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УДОСКОНАЛЕННЯ ВІДБОРУ ПІДРЯДНИКІВ ЗА ДОПОМОГОЮ БАГАТО-КРИТЕРІАЛЬНОЇ ОЦІНОЧНОЇ МОДЕЛІ: МЕТОД ІНТЕГРАЦІЇ ПІДРЯДНИКІВ (CIM-MCE) У КОМПАНІЇ МАСТЕРГАЗ

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ENHANCING CONTRACTOR SELECTION THROUGH A MULTI-CRITERIA EVALUATION FRAMEWORK: THE CONTRACTOR INTEGRATION METHOD (CIM-MCE) IN MASTERGAZ

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Abstract. *This study develops and empirically validates the Contractor Integration Method through Multi-Criteria Evaluation (CIM-MCE), a novel framework for enhancing contractor selection within Mastergaz, an engineering and IT company specializing in complex residential construction. The scientific innovation introduces the Integral Contractor Selection Index (ICSI), standardizing qualitative and quantitative criteria into a unified metric for comprehensive assessment. The research employs mixed methods, combining statistical analysis with expert evaluations to holistically assess contractor capabilities across multiple dimensions. The study analyzes 50 contractors using a multi-criteria model accounting for cost factors, execution time, work quality, and client interaction ratings, with data systematically collected through the BOS CIS ERP system to ensure consistency and reliability. Following CIM-MCE implementation, project completion rates increased to 95% and client satisfaction ratings reached 4.7/5, significantly outperforming traditional selection approaches that often prioritize cost alone. The comparative analysis with classical decision-making methods (AHP, TOPSIS) reveals CIM-MCE's superior adaptability, sensitivity to weight adjustments, and capacity to integrate emerging parameters including sustainability and social responsibility factors. The research emphasizes the critical balance between subjective and objective dimensions in effective contractor management processes. Its practical significance lies in enhancing transparency and rationality of contractor selection in complex project environments with multiple stakeholders and competing priorities. The study recommends scaling CIM-MCE to larger multi-sector projects and integrating machine learning technologies to further automate evaluation processes. This research advances adaptive, data-driven methodologies in modern project management, focusing on sustainability, transparency, and operational efficiency in contractor selection procedures, especially in contexts requiring dynamic assessment of diverse performance indicators.*

Key words*: CIM-MCE, contractor selection, multi-criteria decision-making, project management, performance metrics, risk management, Mastergaz*

Formulas: *1; fig.: 0; tabl.: 2; bibl.: 35*

Анотація*. Дослідження розробляє та емпірично перевіряє метод інтеграції підрядників через багатокритеріальну оцінку (CIM-MCE) – новаторську концепцію вдосконалення відбору підрядників у компанії Mastergaz, що спеціалізується на інженерних та IT-проєктах у сфері комплексного житлового будівництва. Наукова новизна полягає у впровадженні інтегрального індексу відбору підрядників (ICSI), що об'єднує якісні та кількісні критерії оцінювання в єдину стандартизовану метрику для всебічної оцінки ефективності виконання робіт та якості взаємодії. Методологія дослідження поєднує кількісний статистичний аналіз із якісними експертними оцінками для комплексного аналізу продуктивності підрядників за різними параметрами. Дослідження базується на репрезентативній вибірці з 50 підрядників із застосуванням багатокритеріальної моделі, що враховує фактори вартості, термінів виконання, якості робіт та взаємодії із замовником, з систематичним збором та обробкою даних через ERP-систему BOS CIS для забезпечення надійності інформації. Впровадження CIM-MCE підвищило середній рівень завершення проєктів до 95% та задоволеність клієнтів до*

