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Incorporating Social Equity into Multi-Criteria Decision-Making for Project Bidding

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The paper presents a Multi-Criteria Decision-Making (MCDM) framework that integrates the Analytic Hierarchy Process (AHP) and the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) to assist contractors in selecting which construction projects to bid on. AHP is used to assign weights to decision criteria, including bid amount, expected profit, company fit, social impact, project location, and contract terms. These weights are then applied in TOPSIS to rank projects based on their proximity to ideal solutions. The study seeks to understand how contractors prioritize these factors, with a focus on the role of social impact alongside financial and operational considerations. The results suggest that while social responsibility is acknowledged, practical and strategic factors such as financial viability and company fit often take precedence in the bidding process. This highlights the complexities contractors face in balancing multiple priorities while striving to align their project selection with both business objectives and evolving expectations around corporate social responsibility. The research offers valuable insights into how contractors can enhance their bidding strategies by considering a broader range of criteria, including the growing importance of social impact in the construction industry.

Keywords: AHP, TOPSIS, Bid/ No Bid Decision Making, Social Impact

Introduction and Purpose

Decision-making significantly shapes our lives, with the average person making 33,000 to 35,000 decisions daily, according to a Harvard Business study (Reill, 2023). These choices, ranging from minor to major, influence personal and professional outcomes. In the construction industry, decision-making, particularly for general contractors, is equally crucial, as selecting the right projects to bid on determines their success.

The construction industry plays a pivotal role in economic growth and societal development. The industry is vast, encompassing a wide range of activities from residential and commercial building to large-scale infrastructure projects like roads, bridges, and utilities. Construction is a project-driven field where each undertaking is unique, requiring precise planning, resource management, and coordination among multiple stakeholders, including architects, engineers, subcontractors, and suppliers. At the core of the industry are general contractors, who are responsible for overseeing the day-to-day operations on a construction site, managing teams, adhering to safety and regulatory standards, and ensuring the timely delivery of projects within budget. Their role is not only operational but also strategic, as they must decide which projects to pursue, balancing financial goals with resource constraints, market conditions, and competitive pressures.

In recent years, decision-making in the construction industry has become increasingly complex. Factors such as fluctuating material costs, labor shortages, regulatory requirements, and growing environmental and social concerns have added layers of uncertainty, as highlighted by Mischke et al. (2017). For general contractors, the decision to bid on a project now requires navigating a multitude of considerations, including financial viability, operational compatibility, and broader social and environmental impacts.

A study by Junaid et al. (2020) highlights the vital role of social impact in the construction industry, emphasizing that neglecting factors like equity, community engagement, and stakeholder involvement can result in community opposition, project delays, and operational challenges. Incorporating social considerations into decision-making frameworks ensures inclusivity, fosters community support, and aligns projects with broader sustainability goals. This evolving landscape requires contractors to consider not only profitability but also the broader societal outcomes of the projects they choose to bid on. Despite the growing emphasis on corporate social responsibility (CSR) and Environmental, Social, and Governance (ESG) factors, it remains unclear how general contractors prioritize these considerations alongside traditional criteria like cost, timelines, and operational efficiency. While the construction industry plays a pivotal role in shaping communities and ecosystems, the balance between immediate business goals and long-term social impact is not well understood. This gap underscores the need for a structured framework to evaluate how contractors weigh these diverse and often competing factors in their decision-making process.

To address this, the study seeks to answer three key questions:

1. What criteria are considered most important by general contractors among a specified set?
2. How do general contractors prioritize social impact compared to other criteria when selecting projects?
3. Do different contractors attribute similar levels of importance to the same set of criteria when deciding to bid on projects?

