

POTENTIAL APPLICATION OF MARGINAL ANALYSIS IN CONSTRUCTION PROJECTS

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ABSTRACT

Objective: This article discusses the marginal analysis and how it can be used to determine construction projects. It presents the features of marginal analysis with their relevant characteristics, as well as examples of how marginal analysis can be used to optimize the cost of construction projects. Finally, it presents a series of previous related research works on marginal analysis applied in the construction industry.

Research Method: This research was carried out using the literature from a previous related study on the application of marginal analysis in the construction industry.

Findings: Marginal analysis is a useful tool for assessing the additional costs and benefits of minor changes in the construction process. It can be used in construction projects to optimize cost, safety, environmental impact, project management, BIM technology implementation, procurement methods, project financing methods, and advanced technology implementation.

Originality: It is a review work of previous studies

Keywords: Marginal analysis, construction projects

1. INTRODUCTION

The construction industry is now one of the most dynamic and complex industries (Zin et al. 2006; Memon et al. 2010). Any country's economic development is greatly influenced by the construction industry (Hussin et al. 2013; Memon et al. 2011). Construction projects include the planning, design, and execution of building or infrastructure projects. They can range from minor repairs to large-scale construction projects such as skyscrapers, airports, and highways. The use of project management methodologies to ensure that construction projects are completed on time, within budget, and to the satisfaction of all stakeholders is an important aspect of construction projects. The Construction Management At-Risk (CMAR) approach is one commonly used methodology, which involves the contractor taking on a significant level of risk in the project in exchange for the potential to earn a higher profit (Kerzner, 2017). Another critical factor to consider in construction projects is sustainability. To reduce the environmental impact of a project, many architects and builders are now incorporating green building principles into their designs, such as using energy-efficient materials and systems and incorporating renewable energy sources (Najjar et al., 2019). Furthermore, Building Information Modelling (BIM) has grown in popularity in recent years as a means of improving collaboration and communication among all stakeholders in a construction project. BIM (Building Information Modeling) is a digital representation of a building or infrastructure that allows for better coordination among all design and construction disciplines and can result in cost and time savings (Chahrouh et al., 2020).

The cost of a construction project is an important factor in determining its viability. Cost is a key factor in project success and is taken into account at various stages of the project management life cycle (Rahman et al. 2014). Marginal analysis can help you understand the costs and benefits of various options and make informed decisions about how to proceed with the project. This method compares the extra costs and benefits of a specific action or decision to the costs and benefits of the current situation (Mitton et al., 2014). Project managers can determine the most cost-effective approach and make adjustments as needed to keep the project on track and within budget by weighing the marginal costs and benefits of various options (Kerzner, 2017). This procedure is critical for ensuring the project's success and maximizing the return on investment for all stakeholders (Ji et al., 2020).

A marginal analysis is a technique for weighing the additional costs and benefits of minor changes to a process or system. This method of analysis compares the marginal cost and marginal benefit of a specific action to determine the optimal level of output or resource allocation. Several studies have used marginal analysis to evaluate the costs and benefits of various options in fields such as construction, transportation, and energy. For example, (Litman, 2020) used marginal analysis to compare the costs and benefits of various transportation options for a city and discovered that using light rail transit had the highest net benefit.

2. FEATURES OF MARGINAL ANALYSIS

In his 1890 book "Principles of Economics," economist Alfred Marshall introduced the concept of marginal analysis for the first time. He defined marginal analysis as "the process of weighing the additional benefits of a specific action against its additional costs." Marginal analysis has since become widely used in many fields, including economics, finance, and engineering. In economics, marginal analysis is used to compare the marginal cost and marginal revenue to determine the optimal level of output for a firm or industry. In finance, marginal analysis is used to determine the optimal level of investment by comparing a potential investment's marginal benefit and marginal cost. Marginal analysis is used in engineering to determine the best design or operational strategy for a system by comparing the marginal costs and benefits of various options.

One of the most important aspects of marginal analysis is its emphasis on the additional costs and benefits of a specific action. This means that it only considers the cost and benefit changes caused by a minor change in the process or system. This method allows for a more precise assessment of the costs and benefits of a specific action, and it can aid in determining the optimal level of output or resource allocation.

3. CHARACTERISTICS OF MARGINAL ANALYSIS

Marginal analysis is a type of economic analysis that examines the change in overall benefit or cost that results from a minor change in one aspect of a decision, and its characteristics are as follows (Dietz & Hepburn, 2013; McDonald, 2018; Peacock et al., 2014);

- a. It focuses on the change in the overall benefit or cost resulting from a small change in one aspect of a decision.
- b. It compares the marginal benefit and marginal cost to determine the optimal decision.
- c. It is used in microeconomics to analyse the behaviour of individuals, firms and markets.
- d. It is also used in macroeconomics to analyse the impact of fiscal and monetary policies on the economy.

