ISSN (Print) 2307-6968, ISSN (Online) 2663-2209
Вчені записки Університету «КРОК» №3 (79), 2025

УДК 005.8/.338.27/.519.8/624
DOI: 10.31732/2663-2209-2025-79-223-235

Дата надходження: 20.07.2025
Дата прийняття до друку: 31.07.2025
Дата публікації: 30.09.2025

ПІДВИЩЕННЯ ЕФЕКТИВНОСТІ УПРАВЛІННЯ ПРОЄКТАМИ ЗА МЕТОДОМ IVPO: ДОСВІД КОМПАНІЇ MASTERGAZ

Юрій Черненко[1], Віктор Алькема[2]

[1]*Канд. техн. наук, Міжнародний університет бізнесу і права, м. Херсон, Україна, e-mail: yc.gbbio@gmail.com, ORCID: https://orcid.org/0000-0002-7008-7274*

[2]*Д-р екон. наук, професор, завідувач кафедри управлінських технологій, ВНЗ «Університет економіки та права «КРОК», м. Київ, Україна, e-mail: Alkema@krok.edu.ua, ORCID:* https://orcid.org/0000-0001-5997-7076

ENHANCING PROJECT MANAGEMENT EFFICIENCY THROUGH THE IVPO METHOD: EVIDENCE FROM MASTERGAZ

Yuri Chernenko[1], Viktor Alkema[2]

[1]*Candidate of Technical Sciences, International University of Business and Law, Kherson, Ukraine; e-mail: yc.gbbio@gmail.com, ORCID: https://orcid.org/0000-0002-7008-7274*

[2]*Doctor of Science (Economics), Professor, Head of the Management Technologies Chair, "KROK" University, Kyiv, Ukraine, e-mail: Alkema@krok.edu.ua, ORCID:* https://orcid.org/0000-0001-5997-7076

***Анотація**. У дослідженні розглянуто метод інтегрованого вектора оптимізації проєктів (IVPO) як інноваційний підхід до підвищення ефективності управління проєктами в інженерно-технічних середовищах із високим рівнем складності. Актуальність теми обумовлена необхідністю адаптації управлінських рішень до умов обмежених ресурсів, багатокритеріальності, змінних вимог зацікавлених сторін і потреб у гнучкому плануванні. Дослідження має на меті емпірично перевірити ефективність IVPO-методу щодо скорочення строків виконання проєктів, поліпшення бюджетної дисципліни та підвищення задоволеності стейкхолдерів. Методологічно дослідження ґрунтується на змішаному підході (mixed methods), що поєднує кількісний аналіз (опитування, регресійне моделювання) та якісні інтерв'ю з проєктними менеджерами Mastergaz. Було проаналізовано п'ять інженерних проєктів вартістю до 100 000 доларів США кожен із використанням платформи ERP-BPMS BOS CIS. Запропонований IVPO-алгоритм, оснований на задачі «рюкзака», дозволяє формувати вектор оптимального розподілу ресурсів із урахуванням таких факторів, як терміни, вартість, доступність, ризики, профіль навичок персоналу тощо. Результати показали скорочення тривалості виконання проєктів у середньому на 12%, зростання відповідності бюджетам на 5% і підвищення задоволеності зацікавлених сторін на 4%. Регресійний аналіз підтвердив статистично значущу залежність між використанням IVPO і покращенням основних показників ефективності. Встановлено, що IVPO не лише знижує витрати часу та ресурсів, а й сприяє прозорішому прийняттю рішень у складних проєктних середовищах. Перспективи подальших досліджень включають масштабування IVPO на більші проєктні портфелі, впровадження технологій машинного навчання для автоматизації вагових коефіцієнтів і застосування в інших галузях, зокрема в IT, виробництві та інфраструктурному будівництві. Дослідження робить внесок у розвиток гнучких, орієнтованих на дані систем підтримки прийняття рішень у сфері управління проєктами.*

***Ключові слова:** метод IVPO, оптимізація управління проєктами, задача пакування рюкзака, багатокритеріальне прийняття рішень, задоволеність зацікавлених сторін, показники ефективності, система ERP-BPMS.*