The research explores the varying strategies contractors use in bid decisions, hypothesizing that different contractors weigh criteria such as cost, project scope, potential returns, and operational timelines differently. Additionally, it investigates how social impact, including community benefits and environmental sustainability, is evaluated in comparison to these traditional criteria. Finally, the study aims to determine whether there is uniformity across the industry or if contractors attribute different levels of importance to these factors, revealing potential variations that could shape strategic planning and competition. To address these objectives, this study utilizes two multi-criteria decision-making approaches, Analytic Hierarchy Process (AHP) and the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) as will be discussed below.

Literature Review

Multiple Criteria Decision-Making (MCDM) and its use in Construction

The integration of Multiple Criteria Decision-Making (MCDM) methods in construction-related decision-making has been widely recognized for its ability to handle both quantitative and qualitative factors. In a study on sustainable housing affordability, Mulliner et al. (2013) applied the COPRAS (Complex Proportional Assessment) method, demonstrating its effectiveness in evaluating housing affordability using multiple criteria such as economic, environmental, and social aspects. The study highlighted those traditional methods, which focus solely on economic indicators like housing costs, can often overlook crucial factors such as housing quality, location, and social sustainability. By utilizing a more comprehensive MCDM approach, the research was able to produce a ranking system that better reflects the full range of criteria affecting housing affordability. This approach can similarly be adapted for construction project bidding, where decision-makers need to balance a variety of criteria beyond cost, such as social impact, sustainability, and project scope, to ensure a more holistic evaluation of potential projects.

Taherdoost (2017) explores the Analytic Hierarchy Process (AHP) as a robust decision-making tool, especially when multiple criteria are involved. Developed by Thomas Saaty in 1980, AHP organizes decision factors into a hierarchical structure, which allows for a systematic comparison of qualitative and quantitative elements. This methodology makes it easier to weigh various options and criteria, ultimately leading to more structured and logical decision-making. One of the key benefits of AHP is its ability to assign relative weights to each criterion, helping decision-makers prioritize factors effectively.

The study by Wijayaningtyas et al., (2024) applies AHP to assess and prioritize risks in a construction project, specifically targeting delays, cost overruns, and quality impacts. By using Risk Breakdown Structure (RBS) alongside AHP, the researchers identify and categorize key risks, such as increases in material prices and fuel costs, and delays in land acquisition. The AHP method enables structured decision-making by calculating the weights of various risk factors based on expert input, resulting in a quantifiable hierarchy of project risks.

After prioritizing criteria using AHP, decision-makers can further refine their choices by applying the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS). In the study by Pandey et al., (2023), the authors offer a detailed review of TOPSIS and its various extensions, underscoring its ability to handle complex multi-criteria decision-making (MCDM) problems across numerous domains. The review examines 184 studies from 1981 to 2023, reflecting the growing versatility of the TOPSIS method, with applications spanning fields such as engineering, technology, environmental management, and more. Central to this discussion is the fuzzy TOPSIS variant, which integrates fuzzy logic to address uncertainty in decision-making, enhancing its capacity to deal with subjective judgments and incomplete data.

TOPSIS ranks projects based on their distance from the ideal solution, evaluating how closely each alternative meets desired criteria. This method is particularly useful when decision-makers need to compare various project options against both positive-ideal (best-case) and negative-ideal (worst-case) scenarios. The strength of TOPSIS lies in its ability to rank alternatives efficiently, making it a highly effective tool for project selection in industries like construction, where factors such as bid amount, expected profit, social impact, and project location must be considered. By integrating AHP to weigh criteria and TOPSIS to rank the alternatives, contractors can systematically evaluate projects and make more informed, balanced decisions.

While decision-making frameworks like AHP and TOPSIS are well-documented for their effectiveness in evaluating multi-criteria problems, limited research exists on their application within the construction industry's bid/no-bid decision-making process, particularly in balancing traditional project criteria with social and environmental impacts. Existing studies often overlook how general contractors prioritize and weigh these factors in practice, leaving a gap in understanding the integration of social impact within structured decision-making frameworks. This underscores the need for a more comprehensive decision-making framework capable of capturing nuanced relationships among various criteria. Such a framework would enable decision-makers to evaluate the ripple effects of interconnected factors, ensuring more holistic and adaptive project evaluations. Without this complexity, critical interdependencies may be overlooked, leading to suboptimal decision-making in an industry where stakes are high, and impacts are multifaceted. By leveraging both AHP for weighing and TOPSIS for ranking, contractors can enhance their decision-making process, ensuring they select projects that align with strategic objectives while minimizing risk.