The marginal analysis can be conducted according to the following steps;

- a. Define the decision problem and identify the relevant variables and their ranges.

- b. Find the objective function, which is the value or profit that needs to be increased or decreased.
- c. Use math like calculus to find the best solution, which is usually written as the first or second derivative of the goal function.
- d. Perform sensitivity analysis to determine how changes in the inputs (e.g., prices, costs, etc.) affect the optimal solution

4. EXAMPLES OF MARGINAL ANALYSIS IN CONSTRUCTION

A contractor deciding whether to invest in new equipment is an example of using marginal analysis in construction. According to a study published in the Conference Series: Materials Science and Engineering by (Szafranko, 2017), the marginal benefit of investing in new equipment is increased productivity and efficiency, while the marginal cost is the cost of the equipment and maintenance. The contractor would start by thinking about the potential increase in productivity and efficiency that the new equipment would provide. The contractor would decide to invest in new equipment if the marginal benefit (additional productivity and efficiency) outweighed the marginal cost (the cost of the equipment and maintenance). The contractor would continue to assess potential new equipment investments until the marginal benefit equaled the marginal cost. At this point, the contractor would invest in the least amount of equipment possible because any additional investments would not provide enough additional productivity and efficiency to justify the cost.

A developer deciding whether to include extra features in a construction project. According to Sandmo (2015), the marginal benefit of adding extra features is an increase in property value and potential rental income, while the marginal cost is the cost of designing, engineering, and constructing the extra features. The developer would start by thinking about the potential increase in property value and rental income that the additional features would bring. If the marginal benefit (increased property value and rental income) exceeds the marginal cost (cost of designing, engineering, and constructing the extra features), the developer will decide to include them. The developer would keep weighing the pros and cons of investing in extra features until the marginal benefit equaled the marginal cost. At this point, the developer would invest in the least amount of extra features possible because any additional investments would not provide enough additional property value or rental income to justify the cost.

A construction firm considers whether to invest in a new construction method. According to Jakob (2006), the marginal benefit of investing in a new construction method is the potential reduction in construction time and costs, whereas the marginal cost is the cost of researching and implementing the new method. The construction company would start by thinking about how the new method could reduce construction time and costs. If the marginal benefit (reduced construction time and costs) outweighs the marginal cost (cost of researching and implementing the new method), the company will invest in the new construction method. The company would keep weighing the pros and cons of new construction methods until the marginal benefit equaled the marginal cost. At this point, the company would invest in the best construction method available, as any additional investments would not provide a significant enough reduction in construction time and cost to justify the cost.

5. RESEARCH WORKS RELATED TO MARGINAL ANALYSIS IN CONSTRUCTION INDUSTRY

Building construction is an important part of the global economy and has a significant impact on the built environment. Construction costs are a major concern for both private and public sector stakeholders because they impact the affordability and feasibility of building projects. Marginal analysis is an important tool for analysing and optimising building construction costs. Marginal analysis is an effective tool for assessing the additional costs and benefits of minor changes to the construction

process. It can be used in the construction industry to determine the optimal level of output or resource allocation by comparing the marginal cost and marginal benefit of a specific action. The selection of materials is one of the key areas where marginal analysis has been used in the construction industry. According to (Shahzad et al., 2015), using sustainable materials such as bamboo can result in significant cost savings in building construction. They discovered that bamboo was frequently less expensive than traditional building materials such as wood and concrete, and it also had additional advantages such as being more durable and having a lower carbon footprint. Labor practises are another area where marginal analysis has been used in the construction industry. According to a study (Ozturk et al., 2020), the use of modular construction techniques can result in significant cost savings in building construction. They discovered that modular construction can reduce labour costs by up to 30% while also resulting in faster construction times and better quality control.

According to one study (Tay et al., 2017), the use of advanced construction equipment, such as 3D printing, can result in significant cost savings in building construction. They discovered that 3D printing can reduce labour and material costs while also speeding up construction and improving quality control. According to one study (Mao et al., 2013), the use of prefabrication and off-site construction methods can result in significant cost savings in building construction. They discovered that these methods can lower labour costs and increase construction efficiency. Furthermore, these methods can lead to better quality control and a reduction in construction waste. Another application of marginal analysis in the construction industry is in the selection of construction equipment. According to (Li & Liu, 2018), the use of advanced construction equipment with features such as GPS and remote control can result in significant cost savings in building construction. They discovered that these features can increase construction efficiency while decreasing the need for manual labour. In terms of cost savings, marginal analysis can also be used to assess the environmental impact of various construction methods and materials. According to one study (Dadhich et al., 2015), using green building materials and techniques can result in significant reductions in greenhouse gas emissions and energy consumption in building construction. They discovered that these techniques can also improve indoor air quality and reduce water consumption.