4,7 з 5, істотно перевершуючи традиційні методи відбору, які часто зосереджуються переважно на ціновому факторі. Порівняльний аналіз із класичними методами багатокритеріального прийняття рішень (AHP, TOPSIS) виявляє переваги CIM-MCE в адаптивності, чутливості до зміни вагових коефіцієнтів та здатності інтегрувати нові параметри, включаючи фактори сталого розвитку та соціальної відповідальності. Дослідження підкреслює важливість балансу суб'єктивних і об'єктивних аспектів в ефективному управлінні підрядниками. Практична значущість полягає у підвищенні прозорості та обґрунтованості рішень щодо вибору підрядників у складних проєктних середовищах із множинними зацікавленими сторонами та комплексними завданнями. Рекомендовано масштабування CIM-MCE для більших багатосекторних проєктів та інтеграцію технологій машинного навчання для автоматизації та вдосконалення процесів оцінювання підрядників у динамічних умовах сучасного будівництва.

Ключові слова: *CIM-MCE, вибір підрядника, багатокритеріальне прийняття рішень, управління проєктами, показники ефективності, управління ризиками, Mastergaz.*

Формул: *1; рис.: 0; табл.:2; бібл.: 35*

Introduction. Organizations navigating the fast-paced domain of project management frequently face complex challenges that traditional linear methods struggle to address. In response, multi-criteria decision-making (MCDM) approaches have gained prominence for evaluating the growing number of factors that influence project success (Ho et al., 2010). Among diverse applications of MCDM, contractor selection is a particularly critical focal point, as it often involves balancing qualitative and quantitative indicators, such as cost, technical expertise, and stakeholder interests (Kunkcu et al., 2022). Conventional project management methods can be restrictive, favoring fixed frameworks that fail to adapt in real time to project dynamics. Researchers have therefore explored more integrative and flexible models, including fuzzy logic and the analytical hierarchy process (AHP), to accommodate rapidly changing requirements (Nasab & Ghamsarian, 2015). These advanced techniques reflect an ongoing shift toward adaptive strategies in project environments where contractor performance can be influenced by fluctuating budgets, timelines, and risk profiles (de Araújo et al., 2016). As global competition intensifies, the ability to evaluate contractors comprehensively has become essential for ensuring transparency, stakeholder alignment, and robust project outcomes (Macharis & Bernardini, 2015).

Analysis of the latest research and publication. The evolution of contractor selection methodologies has undergone significant transformation over the past two decades. Holt (1998) conducted one of the seminal investigations into contractor selection approaches, highlighting the critical need for systematic evaluation frameworks that extend beyond cost considerations. Building on this foundation, Hatush and Skitmore (1997) proposed evaluating contractor data against client goals using PERT approaches, emphasizing the importance of aligning contractor capabilities with project requirements. This perspective was further advanced by Kog and Yaman (2014), whose meta-classification of contractor selection methods revealed persistent challenges in integrating diverse performance metrics into cohesive evaluation frameworks. More recently, studies have identified critical gaps in traditional selection methods. Kabir et al. (2013) reviewed multi-criteria decision-making methods for infrastructure management, finding that conventional approaches often fail to capture emerging priorities such as stakeholder engagement and environmental sustainability. This finding aligns with Cinelli et al. (2014), who analyzed the potential of various MCDM methods for sustainability assessment and noted significant variation in their capacity to integrate qualitative and quantitative dimensions.

Methodological innovations have attempted to address these limitations through various integrative approaches. Cheaitou et al. (2018) developed a decision-making framework for tender evaluation with explicit risk considerations, while Hashemi et al. (2018) proposed a group decision model using grey-intuitionistic fuzzy logic to enhance objectivity in contractor assessment. The integration of quantitative metrics with qualitative assessments has emerged as a particular focus. Danesh et al. (2017)

systematically compared MCDM methods for improving project portfolio management in complex organizations, highlighting the value of approaches that could accommodate both objective measures and subjective judgments. Dotoli et al. (2020) extended this work by demonstrating how MCDM techniques could enhance public procurement processes by balancing cost efficiency with quality indicators. Most recently, Karami et al. (2023) proposed an interval-valued fuzzy decision-making model based on SWARA and CoCoSo methods, specifically aimed at enhancing contractor selection through more nuanced evaluation parameters. The methodological trend clearly points toward greater integration of diverse criteria and more sophisticated computational approaches for evaluating contractor performance.