Use of Corporate Social Responsibility and Social Equity in Decision-Making

Beyond traditional financial metrics, there is a growing recognition that social equity plays an essential role in modern project selection. In the construction industry, where projects significantly impact communities, factors such as social impact and corporate social responsibility (CSR) are gaining prominence. The integration of AHP and TOPSIS allows for a more holistic approach to decision-making, ensuring that projects are not only profitable but also align with broader societal goals.

Social equity is becoming a key criterion in project evaluation, particularly as stakeholders, including governments and the public, demand that companies address the social and environmental consequences of their operations. By incorporating social equity into decision-making frameworks like AHP and TOPSIS, companies can prioritize projects that contribute positively to the communities in which they operate. This means evaluating factors such as local employment generation, community development, environmental sustainability, and inclusivity alongside traditional project metrics. Social equity is an increasingly critical factor in modern decision-making frameworks, particularly within industries like construction and transportation. It refers to ensuring that all individuals, especially underserved or marginalized groups, receive fair treatment in the development, implementation, and impact of projects. As Seyedrezaei et al. (2023) reports, the built environment has historically failed to meet the needs of these groups, leading to persistent inequities. Similarly, a study by (Khalife et al., 2023) emphasizes that transportation asset management practices often overlook the specific needs of disadvantaged communities. By integrating social equity into decision-making, organizations can prioritize not only financial and operational goals but also the broader societal impacts of their projects. Passos Neto et al., (2023) explores the complexity of social sustainability in the construction industry, emphasizing that it is a multifaceted concept that cannot be captured by a single set of criteria. Social sustainability includes various dimensions such as community well-being, equitable access, environmental justice, and long-term societal impacts. The authors argue that decision-makers must adopt a framework that accounts for this complexity by integrating diverse criteria into their evaluation processes. This allows for a more accurate assessment of how construction projects contribute to social sustainability, particularly in relation to their impact on marginalized communities.

A study by Besiktepe et al., (2021) highlights the importance of adopting a systematic approach to decision-making but stress that no single method is universally applicable. Their study suggests that decision-making frameworks should be flexible and adaptable, reflecting the specific goals and

contexts of each project. For example, tools like AHP and TOPSIS may be more appropriate in different scenarios, depending on the project's focus—whether it's maximizing economic benefits, prioritizing social impact, or achieving environmental goals. The key takeaway from this research is that decision-making methodologies should be selected based on the unique requirements of the project, ensuring that both operational efficiency and social sustainability are considered.
This approach underscores the need for construction decision-makers to carefully choose the right framework based on the project's specific needs, rather than relying on a one-size-fits-all solution. By doing so, they can better align their decisions with both the business objectives and broader societal goals.

Methodology

A structured method was employed in this study to ensure consistency and accuracy in the decision-making analysis for construction project bids. The study focused on general contractors, offering a comprehensive evaluation framework that applies across various types of construction projects. This approach was essential in minimizing variability and ensuring that the analysis accurately reflects the factors influencing bidding decisions within the general contracting industry.

Step 1: Contractor Selection & Identification of the Criteria

The preconstruction teams from three well-established general contractors were selected for this study to ensure a diverse yet credible perspective on bid/no-bid decision-making processes. These contractors were chosen due to their extensive industry experience, ranging from 10 to 50 years, which reflects their proven ability to navigate complex construction projects successfully. Their long-standing presence in the industry demonstrates their resilience and adaptability, making their insights particularly valuable in identifying key criteria and strategies relevant to real-world decision-making.