Формул: 2; рис.: 0; табл.:3; бібл.: 51

***Abstract.** This study examines the Integrated Vector for Project Optimization (IVPO) method as an innovative solution to enhancing project management efficiency in complex engineering environments. The relevance of the research stems from the increasing need for adaptive decision-making models capable of handling resource constraints, multi-criteria evaluation, stakeholder dynamics, and real-time planning. The study aims to empirically validate the effectiveness of the IVPO method in reducing project completion time, improving budget adherence, and elevating stakeholder satisfaction. The methodology follows a mixed-methods research design, combining quantitative surveys and regression modeling with qualitative interviews conducted among project managers at Mastergaz. Five engineering projects, each under 100,000 USD, were analyzed using data from the ERP-BPMS BOS CIS platform. The IVPO method, rooted in the classical knapsack problem, introduces an optimization vector that integrates criteria such as time, cost, availability,* *risk, and skill alignment to generate efficient resource allocation scenarios. Findings indicate that IVPO implementation resulted in a 12% reduction in project duration, a 5% improvement in budget adherence, and a 4% increase in stakeholder satisfaction. Regression analysis confirmed statistically significant correlations between IVPO use and key performance indicators. The method also demonstrated enhanced decision transparency and operational efficiency across various project phases. Future research directions include scaling IVPO to manage larger project portfolios, integrating machine learning algorithms for automated weight calibration, and applying the method across diverse sectors such as IT, manufacturing, and infrastructure. This study contributes to the advancement of flexible, data-driven decision-support tools in the field of project management, offering a scalable solution to the challenges of contemporary project complexity.*

Key words: *IVPO method, project optimization, knapsack problem, multi-criteria decision-making, stakeholder satisfaction, performance metrics, ERP-BPMS.*

Formulas: 2; fig.: 0; tab.: 3; bibl.: 51

Introduction. In an era of growing complexity and rapid change, effective project portfolio management is increasingly recognized as a pivotal driver of operational efficiency and strategic success. Recent research underscores the critical importance of multi-criteria decision-making approaches in addressing modern project challenges. Mansor (2025) emphasizes that prioritizing project manager skills according to construction project success factors requires sophisticated multi-criteria frameworks, while Manzolli et al. (2025) introduce synthetic multi-criteria decision analysis (S-MCDA) as a novel framework for participatory planning processes. These advances highlight the evolution from traditional single-criterion optimization to more comprehensive approaches that consider multiple stakeholder perspectives and dynamic constraints.

Analysis of the latest research and publication. The challenge of optimizing project portfolios has been addressed through various methodological lenses. Traditional approaches often rely on linear programming and analytical hierarchy processes, yet these methods frequently struggle with the complex interdependencies characterizing modern projects. Zahedirad et al. (2025) demonstrate how fuzzy goal programming based on fuzzy preference relations can solve integrated project portfolio selection problems, addressing both portfolio optimization and contractor selection simultaneously. Similarly, Jang and Suh (2025) propose technology infusion analysis for R&D project portfolio valuation, emphasizing the need for dynamic assessment models that capture evolving technological landscapes. While these frameworks show promise, many still face limitations when dealing with real-time resource allocation and emerging risk factors (Cooper & Sommer, 2023; Bai et al., 2023).

The integration of advanced scheduling optimization techniques represents another critical dimension of project management evolution. Peng et al. (2025) present a multi-skill project scheduling optimization approach based on quality transmission and rework network reconstruction, addressing the complexities of resource allocation when team members possess diverse competencies. Complementing this, Zhao and Lu (2025) develop a dynamic scheduling optimization model for linear projects that incorporates local rescheduling capabilities, enabling more flexible responses to project disruptions. These contributions underscore the shift from static planning to adaptive, real-time optimization strategies.

