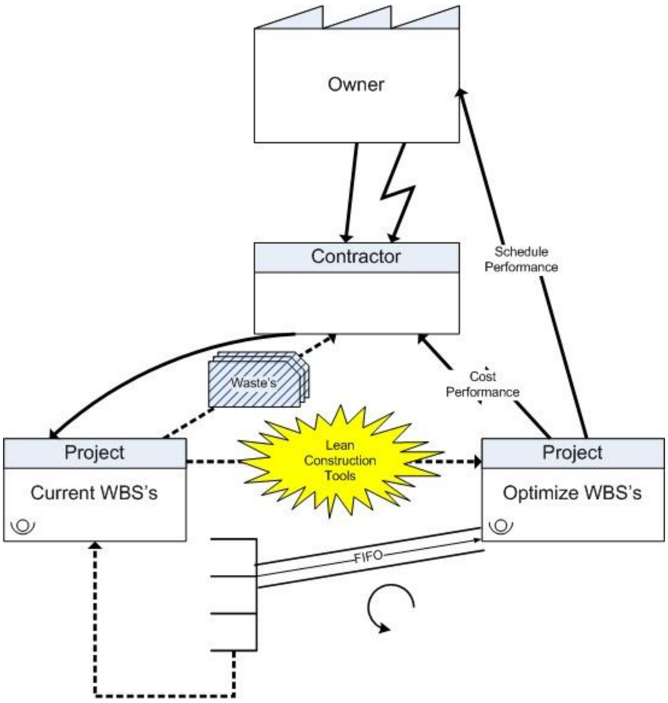

Figure 1 Proposed conceptual framework

2.2 From Optimized Work Breakdown Structure To Cost Performance Improvements

Lean construction is an approach that is possible to optimize the work breakdown structure. Lean construction is a strategy that results in more minor variations in the development process and early detection, and ongoing problem resolution to ensure the system operates smoothly [60]. In general, a lean approach aims to create the highest value for the customer and reduce or eliminate waste [38]. The application of lean construction can reduce waste by adopting lean construction tools at the project site [27]. Lean systems can be integrated across the construction value chain: project definition, lean design, lean supply, lean construction/assembly, and finally, during the use phase [61].

Lean construction refers to maximizing productivity and minimizing waste in construction projects [40]. Lean construction techniques promise to reduce, if not complete removal, non-value-added works [23]. Lean construction needs to be utilized together to improve reliability between project participants and increase actual value for everyone [62]. These impediments can further promote intelligent integration of building information modeling technologies with efficient construction processes. The growth of digital construction practices is part of a proposed strategy that leads to more innovative, productive, and sustainable outcomes [29].

Lean construction is a viable approach of systematic management of all phases of a construction project's life cycle to minimize time and cost expenditures [33]. Lean construction strives for optimal plans to address deviations and waste with captured contextual knowledge and continuous correction [63]. Proactive management that enables better decision making and higher quality of what is executed, avoids bad practices and rework, occurs through initial management conducted during forward-looking sessions within a lean construction framework [35]. Lean construction supports construction organizations in detecting and evaluating waste to increase productivity, reduce project time, improve safety, improve quality, improve reliability, ensure customer satisfaction, and reduce total project costs [2].

The cost performance index indicates cost and time performance [19], [20], [24]. The cost performance index can estimate project costs for completing projects based on performance according to time targets [64]. Prefabricated structures benefit from lowering construction time and environmental pollution and the consumption of energy, water, and other resources in subsequent building operation and management, which helps to enhance the cost performance of building goods [65].

Cost performance is one of four valuable indices for forecasting project performance [66]. Meeting or exceeding time and cost performance measures in design/build projects, on the other hand, is more common than in design/bid/build projects [1]. Innovative studies are the best alternative recommendations for project cost performance for service providers [6]. Value management is a well-known approach in project management that can simultaneously monitor the schedule and index of cost performance in a project. The value management obtained detects the current project performance and predicts the cost of project completion [67]. Eight key factors affect cost performance: accurate project planning and monitoring, design efficiency, effective location management, communication, contactor efficiency, project characteristics, due diligence, and market competition [28].

Adopting lean thinking and lean construction techniques and principles improves labor productivity and cost performance [27]. This approach has been enhanced by building lean information models and practices and improving project performance, mainly cost and schedule [63]. Therefore, the relationship between the formulation and realization of optimized work breakdown structure through lean construction to improve cost performance can be explained by the following proposition:

Proposition 2. Optimization of the structure details of construction project works into improved cost performance through a streamlined construction approach.

3 Conclusion

The manuscript reduces the waste of construction projects involved in improving project cost performance by developing literature on cost performance improvement processes and lean construction approaches. The study created a conceptual framework to explain the waste-reduction process to improve project cost performance. It consists of waste, optimized work breakdown structure, and cost performance improvement. The suggested framework gives a more in-depth knowledge of the strategic activities that must don and fresh insights on the growth of waste reduction technologies on building sites.

This paper carries the concept of waste and lean construction mechanisms. Studies state that the waste reduction process can evaluate and eliminate waste construction projects, where it can formulate and realize optimize work breakdown structure with cost performance improvements. Furthermore, a strong belief is that applying a lean construction approach to construction projects can complete projects without excess time and cost.

Currently, the authors are conducting an in-depth qualitative study to examine the proposed that are appropriate for use in Indonesia's construction industry. Next, it can be seen and proved how much value lean construction influences construction projects' performance in Indonesia.

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