Based on a consensus from discussions with preconstruction teams from three general contractors included in this study, the study identified the most used criteria in the bid/no-bid decision-making process. These insights reflect industry-wide practices and highlight the key factors contractors consider when evaluating projects. By drawing from the collective expertise of professionals across multiple firms, the study provides a broad yet consistent perspective on decision-making criteria. The six criteria selected for the Analytic Hierarchy Process (AHP) analysis were derived from these discussions, ensuring that the study focuses on the most relevant and frequently used factors in real-world project evaluation. This approach enhances the study's practical relevance by grounding it in widely acknowledged industry practices.

Table 1 presents the key factors contractors consider during the bid evaluation process, clearly defining each criterion that influences their decision to pursue a project. These criteria span from financial considerations such as Bid Amount and Expected Profit to strategic and ethical factors like Company Fit and Social Impact.

Table 1. Decision-Making Criteria for Construction Project Bidding

Criteria	Definition
Bid Amount	The total contract amount of the project
Expected Profit	The anticipated profit margin after completion of the project
Company Fit	Project's alignment with the contractor's expertise, values, and strategic goals
Social Impact	The potential for the project to contribute positively to the community or environment
Project Location	The geographic position of the project and its implications for logistics and operations
Contract Terms	The specifics of the agreement, including obligations, timelines, payments, and penalties

The general contractors involved in the study had industry experience ranging from a minimum of 14 years to 52 years, ensuring that the insights reflected a broad spectrum of expertise. To support the bidding team's understanding of these criteria, the table, along with an Excel file for Analytic Hierarchy Process (AHP) analysis, was distributed. This material reinforced the importance of each factor and clarified their significance in evaluating potential projects. The above table served as a structured tool, guiding bidding teams to evaluate projects systematically. By clearly defining criteria ranging from financial aspects like Bid Amount to strategic and community-focused factors such as Company Fit and Social Impact, the approach ensured alignment between bidding strategies and the overall objectives and values of the contracting firms.

Step 2: Use of AHP to Identify Criteria Weights

AHP was used to systematically determine the relative weights of decision-making criteria: Bid Amount, Expected Profit, Social Impact, Company Fit, Project Location, and Contract Terms. Decision-makers performed pairwise comparisons on a 1-to-9 scale, with higher values reflecting stronger preferences. These inputs were processed to calculate consistency ratios, ensuring logical and reliable comparisons. The normalized weights derived from AHP represented the importance assigned to each criterion, forming the basis for further TOPSIS analysis. A key challenge was ensuring consistent inputs from bidding teams. The Excel template included a consistency check, prompting revisions if the ratio exceeded 0.1. This iterative process enhanced the accuracy of the AHP analysis.

Step 3: Implementing ChatGPT to generate hypothetical and unbiased project attributes

In the next phase, ChatGPT was utilized to generate data for three hypothetical construction projects as shown in Table 2. This method was chosen to ensure the scenarios were created systematically and uniformly, minimizing human errors and avoiding potential biases that might arise from manually configuring the projects.

Table 2. Attributes of Hypothetical Construction Projects Based on Bid Criteria

Criteria	Project 1	Project 2	Project 3
Bid Amount	$ 950,000	$ 1,500,000	$ 1,100,000
Expected Profit	7	5	6
Company Fit	6	8	3
Social Impact	5	3	9
Project Location	9	2	7
Contract Terms	4	6	8

In the evaluation of project attributes, a **Likert scale** ranging from 1 to 9 is used to quantify subjective assessments across various criteria:

- **1 to 3 (Unfavorable to Slightly Unfavorable):** Indicates poor alignment with the contractor's capabilities or goals.
- **4 to 6 (Neutral to Favorable):** Suggests moderate to good alignment, with manageable challenges.
- **7 to 9 (Very Favorable to Extremely Favorable):** Reflects strong alignment, significantly enhancing the project's feasibility.