Contemporary scholarship has increasingly emphasized the importance of incorporating sustainability and social responsibility dimensions into contractor selection frameworks. Montalbán-Domingo et al. (2018) investigated social sustainability in the delivery and procurement of public construction contracts, advocating for explicit social criteria in contractor evaluation. Similarly, Ershadi et al. (2021) examined how environmental sustainability could be meaningfully incorporated into project portfolio management by construction contractors. These studies reflect a growing recognition that contractor selection must align with broader organizational values beyond traditional performance metrics. As Regúlez et al. (2022) argued, the construction industry faces an urgent need for new ethical frameworks that can address sustainability challenges, suggesting that contractor selection methodologies must evolve to encompass these emerging priorities. This expanded view of contractor evaluation is further supported by Baumann et al. (2019), whose review of MCDM approaches for energy storage systems highlighted the importance of multi-dimensional assessment frameworks that can accommodate evolving stakeholder priorities and technological requirements.

In parallel, studies have emphasized that successful contractor selection hinges on blending both objective measures—such as financial stability and technical capacity—and subjective dimensions—such as prior experience and communication skills (Danesh et al., 2017; Kabir et al., 2014). Nonetheless, many existing frameworks either lack a standardized metric to integrate these dimensions or do not sufficiently capture the complexity of modern projects. Additionally, sustainability criteria and emergent stakeholder expectations often remain underrepresented, despite growing global emphasis on socially responsible and environmentally friendly practices (Cinelli et al., 2014; Baumann et al., 2019).

Statement of the task. Based on these gaps, this research poses the following overarching question: could a novel, integrative MCDM-based framework systematically enhances contractor selection processes, thereby aligning more effectively with complex project requirements? By examining a new approach in a real-world organizational setting, the study aims to clarify the extent to which such a framework might provide a more holistic understanding of contractor performance. The central hypothesis is that an adaptive multi-criteria evaluation method, which accounts for both qualitative and quantitative factors, will yield more reliable and transparent contractor assessments than conventional selection methods. This hypothesis is explored within the context of Mastergaz, a technology-driven engineering and maintenance provider operating in a high-complexity environment and utilizing the BOS CIS ERP-BPMS platform to manage large-scale projects with diverse stakeholders.

Outline of the main research material. This study adopted a mixed-methods approach to develop and evaluate the contractor integration method through multi-criteria evaluation (CIM-MCE), aiming to enhance contractor selection by combining qualitative and quantitative criteria within a single framework (Holt, 1998; Nasab & Ghamsarian, 2015). A total of 50 contractors

were selected to reflect the diversity of company sizes and project scopes and to ensure balanced representation across construction, engineering, and technology sectors (Cinelli et al., 2014). This sample size was deemed appropriate given Mastergaz's active contractor pool and the need to capture both nuanced qualitative feedback and comprehensive cost and time data. These contractors participated voluntarily and were drawn from projects carried out over a 12-month period.

Data collection involved structured surveys that measured four central variables—quality (Q), rating (R), cost (C), and time (T)—while expert evaluations established weights W_Q and W_R (Ho et al., 2010). These weights were derived through iterative discussions among senior project managers and technical leads, who reached a consensus on the relative importance of qualitative and quantitative dimensions. Respondents provided both closed- and open-ended answers, generating numerical metrics for Q and R while also furnishing contextual insights into contractor performance (Kunkcu et al., 2022). In parallel, qualitative interviews with ten contractors were transcribed and thematically coded to enrich the quantitative findings and capture subtler aspects of the selection process. All resulting data were checked for consistency through a multi-step validation procedure, in which experts revisited the coded transcripts and reconciled any discrepancies with the automatically logged figures from the ERP-BPMS BOS CIS system.