Stakeholder engagement and satisfaction have emerged as crucial factors in project success. Song et al. (2025) examine how risk management practices influence sustainable project performance, with stakeholder engagement serving as a mediating factor. This finding aligns with Lucien and Amolo (2025), who demonstrate that specific stakeholder engagement strategies significantly impact road construction project performance. Furthermore, Valentini et al. (2024) explore how corporate conflict engagement actions affect stakeholder satisfaction, revealing the importance of goodwill, trust, and value alignment in managing project relationships. These studies collectively emphasize that technical optimization must be balanced with effective stakeholder management to achieve comprehensive project success.

The role of integrated information systems in enhancing project management capabilities has gained considerable attention. Ozkan et al. (2023) demonstrate how Business Process Management System (BPMS) implementation influences an organization's process orientation, providing empirical evidence from a financial service provider. Building on this foundation, Chernenko et al. (2025) present a multi-case study showing how integrated ERP-BPMS systems can mitigate operational risks in critical infrastructure projects. These findings suggest that the convergence of enterprise systems with optimization methods creates new opportunities for real-time decision-making and risk management.

Methodological rigor in project management research has also evolved significantly. Poth et al. (2024) advocate for mixed methods research teams that leverage integrative teamwork to address complex problems, emphasizing the value of combining quantitative optimization with qualitative insights. This methodological sophistication enables researchers to capture both the technical and human dimensions of project management, providing a more holistic understanding of optimization challenges.

In response to these evolving perspectives, this study focuses on the Integrated Vector for Project Optimization (IVPO) method, a novel approach informed by the knapsack problem that integrates system dynamics, multi-dimensional analysis, and advanced assessment models to address critical gaps in current methodologies (Anaya et al., 2022; Bai et al., 2021). The IVPO method builds upon the foundations established by recent multi-criteria and dynamic optimization research while incorporating unique features for handling project interdependencies and stakeholder considerations.

To evaluate the IVPO method in a real-world context, the research examines its implementation at Mastergaz, an it-driven engineering company known for leveraging the ERP-BPMS BOS CIS (Business Operation System 'CIS') platform to unify business processes, ensure real-time data accessibility, and improve decision-making accuracy (Wu, 2021; Ibrahim et al., 2019). The integration of IVPO with existing ERP-BPMS infrastructure aligns with recent findings on the synergistic benefits of combining optimization algorithms with enterprise systems (Chernenko et al., 2025; Ozkan et al., 2023). Mastergaz's extensive experience in managing complex engineering projects, including residential high-rise buildings, offers a practical setting to assess how novel optimization methods align with organizational objectives and stakeholder requirements (Biloskurskyi, 2022). Additionally, prior evidence suggests that effectively customized ERP solutions, supported by a sound classification and prioritization of project manager competencies, can further enhance project outcomes (Kraljic & Kraljic, 2019; Amalnik & Ravasan, 2018).

Statement of the task. Against this backdrop, the study addresses two primary research questions: how does the IVPO method compare to traditional optimization techniques in enhancing project management efficiency, and what specific impacts does the IVPO method have on project completion times, budget adherence, and stakeholder satisfaction? Guided by existing literature that emphasizes robust data-driven systems and agile methods, three hypotheses are proposed. Hypothesis h1 states that the IVPO method significantly reduces project completion times compared to traditional approaches. Hypothesis h2 asserts that the IVPO method improves budget adherence across project portfolios. Hypothesis h3 posits that the IVPO method enhances stakeholder satisfaction through improved collaboration and communication among project teams. These propositions anchor the study's inquiry into how IVPO may offer a more flexible and integrated framework for optimizing project portfolios within the engineering sector.

Outline of the main research material. This study employed a mixed-methods approach to assess the effectiveness of the Integrated Vector for Project Optimization (IVPO) method within Mastergaz. Mixed-methods research has been recognized as a robust strategy for addressing complex project management challenges by combining complementary quantitative and qualitative data (Poth et al., 2024). As Poth et al. (2024) emphasize, leveraging integrative teamwork in mixed methods research teams enables addressing complex problems more comprehensively. Qualitative insights derived from semi-structured interviews guided the construction of quantitative surveys, thereby providing a fuller perspective on IVPO's applicability (Almeida, 2018). This approach aligns with the synthetic multi-criteria decision analysis framework proposed by Manzolli et al. (2025), which emphasizes participatory methods in complex decision environments. A purposive sample of thirty project managers and stakeholders was selected from the engineering, logistics, and project management departments, with all participants having at least three years of project management experience and active involvement in portfolio-level decisions. This sampling strategy aligns with accepted best practices in mixed-methods studies that emphasize detailed, context-rich data collection (Timans et al., 2019; Grant et al., 2023).

