"Lean Management for Highway Construction

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Abstract: When it comes to project waste, the construction sector always comes out on top, whether it be in terms of material resources or personnel. This has increased the demand for a better and more organized management method. Lean management concepts and practices relevant to highway building projects are examined in this research to see if lean management approaches may increase management efficiency for complicated projects. A linear regression model was utilized to analyze the relationships between the lean test parameters and the efficiency-dependent variables in this research, which used a quantitative approach. Efficiency gains in highway building projects were shown to be connected with the adoption of lean management methods that are repeated and demand a high degree of detail. Highway building technologies such as LPS, JIT, and VM have been extensively used. Using the results of this research, project managers will be able to map numerous lean tools with their benefits and limitations and then choose the one that best fulfills the project's objectives and deliverables from the list.The interpretivism paradigm may be used to investigate new ideas and concepts in highway construction management in the future.

Keywords: Leanmanagement;projectmanagement;highwayconstructionproject;complexproject

1. Introduction

BackgroundoftheResearch

It is impossible to avoid cost and schedule overruns in construction projects, which often lead to project failures [1.] There are numerous activities and processes to be followed throughout the planning and execution phases of infrastructure projects since their supplier chains are intricate and multi-layered [2]. [3] A lack of planning and coordination may lead to delays and budget overruns. 76.3 percent of construction

projects have an issue with going above their original estimate [5]. Stakeholders typically become skeptical of the progress and Return on Investment (ROI) of projects as costs mount, leading to increased delays, unpaid invoices, and an increasing probability of canceling the whole building plan. When it comes to highway construction, the government can not just stop the project and stop investing money and resources on it. It says that a motorway project is a complicated management project, comprising long-distance and spread logistical planning and severe time restrictions [4]. Delaying a project by even one day raises the entire cost of materials, labour, and utility use.

For multi-tiered systems, traditional quality management strategies often fail to provide appropriate results [7]. "Lean Management" has been supported as the best answer for projects, including construction work and infrastructure design [8,9]. In lean management, the primary goal is to reduce waste by analyzing whether or not an action or process contributes to the project. It is easier for project managers to focus on the individual project deliverables and unique client objectives when it comes to supply chain roles and procedures [8,10].The research will look at how lean management may assist increase the management efficiency of highway building projects after establishing this fact.

WhyLeaninConstruction

Asking why lean methods are better than others for building projects is key. According to Jamil and Fathi, sustainable building is more important than meeting economic norms when it comes to construction projects [11]. Sustainable building is a direct result of lean management's recent advancements in this industry. Sustainability in construction is greatly enhanced when all lean concepts for quality efficiency and waste reduction are strictly followed in a given project. For another thing, assuming that building projects are wholly distinct from manufacturing and other endeavors constrained by both time and resources is a mistake. As a result, construction projects may benefit just as much, if not more, from the time and resource savings that come with using lean concepts.

All of these issues are addressed in the lean process by using the term 'efficiency' in this investigation. "Lean thinking" is a term used in

manufacturing and construction projects to describe the idea of continually improving a particular project via innovative thinking. That is why using lean principles may help identify the ways most suited to each project's unique requirements rather than producing an uniform template.The study's goal is to propose management solutions based on the goals, difficulties, and limits of highway building projects, using a lean approach to governance.

ProblemStatement

Project schedule and budget overruns have been widely reported due to ineffectiveness lack construction project management[6]. There is a lot of wastage and waste in the construction industry because of the lack of coordination between many stakeholders and third parties, as well as the industry's sensitivity to political and economic conditions and its convoluted critical path. As a consequence of these discrepancies, project management in the construction industry may be difficult. These worries are amplified in highway construction projects since the margin of error is almost zero, and the road will be tested with a total load force quickly after it is finished [19,20]. An increased level of attention to detail and a more targeted approach to project management are therefore required when working with such large-scale building projects.

ResearchObjectives

The following aims will be pursued in the planned research:

(i) To provide light on the fundamental concepts of lean management relevant to highway building projects.

(ii) To identify the most common issues affecting road building projects' efficiency.

(iii) To provide highway construction project managers with new lean tools to help them work more efficiently.

(iv) To see whether there are any trade-offs and restrictions to using lean management technologies on major roadway projects.

2. LiteratureReview

ConceptsofLeanManagementinConstruction

The existence of waste and overlapping processes has been well-documented in the scientific literature. The idea of waste in lean management refers to any method, resource, or overhead that is not absolutely essential and only serves to raise the overall cost or duration of a project. Overproduction, overprocessing, delays, extra inventory and movements, failures, and defects are all examples of waste that the lean approach identifies.When it comes to construction waste management, the lean approach does not just consider material waste; it also considers the loss of resources and mobility.