Step 4: Use of TOPSIS to Identify the Rankings of the Projects

In the TOPSIS method, once the criteria and alternatives are established, the decision matrix is normalized, and both the Positive Ideal Solution (PIS) and Negative Ideal Solution (NIS) are identified. The PIS maximizes the benefit criteria, representing the most favorable outcome, while the NIS reflects the least favorable scenario. This process allows decision-makers to quantitatively evaluate alternatives and guide them toward the most advantageous choice.

Table 3 outlines the Ideal Solutions for each decision-making criterion, with "Max" representing the highest value on the Likert scale and "Min" representing the lowest.

Table 3. Positive and Negative Ideal Solutions for Criteria in TOPSIS Analysis

Criteria	Bid Amount	Expected Profit	Company Fit	Social Impact	Project Location	Contract Terms
Positive Ideal Solution	Max	Max	Max	Max	Max	Max
Negative Ideal Solution	Min	Min	Min	Min	Min	Min

After identifying the ideal solutions through the TOPSIS method, the next step was creating a weighted normalized decision matrix. First, the Analytic Hierarchy Process (AHP) was used to assign weights to each criterion based on their relative importance, determined through pairwise comparisons and consistency checks. These weights were then applied to the normalized values of each criterion to ensure comparability. Once the weighted matrix was constructed, the distances from the positive and negative ideal solutions were calculated for each alternative. Projects closer to the positive ideal solution (best scenario) and farther from the negative ideal solution (worst scenario) were ranked higher, guiding contractors toward the most suitable project based on their criteria preferences.

Results

The results reveal notable variations in how contractors prioritize the bidding decision-making criteria, likely influenced by their unique business models and strategies. Table 4 shows the ranking preferences of each contractor for different decision-making criteria, revealing both their most and least preferred factors. Company A ranks Company Fit as the highest priority, indicating a strong focus on aligning the project with its internal capabilities and long-term strategic objectives. On the other hand, Social Impact is ranked lowest for Company A, suggesting that community and environmental considerations play a less critical role in their decision-making process.

Company B places the highest priority on Bid Amount, with Project Location ranked the lowest, reflecting a focus on financial competitiveness over logistical factors. In contrast, Company C ranks Expected Profit as the most important and Bid Amount the lowest, emphasizing profitability over initial bid costs. Lower rankings for criteria like Social Impact and Project Location suggest a stronger focus on financial performance before addressing other considerations. For example, Company C's prioritization of Expected Profit over Social Impact indicates that profitability takes precedence in their decision-making process. This analysis highlights the varied strategies contractors use to address immediate project goals alongside long-term objectives. The consistency ratio for each contractor remained within the acceptable threshold of 0.1, confirming the reliability of their pairwise comparisons.

Table 4. Contractor Ranking for Each Criteria

Criteria	Company A	Company B	Company C
Bid Amount (BA)	4	1	6
Expected Profit (EP)	3	3	1
Company Fit (CF)	1	2	2
Social Impact (SI)	6	4	5
Project Location (PL)	5	6	3
Contract Terms (CT)	2	5	4

The performance index for each project, based on TOPSIS, was calculated by measuring its proximity to the ideal and negative ideal solutions. The project closest to the ideal solution and farthest from the negative ideal solution was identified as the most favorable. This dual approach ensured that both the positive and negative aspects of each project were evaluated, providing a balanced assessment. Once the performance indices were established, the projects were ranked accordingly. This ranking provided a clear, quantifiable order of preference, guiding decision-makers toward the project that best aligned with their strategic goals and operational capacities.

Table 5 shows that both Company A and Company B ranked Project 2 as their top choice, while Company C preferred Project 1. These rankings align with the unique attributes and priorities of each contractor, as reflected in Table 4.