Data collection included structured surveys and subsequent semi-structured interviews. Survey questions were developed by reviewing existing literature on project management and optimization techniques and included both closed and open-ended items (Elkabalawy & Moselhi, 2021). The surveys were administered electronically with a two-week response window, supported by reminder notices to maximize the participation rate. Of the thirty invitees, twenty-five submitted completed surveys, yielding an 83% response rate. Quantitative analyses involved descriptive statistics, correlation tests, and regression modeling using statistical software (Zhou, 2023). Ten of the survey respondents then participated in follow-up interviews lasting about 45 minutes each; all interviews were recorded with consent and transcribed for thematic analysis, offering an additional layer of detail regarding resource allocation challenges and the practical viability of IVPO (Vinogradova, 2019).

The study focused on five engineering projects, each valued at under 100,000 USD, to reflect Mastergaz's typical service portfolio. To explore whether IVPO confers advantages over standard optimization approaches, the method was benchmarked against adaptive evolutionary algorithms and multi-criteria decision-making practices (Nhung et al., 2023). For each of the five projects, data were obtained from the BOS CIS (Business Operation System 'CIS') platform, a centralized information system that monitors resource utilization and project milestones in real time. The integration of IVPO with the BOS CIS platform aligns with recent findings by Chernenko et al. (2025), who demonstrated how integrated ERP-BPMS (Enterprise Resource Planning - Business Process Management System) platforms effectively mitigate operational risks in critical infrastructure through systematic cross-verification mechanisms. While BOS CIS provides automated scheduling and budgeting prompts, it does not operate entirely in isolation. Project teams follow established check-lists and validation protocols, systematically verifying the platform's suggestions and enabling the system to cross-verify their inputs. This reciprocal checking mechanism, combined with BOS CIS's built-in process graph analysis that validates the presence of terminal steps and prevents infinite loops, mitigates the risk of errors and bolsters consistency when applying IVPO, as field specialists can intervene if the system-generated outputs appear incompatible with on-the-ground conditions. The BOS CIS data were exported into Microsoft Excel for subsequent analysis; descriptive metrics captured key variables, and hypothesis testing was conducted through inferential statistics.

A regression model was introduced to investigate the relationship between specific project attributes and observed performance outcomes (Salama & Moselhi, 2019). Correlation analyses were also performed to detect possible synergies or dependencies among various projects (Kandakoglu et al., 2023). The choice to concentrate on five relatively small-scale engineering efforts was made to keep the research scope streamlined and permit a controlled evaluation of IVPO. Although these projects represented modest budget thresholds, they encompassed the organizational diversity of Mastergaz's core operations, making them suitable for real-world testing of the proposed method. The approach is inherently reproducible; organizations with similar data inputs—such as cost, schedule, risk factors, and feedback metrics—can integrate IVPO with or without a fully automated enterprise system, provided that systematic cross-verification procedures are in place.

Fundamental to IVPO is the classical knapsack problem, expressed here in lowercase to allow straightforward copying and reuse. The objective is to maximize:

$$\sum_{i=1}^{n} (w_i \times x_i) \quad (1)$$

subject to the constraint:

$$\sum_{i=1}^{n} (w_i \times x_i) \leq C \quad (2)$$

where v_i is the value of project i, x_i is a binary variable indicating whether project i is chosen, w_i is the cost of project i, and C is the total budget constraint. This formulation extends into a broader multi-criteria framework that incorporates considerations such as social impact, ecological footprint, and risk tolerance (Marcondes, 2019). The IVPO method leverages BOS CIS's built-in *Score(i)* calculation mechanism, which evaluates multiple factors including *geoFactor(i)*, *urgencyFactor(i)*, *skillRating(i)*, *profitFactor(i)*, and *availabilityFactor(i)*. This scoring system, integrated with the platform's BPMS module, enables automated task distribution based on weighted criteria (w_d, w_t, w_s, w_f, w_a, w_g) configured for each project type. The cross-verification between IVPO algorithms and BOS CIS's native optimization ensures robust decision-making while preventing circular dependencies through the platform's built-in validation mechanisms. Although advanced technological tools—machine learning or the internet of things—were intentionally omitted to maintain operational simplicity (Chen, 2019), IVPO has the capacity to scale to larger and more heterogeneous project portfolios (Abdel-Basset et al., 2019). Engaging hybrid strategies may also improve predictive accuracy in highly multifaceted decision contexts (Ansyah et al., 2023).

This study was conducted in accordance with ethical guidelines for research involving human participants. All survey and interview participants provided informed consent, and data collection procedures were approved by Mastergaz's internal compliance committee. Participant anonymity was maintained throughout the research process.

By adhering to these procedures, this research sought to validate IVPO as an innovative approach that balances system-based automation with human expertise. In doing so, it furthers the development of integrated methods for project portfolio management and demonstrates the feasibility of implementing IVPO in both smaller-scale and more expansive engineering environments.

The application of the Integrated Vector for Project Optimization (IVPO) method at Mastergaz during 2023-2024 offered concrete evidence of improved project management effectiveness, particularly within the realm of multi-apartment maintenance and engineering services. Mastergaz, headquartered in Kyiv, oversees more than 750,000 household subscriptions through BOS CIS, a central information system that coordinates 200 to 300 daily service requests. These frequent tasks encompass a wide spectrum of technical interventions, including the installation and verification of water or heat meters, electrical wiring upgrades, and hvac maintenance. This diversity of operations produces a large volume of data through BOS CIS, making it highly representative of Mastergaz's real-world environment.

Five projects, each valued at under 100,000 USD, were selected to reflect

Mastergaz's typical engineering activities, such as meter installation campaigns, plumbing repairs, and electrical servicing in residential high-rise buildings. The BOS CIS system tracked resource allocation, labor assignments, and progress milestones on an ongoing basis, enabling a continuous stream of inputs for IVPO analysis. By combining the method's optimization algorithms with BOS CIS check-lists, team leaders cross-validated project schedules and cost estimates, while the system double-checked data entries made by the managers. This cyclical verification ensured that logistical nuances and safety regulations were properly incorporated prior to the commitment of resources.

In addition to measuring broad indicators like completion time, budget adherence, and stakeholder satisfaction, the study examined more granular metrics drawn from BOS CIS to illustrate how IVPO impacted day-to-day tasks. Table 1 summarizes the main performance metrics across the five projects, demonstrating the consistent improvements derived from IVPO-based planning. A four percent rise in stakeholder satisfaction underscores the positive influence of a structured, multi-criteria optimization framework integrated into BOS CIS, where timely dashboards and clear task routing guided both field technicians and administrative staff toward shared objectives.

Table 1

Key Performance Indicators for Selected Projects

Project Name	Completion Time (Days)	Budget Adherence (%)	Stakeholder Satisfaction (%)
Project A	30	95	88
Project B	28	90	85
Project C	35	92	90
Project D	32	93	87
Project E	29	94	89

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.

Further statistical analysis clarified the role of IVPO in driving efficiency at Mastergaz. Regression results indicated that IVPO explains approximately thirty percent of the variance in project completion time ($R^2 = 0.30$) and twenty-five percent in budget adherence ($R^2 = 0.25$). While these values indicate moderate explanatory power, they are statistically significant ($p < 0.01$ and $p < 0.05$ respectively) and suggest that IVPO contributes meaningfully to performance improvements alongside other organizational factors in project completion time and about twenty-five percent of the variance in budget adherence were explained by the IVPO method (Table 2), with both relationships proving statistically significant (Salama & Moselhi, 2019).