Figure1. LastPlannerSystem(LPS)[26].

Tezel et al., on the other hand, argue that the adoption of LPS systems is generally done without regard to market needs and supply chain factors. Supply chain cycles and complex transportation networks must be taken into account when creating a work planner system in order to make the process more transparent and robust.

An additional lean management idea is on breaking down the whole process into smaller pieces of events or completion points, so that the real problem may be more easily

understood. It is one of the most often used methods for representing systems and projects in a chronological sequence of events using discrete event simulation (DES). Water channel/pipeline mapping is one example of a work that is approached as an event having a beginning, middle, and end, as well as particular variables and parameters. Modeling the process with a stroboscope is a good way to show how resources, information, and decision-making feedback move through the system. As a result of large-scale initiatives, it is difficult to keep track on the quality of each individual work. In order to maintain a high level of quality, it is necessary to pay close attention to each event in the system and create a level layout plan for each one.

LeanManagementToolsandDelayMinimi zationinConstructionProjects

Construction is responsible for 57 percent of all productive time delays, and many of them are the result of the inadequate project management tools now in use [29]. [29] In order to meet the increased demands of the construction sector, it will be necessary to use new and more efficient equipment. Estimating time overruns and the amount of work done in relation to the amount of time used was done using the Percent Expected Time-overrun (PET) and Percent Plan Completed (PPC) tools, respectively. PET and PPC may be quantified to offer project managers a better sense of the current situation and how much more time is required for the next set of activities. According to a number of studies, lean tools may speed up projects and eliminate delays [32,33]. Visual Management (VM) and the Process Improvement Cycle (PIC) have been used in similar investigations (PIC). Graphics and flowcharts are examples of visual representations that may be used to aid in the lean process. While numerical representations are preferable for 2D and 3D variable issues, the usage of a scatter-plot is favored. Additionally, the stroboscopic system is a sort of visualization tool that depicts the complete system's operation and data flow as a graphical process flow diagram. The PDCA approach aims to continuously improve the process with improved performance matrices after each run by defining

goals and performance matrices for each step. This is how the PIC tool was developed.

It was also noted that the risk-time model developed by Issa included estimations of the probability of hazards and the resulting influence on the time index. Inexperienced contractors may cause briefing delays and redos because to their lack of expertise, and design flaws can also cause a delay. These are all examples of risks. Project schedule is then plotted against the projected time for each risk to see how much time it will take to complete the project if any of these events occur. In the future, project managers will be able to predict delays and accurately estimate project time and resources using these technologies.

LeanManagementinPost-DisasterReconstruction

The vulnerability of road building projects to natural disasters and other tragedies makes them unique and more difficult than other types of projects. The post-disaster building and restoration process must be re-planned in the aftermath of such an incident [39]. Authorities must not only rebuild a road after it is destroyed, but also transfer people into shelter houses, give emergency aid, safeguard government and public assets, and develop plans to endure future catastrophes when a road is damaged or destroyed. It is evident that all of these operations would be practically difficult to handle successfully without a defined strategy and oversight.

Many studies on post-disaster reconstruction have emerged from this integrated approach to natural disaster risk management. For disaster reconstruction to be as effective as possible given the limited time and resources available, the integrated framework developed by Mojtahedi and Oo shows that greater communication and collaboration with government, communities, nongovernmental organizations (NGOs), and other relevant sectors is needed. With the use of "Simplean," a widely-used lean tool, it is easier for different contractors and subcontractors to exchange information.

The use of Simplean, which automatically organizes tasks based on their urgency and shows outstanding duties and the person responsible, should be favored over simple emailing and note-taking.The exchange of data and information among many parties is made easier as a result of this arrangement.

Disaster Risk Reduction (DRR) and Disaster Management (ii) are two lean techniques identified by Mojtahedi and Oo (DM). Disaster preparation and response (DPR) and disaster mitigation (DMR) are two distinct approaches of preparing for disasters. There are a number of factors that the lean concept requires, including how people should be prepared in the event of an emergency, and how they should shift from catastrophe to rebuilding mode.

Figure 2 depicts a flow diagram illustrating the challenge of regulation without concern for maintainability. Roads, on the other hand, are building projects with a radically distinct aesthetic and conceptual flow from many of the others. The final design flow and criteria should take these factors into account when reconstructing roads that have been damaged by natural disasters or other causes. This, however, might end up costing the enterprise more money in the long run.

