REVIEW OF THE UTILITY FUNCTION FOR LEAN CONSTRUCTION

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1. INTRODUCTION

Lean construction is a management concept and methodology that aims to identify problems from end-to-end in the design, construction, and maintenance processes and improve them to optimize project delivery by eliminating waste and improving value. One of the challenges in lean construction is making decisions that maximize value for stakeholders while minimizing waste. In lean construction management for road projects, a utility function can be used to evaluate and prioritize different project options based on the objectives of lean construction, such as reducing waste, improving flow, and increasing value. The application of the utility function has become increasingly popular in decision-making for construction projects, particularly in the lean construction approach. In the context of lean construction, a utility function can be used to model the preferences of stakeholders over different aspects of a construction project, such as cost, quality, safety, schedule, risk, and sustainability.

The goal of this paper is to review the existing literature about the application of the utility function in lean construction in road project management, and to explore its applicability in the Ethiopian context. The significance of this research is to improve road project outcomes by using utility functions in lean construction management in developing countries.

2. METHODOLOGY

To conduct this research, literature review on use of utility function in lean construction was performed. Then, in depth review of its components were analyzed in context of road infrastructure projects. The research question is identified as "How does utility function in lean construction improve the performance of road project outcomes?" A search on relevant academic databases using appropriate keywords such as "utility function," "lean construction," "lean project management," and "traditional project management" was conducted. Then, research papers were selected based on their relevancy and evaluate with respect to the objective of the paper and review of the application of utility function in lean construction. Finally, the application of the utility function and lean construction in the context of Ethiopian road construction management was considered.

3. RESULTS AND DISCUSSION

3.1 Overview of the utility function

A utility function is a mathematical function that assigns a numerical value to each possible outcome or decision in each situation. It is used in decision theory and economics to represent an individual's preferences over different choices or outcomes and to guide decision-making. The utility function reflects the individual's subjective assessment of the desirability or satisfaction associated with each outcome and may be influenced by factors such as risk aversion, time preferences, and social preferences. By comparing the expected utility of different options, decision-makers can choose the one that maximizes their expected satisfaction or well-being.

3.2 Utility functions for lean construction

One important aspect of lean construction is the concept of value, which is defined as the customer's perception of the benefits they receive from a project relative to its cost. To measure value, a utility function can be used, which represents the customer's preferences for different project outcomes. The utility function can help stakeholders weigh the trade-offs between different options based on their preferences and criteria. Most utility functions for lean construction for road projects depend on various factors such as project scope, objectives, timeline, risk, budget, and stakeholder requirements. In general, the following utility function can be used for lean construction in road projects (Georgy et al., 2005):

$$\text{Utility} = \text{Quality} + \text{Safety} + \text{Schedule} + \text{Cost} + \text{Risk} + \text{Sustainability} \quad (1)$$

This multi-criteria utility function aims to prioritize multiple criteria by balancing their relative importance for optimizing project performance across multiple dimensions. The utility function that considers the customer's preferences for time, cost, quality, environmental impact, and stakeholder satisfaction is expressed as:

$$U = T - \alpha C - \beta Q - \gamma E - \delta S \quad (2)$$

where U is the utility function, T is time, C is cost, Q is quality, E is environmental impact, S is stakeholder satisfaction, and α, β, γ, and δ are weighting factors(Jimoh, Richard A., et al., 2015).

Other approaches to developing a utility function for lean construction is to use a multi-criteria decision-making (MCDM) method, such as the Analytic Hierarchy Process (AHP) or the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS). These methods can help stakeholders to rank and prioritize different objectives and criteria based on their relative importance and to select the best alternative based on the trade-offs between these objectives. Another approach is to use a cost-benefit analysis (CBA) framework to evaluate the costs and benefits of different options and to determine the net present value (NPV) or the internal rate of return (IRR) of the project. This approach can help stakeholders to compare different options and to select the one that maximizes the net benefit. In traditional project management, the focus is on completing the project within the given time, cost, and scope.

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In lean project management, the focus is on continuously improving processes, identifying and eliminating waste, and delivering value to the customer. The utility function for traditional project management may prioritize factors such as cost, schedule, and scope, with less emphasis on reducing waste and improving project outcomes, and to identify the most cost-effective project options. On the other hand, the utility function for lean project management prioritizes the reduction of waste and increasing efficiency with high-quality standards. The utility function for lean and traditional construction management in road projects differ in their approach to project scheduling, resource allocation, and risk management. The utility function for lean construction management in road projects offers several benefits over traditional construction management, including improved efficiency, reduced waste, greater flexibility in project scheduling, and increased focus on customer value. By optimizing the use of resources and reducing waste and inefficiencies, lean management can help road projects deliver better outcomes while minimizing costs and delays.

3.3 Studies on the utility function for lean construction

A utility function was developed to evaluate the impact of lean construction practices on the performance of construction projects (Alarcon et al., 2018). The utility function was based on the preferences of stakeholders. It was used to compare the performance of lean and traditional construction projects in terms of cost, time, quality, safety, and sustainability. The results showed that lean construction practices were preferred by stakeholders and had a positive impact on project performance. A utility function to evaluate the impact of lean construction practices on the satisfaction of stakeholders (El-Sayegh, 2019). The utility function was based on the preferences of owners, contractors, and consultants. It was used to compare the satisfaction levels of lean and traditional construction projects in terms of cost, time, quality, safety, and innovation. The results showed that lean construction practices were associated with higher levels of stakeholder satisfaction, particularly in terms of quality and innovation. In another study, the utility function was used to evaluate the impact of lean construction practices on the productivity of construction projects (Alshawi et al., 2020). The utility function was based on the preferences of contractors and was used to compare the productivity levels of lean and traditional construction projects in terms of cost, time, quality, safety, and resource utilization. The results showed that lean construction practices were associated with higher levels of productivity, particularly in terms of resource utilization and time efficiency.

3.4 Applicability to the Ethiopian context

Due to the lack of successful implementation of project management processes, the overall traditional project management performance of road projects in developing countries is not satisfactory. Developing countries particularly suffer from road projects delay, cost overrun, scope change and poor quality performance, the utility function in lean construction is equally applicable. In the case of Ethiopia, the schedule slippage ranges between 61-80%, and the planned cost and other variables such as risk, quality, resource utilization, and safety deviate in the range of 21-40% (Annual progress Report, 2021). For improving the project performance, Ethiopian government can adopt this new approach of project management learning from existing experience in other part of the World.

4. CONCLUSIONS

In conclusion, this research showed that the application of utility function in lean construction time, cost, quality, safety, risk, and sustainability management for road projects improves the overall project outcomes with respect to stakeholders' requirements and expectations. It gave the idea that the utility function in lean construction management is better at addressing issues related to cost and time overrun than in traditional project management. In contrast, the utility function for lean project management takes a broader view of project value and seeks to optimize value by minimizing waste and maximizing efficiency. The focus is not only on achieving project goals and objectives but also on improving the overall process of project delivery. Another key difference is to place a greater emphasis on continuous improvement and learning. So developing countries like Ethiopia can utilize those new concepts in road construction management to improve the overall project performance. This approach is equally applicable in every developing nations.

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