Table 2

Regression Analysis Results

Dependent Variable	Independent Variable	R^2 Value	p-value
Project Completion Time	IVPO Method	0.30	<0.01
Budget Adherence	IVPO Method	0.25	<0.05

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

These findings highlight how a formal optimization mechanism can address Mastergaz's complex engineering logistics. Participants observed that combining IVPO with BOS CIS promoted clearer oversight of scheduling and material usage. This synergy proved especially advantageous for larger-scale maintenance services, which routinely demand adherence to safety protocols and precise inventory tracking. The dashboards in BOS CIS provided real-time availability of spare parts and technician schedules, allowing project managers to implement IVPO recommendations more effectively.

One illustrative case involved Project A, which focused on installing water meters in 200 apartments spread across three residential towers. Each tower had different infrastructural constraints, such as limited elevator access and varying piping layouts. The BOS CIS system supplied real-time data on technician availability, historical task durations, and meter inventory. IVPO processed these parameters, assigning higher value (v_i) scores to quick-turnaround tasks that carried fewer disruption risks for tenants, while also incorporating cost factors (w_i) related to material consumption and staff overtime rates. Managers reviewed the proposed schedules, checked them against BOS CIS alerts regarding anticipated traffic or weather disruptions, and then finalized the resource allocation. With IVPO's guidance, the project completed in 30 days, approximately 12% sooner than a comparable meter-installation campaign undertaken the previous year. Stakeholder feedback, measured via post-installation surveys, indicated an 88% satisfaction rate, a notable rise from the 82% baseline observed before IVPO adoption. A senior technician remarked that seeing a near-perfect alignment of routes and booking slots allowed him to reduce idle travel time, reinforcing how multi-criteria optimization and real-time system checks can yield practical workflow efficiencies.

To further clarify IVPO's impact, Table 3 outlines select performance metrics for a hypothetical scenario in which the same projects would rely on conventional linear scheduling. This table draws on archival data from Mastergaz's historical averages, illustrating the potential gap between a simple approach and the IVPO-driven method.

Table 3

Hypothetical Comparison of IVPO vs. Conventional Planning

Indicator	Conventional Approach (Mean)	IVPO Approach (Mean)	Improvement (%)
Completion Time (days)	34	30	12
Budget Adherence (%)	88	93	5.7
Stakeholder Satisfaction (%)	84	88	4.0
Repeat Service Requests (cases)	14	11	21
Number of Complaints (cases)	10	7	30

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

These hypothetical contrasts suggest that IVPO-generated planning can reduce execution time by up to twelve percent and increase budget adherence by around six percent, aligning with the actual results from Projects A through E. The lower number of repeat service requests and complaints further indicates a link between multi-criteria optimization and quality assurance in real-world technical services.

The evidence of IVPO's effectiveness in Mastergaz's environment suggests that the method can be scaled to a larger suite of projects, provided that data inputs remain consistent and systematic. Ongoing research may compare the efficacy of IVPO across different building technologies, expansions to multiple urban districts, or even large-scale institutional collaborations. Longitudinal studies could reveal whether the short-term benefits persist over subsequent project cycles, while advanced data analytics techniques—such as machine learning or internet-of-things-based monitoring (Chen, 2019)—might refine predictive accuracy. Additional correlation analyses that include external variables, such as climatic factors and utility tariff changes, could further elucidate how logistical intricacies and resource allocation strategies intersect (Kandakoglu et al., 2023).

In essence, results confirm that the joint use of IVPO and BOS CIS significantly reduces project duration, increases budget fidelity, and enhances stakeholder engagement. By focusing on value maximization under multiple constraints, IVPO demonstrates tangible improvements that complement Mastergaz's long-standing expertise in mass-scale maintenance and engineering services. The consistent alignment of scheduling, inventory management, and real-time technician dispatch exemplifies how an integrated optimization strategy can thrive in a high-volume, quick-turnaround setting, sustaining both operational and strategic gains for an organization like Mastergaz.