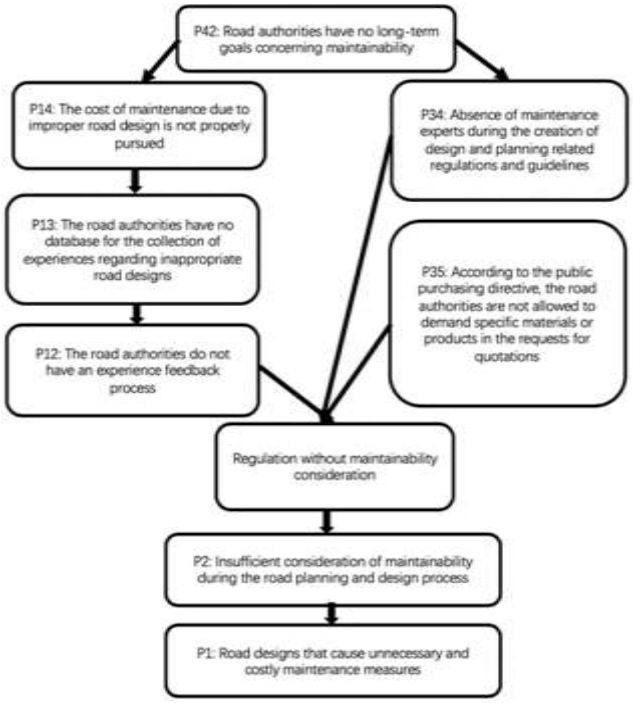

Figure2. Problemgraphforregulationwithout maintainabilityconsideration.

QuestionnaireDesign

A total of four sections make up the questionnaire (refer to Appendix A). Initial responses were solicited on the most prevalent and essential issues encountered during highway building. After that, participants had to choose one of the lean management methods they would read about in the literature.

Instead of using a fairly broad approach, it was believed that a customized lean tool would better guide the correlogram. Fourth component requested about efficiency gain, whereas the third section inquired about the lean tool's attributes (test variables). A Likert scale was used to improve the generalizability of the data results.

EthicalConsideration

Human rights and ethics were protected by adhering to the American Educational Research Association's ethical principles for primary research. Everyone who took part in the study was made aware of the study's purpose and nature, and they were requested to participate voluntarily in accordance with the 'Informed Consent' approach. Furthermore, the participant's privacy was protected by not gathering any personal information about them, such as their names, email addresses, or phone numbers. There was no way to connect back to the participants' email addresses or social media accounts even if they had been utilized to contact them. Additionally, all survey takers were informed that they might opt out of the study at any moment and would not be required to provide a reason.

LeanManagementTools

Participants had to choose one of five lean management methodologies or practices to be examined in this research. Highway construction projects were queried about lean management techniques in order to get an understanding of the industry standard and then relate these tools to highway project efficiency.

Figure 3 shows that 34 participants (28.3%) picked the last planner system (LPS) as the instrument they were most familiar with or the one they used most often when managing highway building projects. Babalola, Ibem, and Ezema also found that LPS was an important and generally recognized lean management strategy in building processes. There were 24.1 percent and 20.0 percent of the population for JIT and PIC, respectively. When it comes to managing highway building projects, VM was found to be utilized by just 15% of the respondents, and PPC by 12.5%.

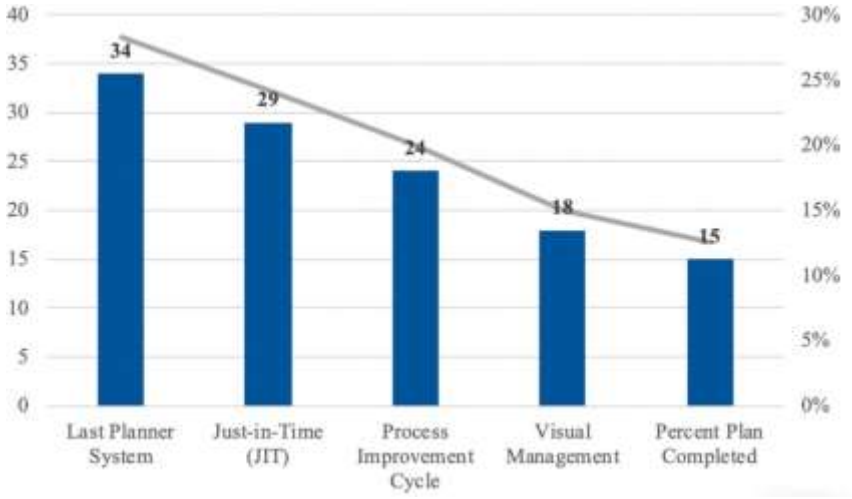

Figure3. Leanmanagementtoolsandpractices.