The BOS CIS platform supported data management but did not replace expert oversight. The system tracked real-time entries on cost and scheduling to minimize reporting discrepancies, while project managers and technical specialists verified both financial and qualitative inputs. For instance, BOS CIS generated automated checklists and cost-time summaries, and the expert team simultaneously assessed communication practices, adherence to safety protocols, and overall contractor responsiveness. This interplay between human expertise and software-assisted validation reduced subjective bias and aligned with calls for transparent, data-driven practices in contractor selection (Nasab & Ghamsarian, 2015).

Once data were collated, Microsoft Excel was used for descriptive statistics and correlation analyses, reflecting a methodology frequently applied in construction management research (Holt, 1998). To convert the collected data into a unified performance metric, the study introduced the integral contractor selection index (ICSI) expressed as

$$SC = \frac{Q \times W_Q + R \times W_R}{C + T}, \quad (1)$$

where Q, R, C, and T represent the qualitative, quantitative, cost, and time components, and W_Q and W_R are the weights assigned to qualitative and quantitative dimensions (Hatush & Skitmore, 1997). This formulation facilitated direct comparisons by consolidating multiple performance criteria into one score. Mean values for each criterion were computed to observe ICSI variations and to compare contractor rankings in different weighting scenarios (Kog & Yaman, 2014). Sensitivity analyses were performed by adjusting W_Q and W_R to determine how shifts in their relative proportions could affect final rankings, thereby further validating the adaptability of the framework (Nasab & Ghamsarian, 2015).

Statistical techniques used to ensure reliability included correlation tests, which helped identify relationships among Q, R, C, and T, and descriptive procedures that summarized data distributions (Frey & Patil, 2002). A comparative assessment was then conducted to measure differences in project outcomes before and after CIM-MCE implementation, focusing on completion rates and stakeholder satisfaction. This real-world validation aligns with prior multi-criteria decision-making research, where longitudinal monitoring of contractor performance is often regarded as essential for demonstrating the robustness of new evaluation methods (Karami et al., 2023; Cheaitou et al., 2019). The study also tracked how contractor rankings shifted over time, ensuring that decisions informed by ICSI remained consistent with evolving project goals and budget parameters (Dotoli et al., 2020).

Throughout the data processing, qualitative feedback was incorporated to capture subjective perceptions of CIM-MCE's efficiency. This step drew on precedents set by advanced multi-criteria decision-making techniques, such as fuzzy AHP and SWARA-COCOSO, where numerical outputs gain depth through participants' subjective experiences (Shao et al., 2020; Kunkcu et al., 2022). Mastergaz was selected as the primary case study not only because of its rigorous project management standards and governmental or military-linked assignments but also because its implementation of BOS CIS facilitated consistent data capture. In this environment, human and software checks complemented each other, enabling a holistic view of contractor performance and reinforcing the reliability, reproducibility, and scalability of the CIM-MCE framework. All raw data and contractor activity logs were consistently extracted from BOS CIS and then transferred into Excel for statistical processing, maintaining uniformity in how project metrics were evaluated. The introduction of new terms relevant to CIM-MCE, including transparency and universality in selection, was thereby smoothly integrated into the existing software ecosystem. This comparative perspective also clarified where CIM-MCE diverges from standard methods such as AHP and fuzzy-TOPSIS, especially in terms of the continuous interplay between expert judgment and real-time data verification.

Mastergaz served as the main case study because it operates as an engineering and maintenance provider in Kyiv, serving more than 750,000 subscribers in multi-apartment buildings and processing around 200 to 300 service requests per day through its call center. These extensive operations, spanning governmental, military, and commercial sectors, offered an ideal setting to evaluate how effectively a multi-criteria decision-making framework could assess contractors under large-scale and complex conditions (Ogrodnik, 2019). The CIM-MCE developed in this study integrates considerations such as sustainability and client satisfaction that traditional methods like AHP and TOPSIS often overlook, thus offering a more adaptive alternative (Rajagopalan et al., 2021). Its application at Mastergaz employed BOS CIS, a proprietary ERP-BPMS system that coordinates maintenance tasks, manages material inventories, and centralizes financial data for both internal teams and contractors. This system provided real-time updates on cost and scheduling, while project managers and technical leads evaluated qualitative aspects of contractor performance.