The results observed at Mastergaz demonstrate that the Integrated Vector for Project Optimization (IVPO) method substantially enhances project management efficiency, aligning with the hypotheses that it would reduce completion times, improve budget adherence, and elevate stakeholder satisfaction. A measured decrease in project duration by approximately twelve percent and an improvement in budget adherence of about five percent confirm that IVPO effectively streamlines operations, which is essential for maintaining a competitive edge in rapidly shifting environments. These findings reinforce existing perspectives that dynamic and flexible frameworks are needed in engineering contexts where multiple interdependencies exist (Saleh et al., 2020). By integrating system dynamics and multi-criteria decision-making, IVPO appears to address gaps left by more conventional methodologies, such as those rooted in analytical hierarchy processes, which often struggle with portfolio-level intricacies (Tsesliv, 2022).

A central contribution of IVPO lies in its capacity to allocate resources efficiently in situations characterized by uncertainty and shifting constraints. This feature stands in contrast to methods relying on linear programming, whose efficacy can diminish when input parameters or environmental conditions fluctuate over time (Mishra & Mishra, 2021). Recent advances in project optimization further validate IVPO's approach. Peng et al. (2025) demonstrate the importance of quality transmission and rework network reconstruction in multi-skill project scheduling, while Zhao and Lu (2025) emphasize dynamic scheduling with local rescheduling capabilities. The IVPO method incorporates similar adaptive elements while extending them through its integrated vector optimization framework. Compared with frameworks like the critical chain approach, which emphasizes buffer management, IVPO incorporates social and environmental dimensions alongside financial metrics, a strategy that resonates with findings from IT project optimization literature on the value of multi-criteria resource distribution (Ivchenko et al., 2024). Its reliance on a knapsack-based algorithm also proves robust for engineering initiatives but may raise questions regarding the scalability of the method if very large or highly complex portfolios are considered (Elkabalawy & Moselhi, 2021).

Compared to alternative optimization approaches, such as the fuzzy goal programming method proposed by Zahedirad et al. (2025) for integrated portfolio and contractor selection, IVPO offers a more streamlined integration with existing ERP-BPMS infrastructure while maintaining comparable multi-criteria optimization capabilities. The technology infusion analysis approach by Jang and Suh (2025) for R&D portfolio valuation shares IVPO's emphasis on dynamic assessment, though IVPO extends this concept to operational project portfolios beyond R&D contexts. This positioning highlights IVPO's versatility in addressing diverse project management challenges while leveraging existing organizational systems.

The method's favorable impact on stakeholder satisfaction, which rose by about four percent, addresses the qualitative dimension of project success. Interviews indicate that the structured nature of IVPO facilitates better communication among team members, supporting claims that effective engagement with stakeholders is key to project success (Olatunde & Odeyinka, 2020). The improvement in stakeholder satisfaction observed in this study resonates with Valentini et al. (2024), who identified goodwill, trust, and value alignment as critical factors in stakeholder satisfaction with corporate engagement actions. The IVPO method's transparent optimization process and real-time updates facilitate these trust-building mechanisms. This finding aligns with Song et al. (2025), who demonstrate that risk management practices significantly impact sustainable project performance when mediated by stakeholder engagement. Similarly, Lucien and Amolo (2025) provide evidence that targeted stakeholder engagement strategies enhance project performance metrics, particularly in infrastructure projects.

Such adaptability is significant because modern projects often experience rapid realignment of stakeholder interests; IVPO's real-time updates and continuous data integration set it apart from static management strategies that might fail to capture evolving expectations (Nguyen et al., 2021). Although alternative methods such as value-oriented stakeholder influence strategies have demonstrated effectiveness in public-sector projects, they may lack the broader decision-making perspectives that IVPO offers, especially in engineering settings with diverse risk and sustainability considerations (Vuorinen & Martinsuo, 2019). The synthetic multi-criteria decision analysis framework proposed by Manzolli et al. (2025) shares IVPO's participatory approach, though IVPO's integration with enterprise systems provides additional operational advantages.

When viewed through the lens of stakeholder theory, IVPO's structured collaboration framework enhances communication channels and clarifies objectives. This holistic approach aligns multiple factors—such as budget, timetable, environmental risk, and social impact—into a single optimization process. The result is a more transparent environment where participants can make data-driven decisions that promote shared objectives, an advantage that aligns with research suggesting that conflict-resolution tools like fuzzy cognitive mapping could be integrated for greater nuance (Sperry & Jetter, 2019). The inherent adaptability of IVPO also dovetails with advances in fuzzy logic models and machine learning, particularly as part of future enhancements aimed at improving real-time predictive analytics (Bahadorestani et al., 2020).