LinearRegressionAnalysis

If there is a statistical relationship between the use of lean management technologies and better performance efficiency in highway construction projects, an LRA was conducted.

Whether or not it was a "first choice" for managing highway building or any other project was another characteristic of the lean management tool. Findings reveal that the first choice has a statistically significant relationship between work speed, transparency, reduced costs, client communication, and grasp of the project deliverables if the first option is chosen.

Using the LRA technique, a straight line is defined by the intercept and the slope (the first option) value.This is the mathematical relationship that we may get from Table 4 when we use "y" for work speed and "x" for first choice.

3. DiscussionandAnalysis

TheNeedforLeanManagementImplement ation

You must first demonstrate a need for lean management tools before you can persuade someone to use them. Obtaining first-hand

information on the primary difficulties associated with highway building project management is essential in order to achieve this goal. The management of traffic and re-routing is a major aspect in highway projects, which are distinct from other construction projects. According to the current research, traffic management is one of the most important difficulties that demand sophisticated management methods.

For projects with several levels of hierarchy and the participation of third-party contractors, traditional management approaches still rely on human reporting. Internal departments, upper-level management, contractors and clients, as well as legal authorities, were also reported to be concerned about proper briefing and reporting. An overly elaborate reporting and communication structure might lead to misunderstandings or information flow problems while managing a large project. To put it another way, we need more effective methods of lean management.

PerformanceEfficiencyImprovement

The dependent variables in the study were used to analyze a few of the chosen lean management strategies. It is possible to acquire an understanding of the most important factors influencing highway construction project efficiency by integrating these data. The use of lean management in highway construction project management has become the standard and is no longer regarded unusual or dangerous due of its widespread use in comparable projects. A total of 82.4% of those polled agreed or strongly agreed that LPS should be the first choice for selection in the crosstabulation, with 17 people agreeing and another 11 strongly agreeing.VM, with a total agreement rate of 55.6 percent, is the next most popular instrument in the category.

4. ConclusionsandRecommendations

Conclusion

Using lean construction management, this research attempted to examine how it may be applied specifically to highway projects. Project managers of highway construction projects may benefit from using lean management concepts and technology, according to the findings of this study. Project speed, reduced delays, improved communication, and project transparency were shown to be linked. A lean management approach, on the other hand,

has the potential to lengthen and increase the cost of the whole project. However, implementing lean management in projects with short deadlines and limited resources has the potential to be a challenge.

Findings from the research show that lean management methods may enhance project efficiency if they are adopted as industry norms and workers and managers are aware of their use. Although it may take more time and money to apply lean principles in the beginning, once the whole project team is comfortable with its operation, it may considerably minimize waste in terms of time and money spent on the project, as well as communication concerns.As these projects get more complicated, future studies might examine the reasons for making the decision to use lean methods.

The mapping of popular lean management methods to the intended outcomes is an important part of this research. Managers are typically hesitant to apply lean processes because they do not know what to anticipate from them or how a certain tool would help them reach a specific project deliverable, as observed by previous study. JIT and VM were found to be more often used in highway construction projects than the other four lean techniques. The best tools for increasing productivity are those that need specialized training and concentrate on project-level details sequentially. Project managers may make an informed decision on how to proceed with their projects when using lean management tools since they can see all of the potential outcomes, deliverables, deadline extensions, and other possibilities.

The research also stated an integrated approach for adopting lean technologies. The LPS tool, for example, can recommend weekly or monthly planning of activities, constraints, and shifting work priorities. Using this phase of JIT, a better model or advice may be offered for prioritizing restrictions and prioritizing goals based on waste reduction and resource optimization principles. Breaking down a construction project into smaller, more manageable portions was another important conceptual lesson discovered from the study's research. Consider the expenses, timetables, and milestones of each individual event while planning a larger project. There is no longer the need to report the project's completion months late and lose millions of dollars since this will allow us to monitor and improve events that did not match the

project's schedule, budget, and other constraints more easily.

The research also examined the limits and trade-offs that come with choosing a certain lean instrument. The project managers might use this to compare the advantages and disadvantages of several lean tools before deciding on the one that best matches their project's requirements and goals, as well as deliverables. A new study backs up earlier results from the lean research group.

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