Lean Construction Model: A Case Study of Manpower Planning

Anggi Febrianto[1,2]

[1] Universitas Logistik dan Bisnis Internasional, Bandung, Indonesia
[2] Universitas Jember, Jember, Indonesia
anggifebrianto@ulbi.ac.id

Abstract. Several construction projects in Indonesia have experienced difficulties or delays in implementation. One of the project's difficulties is due to quite large operational costs. Pareto's largest operational cost is the cost of employing employees as construction project workers. Failure in managing the costs of employing employees is due to the absence of a manpower planning pattern. Purpose Main purpose this paper to make a lean construction model of manpower planning to reduce cost of manpower. This method aims to identify key concepts and approaches for developing a manpower plan, by examining the influencing factors and integrating them with a project management model. Before the improvements, manpower costs are 19 months, multiplied by the estimated average salary of IDR 13 million, the total cost is IDR 6.422 million. After improvements to the process of hiring employees according to the schedule that has been made in each phase of project management, the total manpower costs become IDR 4.810 million in a period of 19 months. The lean construction model developed with a focus on manpower planning can reduce operational costs, especially manpower costs. Manpower fulfillment by aligning needs based on the construction schedule that has been made can have an impact on reducing the cost of manpower by IDR 1.612 million.

Keywords: Lean Construction, Manpower Planning, Reduce Cost, Manpower Cost, Project Management.

1 Introduction

Construction projects in Indonesia frequently face significant challenges, one of the most prominent is high operational costs. A considerable proportion of these costs can be attributed to manpower expenses, making effective manpower planning essential for project success. Despite its importance, many projects still lack structured and optimized manpower planning, leading to unnecessary financial expenditures and project inefficiencies.

Workforce optimization has become a critical focus area for construction companies aiming to improve efficiency and reduce costs. Companies began to invest in comprehensive training programs, skill development initiatives, and sophisticated workforce

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management systems to better manage human resources [4]. Currently, the construction industry is adapting to contemporary workforce demands by incorporating flexible work arrangements, including remote work and adjustable schedules. These adaptations not only enhance employee satisfaction and work-life balance but also contribute to higher retention rates and improved productivity [8].

Manpower planning, often referred to as workforce planning, is crucial in the construction industry due to its direct influence on resource utilization and project performance. Historically, the concept of manpower planning has evolved significantly, influenced by rapid technological advancements, changing market demands, and regulatory shifts. As these dynamics continue to evolve, construction companies must refine their manpower planning strategies to remain competitive and cost-efficient [2].

This paper addresses two primary research questions: (1) What are the critical factors required to effectively implement manpower planning? and (2) How does the implementation of structured manpower planning influence operational costs in construction projects? Through a detailed case study, this research aims to develop and validate a Lean Construction model specifically focused on manpower planning. The main goal is to demonstrate how structured manpower planning, aligned with project scheduling and management phases, can substantially reduce operational costs, thereby improving overall project efficiency and sustainability.

2 Literature review

Manpower planning in the construction industry increasingly emphasizes the use of data analytics to accurately predict future workforce requirements. [3] highlight the significance of data-driven forecasting methods, which involve the continuous monitoring of project performance, market demand trends, and other critical factors influencing labor requirements. Given the dynamic nature of construction projects, which frequently experience shifting timelines and unforeseen challenges, contemporary manpower planning methods must integrate flexibility and adaptability [6]. These developments ensure that workforce allocation remains responsive to changing project demands.

Additionally, the growing emphasis on sustainability and green technologies within the construction sector significantly impacts manpower planning. As highlighted by recent studies, this shift necessitates workforce development through targeted training and skill enhancement initiatives to align employee capabilities with emerging industry standards and technologies [5]. Thus, contemporary manpower planning extends beyond merely determining staffing numbers; it encompasses holistic approaches to workforce composition, collaboration, and organizational culture [10].