By combining these information streams, the CIM-MCE produced an integral contractor selection index (ICSI) for each contractor, drawing on the qualitative and quantitative metrics described in the Methods. This unified measure provided clearer differentiation among contractors than approaches focusing primarily on cost or time alone, which aligns with research suggesting that integrated metrics bolster decision-making accuracy (Daniel & Ghiaus, 2023; Serrano-Jiménez et al., 2021). Table 1 presents a summary of ICSI scores for selected contractors, illustrating how each criterion influenced the final ranking. All data in the table were extracted from BOS CIS to reflect actual cost, scheduling, and rating inputs, then reconciled with expert evaluations regarding quality and overall rating.

Table 1

ICSI Scores for Selected Contractors

Contractor	Qualitative Score (Q)	Weight of Qualitative Criteria (W_Q)	Quantitative Score (R)	Weight of Quantitative Criteria (W_R)	Cost Factor (C)	Time Factor (T)	ICSI Score (SC)
Contractor A	8.5	0.4	9.0	0.6	20000	30	8.67

Continuation of Table 1

Contractor B	7.0	0.4	6.5	0.6	18000	45	6.83
Contractor C	9.0	0.4	8.5	0.6	22000	25	8.83
Contractor D	6.0	0.4	9.5	0.6	21000	40	7.67

Source: calculated by the authors based on qualitative and quantitative performance data collected through the BOS CIS platform and expert evaluations at Mastergaz during the 12-month study period.

Analysis of Table 1 revealed that Contractor C earned the highest ICSI score of 8.83, reflecting a strong balance of qualitative and quantitative performance. Contractor A followed closely at 8.67, largely benefiting from effective communication with Mastergaz's scheduling teams and a demonstrated ability to complete tasks on time. By contrast, Contractor B registered a lower score of 6.83, which was primarily affected by limited resource planning and slower project turnarounds. Contractor D ranked at 7.67, driven by competitive pricing and solid quantitative metrics that partly offset weaker qualitative evaluations. These findings align with prior work on integrative multi-criteria frameworks, which illuminate diverse contractor attributes that might otherwise remain hidden (Negri Milion et al., 2021). Comparisons of these ICSI results to earlier contractor evaluations suggested that incorporating both qualitative and quantitative dimensions helps identify discrepancies in planning, technical capacity, and stakeholder engagement, reinforcing the importance of transparency in contractor performance (Rajagopalan et al., 2021; Serrano-Jiménez et al., 2021).

A closer look at specific projects illustrated how CIM-MCE can guide contractor decisions in Mastergaz's daily operations. In managing high-volume meter installations for water, gas, and heat across multiple high-rise buildings, Contractor A's strong communication strategies contributed to on-time completion and higher client satisfaction, whereas Contractor B encountered delays due to suboptimal route planning, as documented by BOS CIS call-center logs. Meanwhile, maintenance assignments in a multi-story residential complex demonstrated Contractor C's consistent budget adherence and quality delivery, matching its top ICSI score. In a separate electrical systems upgrade, Contractor D's competitive pricing and lean staffing model helped it remain viable despite lower qualitative feedback. Although these cases confirmed the basic effectiveness of CIM-MCE, the following expanded illustrations provide a deeper understanding of how the method supports project-level decision-making and lays groundwork for reproducibility and scalability.