Table 5. Ranking of Projects for each Contractor

	Company A	Company B	Company C
Project 1	2	2	1
Project 2	1	1	2
Project 3	3	3	3

For Company A and Company B, Project 2 appears to stand out due to its strong alignment with key factors like Company Fit and Contract Terms. Company A places high importance on Company Fit (ranked first in their criteria), and Project 2 scores the highest (8) for this factor. Similarly, Contract Terms, which is also significant for both companies, received a relatively high score of 6 for Project 2, making it a strong candidate for their top choice. Despite Project 2 having the highest Bid Amount, its alignment with the strategic priorities of these companies makes it the most appealing option.
In contrast, Company C ranks Project 1 as the best option, likely due to its lower Bid Amount ($950,000) and higher Expected Profit (7). Profitability appears to be a key factor for Company C, as they prioritize Expected Profit the most. Although Project 1 may not perform as well in areas like Social Impact or Company Fit, its financial benefits, such as a lower bid and higher profitability, make it the most suitable choice for this contractor.

This comparison highlights how each company tailors its project selection to its unique priorities, demonstrating distinct strategies within the construction industry. Companies A and B prioritize strategic alignment and operational compatibility, favoring Project 2 despite its lower scores in Expected Profit and Social Impact. Their focus on factors like Company Fit and favorable Contract Terms reflects the importance of aligning projects with their business models and ensuring smooth integration. In contrast, Company C emphasizes financial returns, prioritizing Expected Profit and selecting opportunities that align with its core financial objectives. The importance of financial considerations in bidding decisions is evident, as highlighted by Binshakir et al. (2023), who identified client financial capabilities, payment history, and contractor financial strength as top factors influencing bidding decisions in sustainable construction projects.

Conclusions and Future Research

This research acts as a pilot study and examines how general contractors may apply AHP and TOPSIS to guide project selection decisions. Using AHP, appropriate weights were assigned to various criteria, reflecting their relative importance based on industry input. TOPSIS was then used to rank hypothetical projects by evaluating their proximity to ideal solutions. The findings show that the contractors included in this study focus on financial outcomes and operational fit, with Companies A and B selecting Project 2 due to its alignment with their strategic needs, while Company C preferred Project 1 for its higher profitability. Although Social Impact was included as a criterion, it tended to carry less weight when compared to more immediate business considerations. In summary, the study highlights the practical trade-offs contractors face when balancing financial, operational, and social objectives. While Social Impact may not rank among their top three priorities, these companies often take part in community initiatives, such as charitable programs or outreach activities, demonstrating their broader commitment to social responsibility beyond project-specific goals.

The case studies used in this research do not fully account for the complexities inherent in real-world construction projects, where factors such as legal considerations, environmental regulations, and stakeholder interests play significant roles. These additional variables, which were not comprehensively addressed in the study, may limit the generalizability of the findings. Additionally, given that the data were obtained from only three general contractors for this pilot study, the results of the study are not generalizable. Furthermore, the AHP method, while effective for structured decision-making, becomes increasingly cumbersome as more criteria are introduced, which can lead to human error and subjective bias. Another limitation is the assumption that criteria are independent; in reality, factors like stringent environmental regulations can influence other criteria, such as leading to unfavorable contract terms or affecting project timelines. To address these challenges, there is a pressing need for a decision-making framework that can effectively incorporate complex interdependencies among criteria. Such a framework would provide a more holistic understanding of the decision-making landscape, ensuring that critical relationships between factors are not overlooked.

Future research will aim to refine and expand the decision-making methodology by incorporating a broader range of criteria identified through both industry feedback and a thorough review of the literature. To address the limitations of this study, including the small sample size of only three general contractors, future studies will include a significantly larger and more diverse set of contractors to ensure conclusions that are more representative of the industry. To enhance the method's applicability, it will be tested on real-world projects, integrating actual project data, including factors like contractor performance, regulatory impacts, and market trends. This will ensure that the method remains relevant and adaptable to the evolving construction industry.

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