Effective manpower planning also involves fostering inter-team collaboration, managing conflicts proactively, and cultivating a positive workplace environment. According to [9], optimizing these human factors significantly enhances team productivity and project outcomes. Moreover, occupational health and safety remain integral components of comprehensive workforce planning strategies [4]. Prioritizing safety training, ensuring regulatory compliance, and promoting a robust safety culture are essential

practices to mitigate risks and safeguard employee wellbeing, further contributing to project efficiency and sustainability

3 Methodology

This research employs a structured methodology comprising a sequence of defined steps and processes to facilitate effective manpower planning within construction projects, as illustrated in Fig. 1. Initially, the study begins with a comprehensive literature review on lean construction to establish foundational concepts and identify essential factors influencing manpower planning. Subsequently, the factors essential to manpower planning are defined, focusing specifically on four primary dimensions: project time scheduling, cultural development within the workforce, manpower fulfillment, and reduction of excessive manpower. These dimensions were chosen based on their significant influence on project operational efficiency and effectiveness.

A survey approach utilizing a Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree) was employed to validate these factors. The survey involved 60 respondents, selected purposively from construction industry professionals with direct experience in manpower management. The validated factors underwent further analytical verification to ensure their applicability and reliability within actual construction settings. Finally, implementation and results were documented and analyzed to evaluate the efficacy of the proposed manpower planning framework.

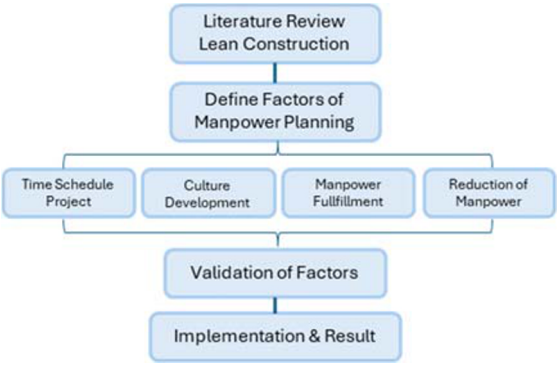

Fig. 1. Conceptual Framework.

4 Results and discussion

The findings of this study underscore a significant interconnection between manpower planning and project management within the construction industry, aligning with previous literature [1],[7]. Manpower planning serves as a crucial element of effective project management, involving comprehensive planning, organization, and management of human resources to achieve strategic objectives. Manpower planning is an integral

part of project management because it involves planning, organizing, and managing human resources to achieve project management goals effectively [7] (see Table 1).

Table 1. Factors of Manpower Planning.

Project Management (PM)	Initiating (IN)	Planning (PL)	Executing (EX)	Controlling (CO)
Time Schedule (TS)	*	*	*	*
Culture Development (CD)	*	*	*	
Manpower Fullfillment (MF)	*	*	*	
Reduction of Manpower (RM)			*	*
Project Management (PM)	Initiating (IN)	Planning (PL)	Executing (EX)	Controlling (CO)

Table 1 illustrates the identified factors integral to effective manpower planning, categorized into specific project management phases: Initiating (IN), Planning (PL), Executing (EX), and Controlling (CO). Each factor, Time Schedule (TS), Culture Development (CD), Manpower Fulfillment (MF), and Reduction of Manpower (RM), is mapped to the project management phases, highlighting their relevance and application throughout the project lifecycle. Table 2 provides a detailed correlation matrix, demonstrating significant statistical relationships among various manpower planning factors and project management phases.

Table 2. Correlation matrix.

Validation	IN - TS	IN - CD	IN - MF	PL - TS	PL - CD	PL - MF	EX - CD	EX - MF	EX - RM	CO - RM	CL - RM
IN - TS	1	.458**	.743**	.396**	.465**	.517**	.387**	.123	.715**	.633**	.469**
IN - CD	.458**	1	.483**	.476**	.601**	.447**	.223	.314*	.252	.129	.338**
IN - MF	.743**	.483**	1	.496**	.543**	.405**	.295*	.191	.638**	.524**	.416**
PL - TS	.396**	.476**	.496**	1	.761**	.590**	.521**	.446**	.301*	.117	.155
PL - CD	.465**	.601**	.543**	.761**	1	.591**	.520**	.431**	.329*	.181	.181
PL - MF	.517**	.447**	.405**	.590**	.591**	1	.747**	.298*	.447**	.264*	.284*
EX - CD	.387**	.223	.295*	.521**	.520**	.747**	1	.277*	.444**	.329*	.218
EX - MF	.123	.314*	.191	.446**	.431**	.298*	.277*	1	.067	.000	.308*
EX - RM	.715**	.252	.638**	.301*	.329*	.447**	.444**	.067	1	.789**	.503**
CO - RM	.633**	.129	.524**	.117	.181	.264*	.329*	.000	.789**	1	.495**