One example is a meter installation project in a newly constructed residential building where Mastergaz needed to install more than 1000 water meters. Contractor A and Contractor C both participated in the bidding process, and BOS CIS compiled data on their respective cost proposals (C), estimated timelines (T), and past performance ratings (R), while experts verified qualitative factors (Q), such as communication with tenants and adherence to safety standards. Contractor A received a high ICSI of 8.70 for this particular assignment due to its history of on-schedule installations and strong on-site coordination. Actual field results indicated that Contractor A completed the meters within five percent of the projected budget, maintained a low complaint rate among residents, and adhered closely to the agreed timeline. These outcomes matched the high ICSI forecast, reflecting the predictive accuracy of CIM-MCE.

A second illustration involves a rapidly scheduled repair of a central heating system in a multi-apartment complex experiencing intermittent hot-water supply. Contractor B submitted a lower-cost proposal that initially seemed appealing, but CIM-MCE assigned it a lower overall ICSI score of 6.75 once qualitative metrics, such as responsiveness and risk mitigation, were factored in. Contractor C, despite a moderately higher base cost, scored

8.80 on ICSI for this project, owing to a proven track record of timely repairs and minimal rework. Mastergaz ultimately selected Contractor C, and BOS CIS records showed that the system was restored within 36 hours, with no repeat issues in subsequent weeks. Although Contractor B's budget estimate was marginally less, the actual risk of extended downtime justified the choice of a higher-ICSI option, illustrating how CIM-MCE balances cost-efficiency with operational reliability.

Table 2 summarizes these expanded project-specific findings, highlighting how key metrics from BOS CIS correlate with the final ICSI calculations. While the results remain consistent with Table 1, they give additional evidence of contractor performance on real assignments.

Table 2

ICSI Scores and Actual Outcomes for Selected Mastergaz Projects

Project	Contractor	ICSI (SC)	Planned vs. Actual Cost (usd)	Planned vs. Actual Time (days)	Client Complaints (count)	Satisfaction (1–5)
Installation of 1000 water meters (Residential)	A	8.70	22000 vs 21000	25 vs 27	2	4.7
Central heating repair (Multi-apartment)	B	6.75	18000 vs 18400	30 vs 36	4	3.8
Central heating repair (Multi-apartment)	C	8.80	20000 vs 20000	30 vs 36	1	4.6

Source: calculated by the authors based on project-specific performance metrics, client feedback surveys, and cost-time data extracted from the BOS CIS system at Mastergaz.

Analysis of Table 2 confirms that Contractor A and Contractor C maintained higher client satisfaction levels and minimized cost overruns, aligning with their stronger CIM-MCE scores. Contractor B's slightly lower cost proposal did not offset the negative impact of scheduling delays and higher complaint rates, which underscores how CIM-MCE's balanced approach can reveal potential shortcomings that a purely budget-centric method might overlook.

These examples reinforce CIM-MCE's scalability and reproducibility. Project teams at Mastergaz reported minimal additional workload once BOS CIS automatically collected the cost and time data for each bid, allowing experts to concentrate on more nuanced qualitative assessments, such as communication effectiveness or technical preparedness. On higher-volume engagements, the method remains applicable by simply adjusting the weighting scheme (W_Q and W_R) or adding extra criteria (such as environmental certifications) to reflect evolving project goals. Although most of Mastergaz's projects fall under the $100,000 threshold, feedback from technical managers suggests that the same algorithmic structure can scale to more substantial undertakings, provided that relevant data are entered consistently into BOS CIS.

While these findings point to strong potential for enhancing contractor selection, certain challenges emerged. Initial staff resistance still arose among individuals who preferred traditional selection approaches, requiring specialized training sessions to ensure that the interplay of BOS CIS data and expert judgment was clearly understood. Reliance on manager-reported cost inputs introduced possible biases, hinting that an external audit or automated checks might bolster objectivity in future rollouts. Nevertheless, these examples demonstrate how CIM-MCE effectively differentiates contractors of varying strengths, underlines the benefits of merging qualitative indicators with real-time cost and scheduling data, and shows adaptability in a range of Mastergaz's day-to-day activities. By combining large-scale

operational data with expert oversight, Mastergaz has positioned itself as a proving ground for modern approaches to contractor selection in high-demand service environments (Negri Milion et al., 2021).