According to a study (Akinlolu et al., 2020), the use of advanced safety technologies such as drones and virtual reality can lead to significant improvements in construction safety. They discovered that these technologies can improve site surveillance, reduce the need for manual inspections, and improve construction worker training. A study by (Sakikhales & Stravoravdis, 2017) discovered that using project management methodologies such as Lean Construction and Agile Project Management can lead to significant improvements in construction project performance. They discovered that these methodologies can boost project efficiency, shorten project duration, and improve project quality. Marginal analysis can also be used in the field of Building Information Modelling (BIM) to evaluate the benefits and costs of implementing BIM technology in building construction projects. According to one study (Ghaffarianhoseini et al., 2017), the use of BIM technology can result in significant improvements in construction project performance. They discovered that BIM technology can enhance project communication, improve project coordination, and reduce project errors and omissions.

A study by (Ruparathna & Hewage, 2013) discovered that using alternative procurement methods, such as design-build and public-private partnerships, can lead to significant improvements in construction project performance. They discovered that these methods can boost project efficiency, shorten project duration, and improve project quality. A study by (Rossi & Stepic, 2015) discovered that using alternative project financing methods, such as project bonds and infrastructure funds, can lead to significant improvements in construction project performance. They discovered that

these methods can increase project financing efficiency, lower project financing costs, and improve project financing security.

Marginal analysis can also be used to assess the benefits and costs of incorporating advanced technologies into building construction projects such as Building Automation Systems (BAS) and the Internet of Things (IoT). According to a study (Shah et al., 2022), the use of these technologies can result in significant improvements in building energy efficiency and building performance. They discovered that these technologies can improve building monitoring, lower energy consumption, and improve building comfort. Table 1 summarises these research projects.

Table 1: summary of using marginal analysis in construction industry

Area of Application	Key Findings	Source
Materials	The use of sustainable materials, such as bamboo, can lead to significant cost savings in building construction.	Shahzad et al., 2015, Ozturk et al., 2020, Tay et al., 2017, Mao et al., 2013, Li & Liu, 2018, Dadhich et al., 2015, Akinlolu et al., 2020, Sakikholes & Stravoravdis, 2017, Ghaffarianhoseini et al., 2017, Ruparathna & Hewage, 2013, Rossi & Stepic, 2015
Labour	The use of modular construction techniques can lead to significant cost savings in building construction.	
Equipment	The use of advanced construction equipment, such as 3D printing, can lead to significant cost savings in building construction.	
Construction Methods	The use of prefabrication and off-site construction methods can lead to significant cost savings in building construction.	
Equipment	The use of construction equipment with advanced features, such as GPS and remote control, can lead to significant cost savings in building construction.	
Environmental Impact	The use of green building materials and techniques can lead to significant reductions in greenhouse gas emissions and energy consumption in building construction.	
Safety	The use of advanced safety technologies, such as drones and virtual reality, can lead to significant improvements in construction safety.	
Project Management	The use of project management methodologies such as Lean Construction and Agile Project Management can lead to significant improvements in construction project performance.	
BIM	The use of BIM technology can lead to significant improvements in construction project performance	
Procurement Methods	The use of alternative procurement methods leads to significant	

	improvements in construction project performance	
Financing methods	The use of alternative project financing methods, such as project bonds and infrastructure funds, can lead to significant improvements in construction project performance	

6. CONCLUSIONS

This paper summarized the use of marginal analysis in the implementation of construction projects. Marginal analysis is a useful tool for assessing the additional costs and benefits of minor changes in the construction process. It can be used to reduce construction costs by comparing the marginal cost and marginal benefit of various materials, labour practices, equipment selection, site selection, design options, and project management. As well as construction methods and environmental impact. Construction materials, labour, and equipment can be determined using marginal analysis. It can also be used in other aspects of building construction such as site selection, design choices, and project management. Construction professionals can make more informed decisions and reduce construction costs by evaluating the marginal costs and benefits of various options.

Finally, marginal analysis is a useful tool for assessing the additional costs and benefits of minor changes in the construction process. It can be used in construction projects to optimize cost, safety, environmental impact, project management, BIM technology implementation, procurement methods, project financing methods, and advanced technology implementation.

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