C	.469*	.338*	.416*	.15	.18	.284	.21	.308	.503*	.495*	1
L - RM	*	*	*	5	1	*	8	*	*	*	

Validation outcomes confirm significant correlations among the identified manpower planning factors and project management phases, indicating that effective manpower planning can substantially enhance project management performance across initiating, planning, executing, controlling, and closing phases.

The results of the validity test state that the time schedule, culture development, manpower fulfillment and the reduction of manpower factor have a significant relationship with project management. The initiating phase, planning phase, executing phase, controlling phase and closing phase also have a close and significant relationship to time schedule, culture development, manpower fulfillment and reduction of manpower.

5 Managerial implication

The factors that have been analyzed in section 5 are then created as a combination model between the time schedule for the arrival of manpower with culture development training for 1 week and a reduction in manpower according to the time schedule shown in Table 3.

Table 3. Manpower Planning.

No	Time Schedule (Project 19 Month)	1 Month	3 Month	12 Month	3 Month
	Project Management	IN	PL	EX	CO
1	Project Manager	√			
2	Deputy Project manager	√			
3	QSHE Manager	√			
4	Quality Assurance Staff			√	√
5	Document Control Crew			√	√
6	Project Planning & Engineering Manager		√		√
7	Site Engineer			√	√
8	Contract Engineer & Procurement			√	√
9	Quantity Surveyor Staff			√	√
10	M&E Engineer			√	√
11	Drafter		√		√
12	Project Control Coordinator		√		√
13	Site Schedule Controller		√		√
14	Site Cost Controller		√		√
15	Procurement		√		√
16	Logistic Group Leader			√	√
17	Project Operation Manager		√		√
18	Construction Manager			√	√
19	Supervisor			√	√
20	Bar Bending Operator			√	√
21	Quality Control Coordinator		√		√
22	Safety Control Coordinator		√		√
23	Surveyor Coordinator		√		√
24	Project Administration Manager	√			

25	Finance Staff	√
26	Human Capital & General Service Staff	√

The manpower planning model shown as Table 3 created by mapping the work to be carried out through a time schedule with Microsoft Project software provides an illustration that in the first month the Project Manager, deputy Project Manager, QSHE Manager and Project administration Manager are the first workers who must be fulfilled when the Project is first running.

By the second month, manpower must be present at project namely Project planning and engineering Manager, Drafter, Project control coordinator, Site schedule controller, Site cost controller, Procurement, Project Operation Manager, Quality control coordinator, Safety control coordinator, Surveyor coordinator, Finance staff and human capital staff.

In the next stage, the manpower requirements that must be brought in, namely in the 4th month, are all staff related to technical construction where construction activities begin. Then the manpower reduction process is carried out after the construction process is completed. In the 16th month a reduction of 21 manpower will be carried out when the project is declared complete The Manpower planning model helps projects schedule manpower arrival and manpower reduction so that manpower costs can be well controlled.

Before the improvement, manpower costs are 19 months, multiplied by the estimated average salary of IDR 13 million, the total cost is IDR 6.422 million. After making improvements to the process of hiring employees according to the schedule that has been made in each phase of Project Management, the total manpower costs became IDR 4.810 million in a period of 19 months.

6 Conclusion

The Lean Construction model developed with a focus on manpower planning can reduce operational costs, especially manpower costs. Manpower fulfillment by aligning needs based on the construction schedule that has been made can have an impact on reducing the cost of manpower by IDR 1,612 million. This model needs to be smoothed with the company's culture development so that workers can adapt quickly to the company's way of working. This model can be well applied to other construction companies.

In the future, the manpower planning model can be used to optimize manpower performance based on its function so that projects can run more effectively and efficiently. The manpower planning model can also have quite a broad impact, such as saving on work clothes and saving on other facilities. The manpower planning model can be combined with other factors so that project construction will be more optimal.

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