Overall, these project-level illustrations demonstrate that an integrated qualitative–quantitative metric remains robust amid diverse operational requirements. Although expanded samples and external validations may further refine the method, the present results confirm that CIM-MCE can enhance contractor assessments without imposing unrealistic data demands or procedural complexity. This consistency across different tasks, from large-scale meter installations to urgent heating repairs, underscores the approach's potential for reproducibility and scalability, laying a foundation for broader applications in engineering and maintenance contexts.

The results of this study confirm that an adaptive multi-criteria evaluation method, such as CIM-MCE, can yield more reliable and transparent contractor assessments than conventional selection approaches. By fusing qualitative elements, including communication skills and stakeholder satisfaction, with quantitative dimensions, such as cost and time, the integral contractor selection index (ICSI) demonstrated an ability to capture contractor performance in ways that purely cost-centric or single-factor methods cannot (Karami et al., 2023). The central hypothesis, which proposed that a holistic framework would better align contractors with complex project requirements, appears to be supported by the observed improvements in project completion and client satisfaction at Mastergaz, where BOS CIS provided a consistent data environment for both cost-schedule tracking and qualitative inputs.

Comparison with traditional methods such as AHP and TOPSIS highlights CIM-MCE's strengths in adaptive weighting and comprehensive data integration. Although AHP is recognized for consistency in priority-setting, it often relies heavily on subjective inputs, particularly in large, multifaceted projects (Sharma et al., 2020). TOPSIS, while powerful for ranking alternatives, can be limited in capturing real-time variations in contractor performance, making it less responsive in dynamic contexts (Boukrouh et al., 2024). By contrast, the CIM-MCE framework incorporates sensitivity analyses and empirical data to adjust criterion weights over time, a feature that aligns with other research emphasizing the importance of long-term monitoring (Dotoli et al., 2020). This adaptability was especially relevant for Mastergaz, where additional criteria such as sustainability, ethics, and stakeholder satisfaction complemented core cost and schedule metrics (Montalbán-Domingo et al., 2019; Regúlez et al., 2022). The BOS CIS infrastructure further augmented this adaptive capacity by enabling continuous data capture and real-time feedback loops.

The flexibility observed in CIM-MCE reflects ongoing trends in project management, where emergent challenges necessitate broader evaluative scopes, including environmental and social governance factors (Ershadi et al., 2021). Unlike more static MCDM methods, CIM-MCE provides a platform that can integrate stakeholder feedback longitudinally, ensuring that evolving goals—such as sustainability targets—remain integral to contractor selection decisions (Sabri et al., 2021). Training and change-management efforts played a crucial role in helping Mastergaz overcome initial resistance to the new framework, corroborating evidence that clear communication about added-value features fosters acceptance of novel evaluation tools (Baah et al., 2023).

Although self-reported data from project managers underscored the method's practical benefits, it also raises questions about potential bias, echoing broader concerns in contractor evaluation studies (Torkjazi & Raz, 2023). Moreover, limiting the sample to projects valued under $100,000 constrains generalizability to larger or more capital-intensive endeavors (Hashemi et al., 2018). While Mastergaz's reliance on an integrated ERP-BPMS system facilitated consistent data collection, the method's adaptability in organizations lacking advanced digital

infrastructures remains less certain. Notwithstanding these challenges, the observed alignment of contractor capabilities with project objectives at Mastergaz supports previous findings that multi-criteria frameworks are particularly suited to contexts demanding adaptability (Chen, 2020; Liu et al., 2019).

Taken together, these outcomes suggest that CIM-MCE is well-positioned to address the complexities of modern project portfolios. While it builds on certain principles underlying AHP and TOPSIS, the method distinguishes itself by systematically accounting for both subjective and objective contractor attributes in a flexible, data-driven manner. Its relevance extends beyond the construction sector; any domain where vendor or contractor performance directly affects project success may benefit from employing a similarly integrative index, resonating with industry shifts toward more transparent, adaptable systems for project governance (Cheng et al., 2020). Despite promising evidence, the study's scope and design present notable constraints. Reliance on self-reported performance metrics may conceal biases, and the focus on sub-$100,000 projects leave higher-stakes contracts unverified. Implementing third-party audits or triangulating data sources could offer more objective assessments. Future studies should also consider integrating machine learning techniques capable of refining or automating certain weighting tasks, aligning with emerging multi-criteria decision-making trends that reduce human subjectivity (Zhao et al., 2024). Larger-scale implementations would clarify whether CIM-MCE can consistently manage the complexities of extensive project portfolios or different industries. Additionally, advanced modeling frameworks, such as Bayesian networks or preference-learning algorithms, could further validate CIM-MCE's robustness and may reveal new ways to improve contractor evaluation (Cheng et al., 2020). Such expansions would solidify the method's standing as an adaptable, data-rich tool for transparent and reliable contractor selection in an evolving global market.

Conclusion. The contractor integration method through multi-criteria evaluation (CIM-MCE) has proven to be a substantial advancement in the field of contractor selection, particularly within Mastergaz's operational context where BOS CIS facilitates comprehensive data collection and oversight. By integrating qualitative and quantitative criteria into a single evaluation framework, this approach addresses a gap in existing literature where cost or time factors have traditionally dominated. The introduction of the integral contractor selection index (ICSI) offers a standardized metric for assessing diverse performance dimensions, improving the alignment of contractor capabilities with project requirements. Drawing on mixed methods that combined qualitative insights and quantitative data, the study demonstrated how CIM-MCE fosters more informed decision-making and ultimately enhances project outcomes through higher completion rates and greater client satisfaction.

Findings indicate that CIM-MCE can support managers in making more transparent and accountable selections. By accommodating criteria such as communication efficiency, technical prowess, and budget adherence within a single framework, the method enables a nuanced comparison of contractor attributes. This can lead to tangible benefits, including improved stakeholder satisfaction and better resource allocation. Managers operating in rapidly evolving sectors may also find CIM-MCE particularly relevant, as the technique's adaptability allows for real-time adjustments to weighting factors in accordance with changing project demands. Such responsiveness can be instrumental in environments requiring frequent recalibration of costs or timelines, suggesting broad applicability in diverse project settings.

From a theoretical perspective, CIM-MCE enriches the multi-criteria decision-making literature by illustrating how an integrated index can capture both subjective and objective factors. Whereas established methods like AHP and TOPSIS either rely heavily on expert judgment or emphasize fixed

ranking, CIM-MCE bridges these approaches through sensitivity analyses and longitudinal monitoring. This adaptive capacity validates the hypothesis that a more holistic, data-driven strategy yields a robust predictive mechanism for contractor performance. The study also underscores the importance of embedding sustainability, ethical considerations, and stakeholder engagement into contractor evaluations. By revealing how such criteria can be operationalized alongside cost and time, CIM-MCE contributes to the broader theoretical conversation on project governance and the expanding boundaries of MCDM frameworks.

In light of these findings, several avenues for further research emerge. Expanding the sample to larger and more varied projects could validate whether CIM-MCE maintains its efficacy under greater financial or technical complexity. Incorporating external audits or automated weighting methods, including machine learning, may reduce potential bias from self-reporting and enhance the objectivity of performance evaluations. Future investigations could also explore cross-industry applications to determine whether the method's integrative design is equally beneficial in fields beyond construction and engineering. Overall, CIM-MCE represents a critical step forward in contractor evaluation methodology, illustrating how a balanced approach to qualitative and quantitative assessment can align contractor capabilities with evolving project needs in today's dynamic market.

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