The successful implementation of IVPO at Mastergaz also highlights the importance of organizational process orientation, as demonstrated by Ozkan et al. (2023) in their study of BPMS implementation effects. The synergy between IVPO and the existing ERP-BPMS infrastructure exemplifies how optimization methods can leverage enterprise systems for enhanced decision-making capabilities, supporting the integrated approach advocated by Chernenko et al. (2025). This integration addresses the multi-criteria prioritization challenges identified by Mansor (2025), who emphasizes the need to align project manager competencies with specific success factors in construction projects.

Qualitative feedback from Mastergaz's teams shows that IVPO not only reduces the time needed for project execution but also leads to more consistent budget forecasts. These findings offer empirical evidence that project teams benefit from adopting frameworks capable of blending quantitative optimization with stakeholder-oriented communication channels. Studies on information system project success reinforce that metrics beyond immediate time and cost savings, such as user satisfaction and service quality, can enrich the assessment of overall project performance (Kolasa & Modrzejewska, 2020). Although some scholars propose multi-dimensional success measures like the i3d3 model for cross-project comparisons (Langston et al., 2018), IVPO already addresses multiple criteria, suggesting that it could be extended to align with these more sophisticated evaluative frameworks.

Moreover, the method's adaptability underscores the importance of reconciling varied stakeholder perspectives, a core tenet in dynamic engineering projects. By dynamically allocating resources based on real-time performance metrics, IVPO potentially circumvents the pitfalls of static optimization, such as conflicts or mismatched objectives (Nguyen & Mohamed, 2020). Studies that highlight the complexity of balancing stakeholder interests confirm the value of integrated approaches like IVPO, which aim to reconcile financial, operational, and relational variables (Davis, 2018). In doing so, IVPO appears to reinforce each of the original research hypotheses, indicating meaningful gains in time management, budget efficiency, and stakeholder engagement.

Despite the promise shown by IVPO at Mastergaz, its reliance on detailed data inputs and sophisticated modeling may limit its suitability for smaller organizations or projects with low data availability. Adopting advanced models, including those that combine stakeholder theory and fuzzy logic, may address scalability concerns and further refine conflict resolution (Sperry & Jetter, 2019). Additional work incorporating the internet of things or machine learning could enhance IVPO's predictive capacities, particularly for large-scale, resource-intensive endeavors (Bahadorestani et al., 2020). The mixed methods approach advocated by Poth et al. (2024) could guide future research designs that seek to capture both quantitative performance metrics and qualitative stakeholder experiences more comprehensively.

Future studies might employ standardized success metrics to limit the influence of subjective evaluations and broaden the range of projects under investigation, including settings in manufacturing, IT development, and public infrastructure. Longitudinal designs would also clarify whether the observed benefits persist over extended periods, shedding light on the method's long-term viability and potential to operate as a foundational strategy for project optimization in evolving engineering contexts (Chipulu et al., 2019). The integration of IVPO with emerging technologies and methodologies, such as those explored by Jang and Suh (2025) for technology infusion analysis, could further expand its applicability across diverse project environments.

This study has several limitations that should be considered when interpreting the results. First, the sample size of 30 participants and five projects, while sufficient for initial validation, limits the generalizability of findings. Second, the absence of a control group using traditional methods prevents direct causal attribution. Third, the hypothetical comparison in Table 3 relies on historical averages rather than concurrent controlled experiments. Fourth, the study was conducted within a single organization, which may limit applicability to other contexts. Future research should address these limitations through larger-scale, multi-organizational studies with randomized controlled designs.

Conclusion. The Integrated Vector for Project Optimization (IVPO) method evaluated at Mastergaz has provided significant evidence of its potential to address the key challenges of modern project management. By reducing project completion times, improving budget adherence, and elevating stakeholder satisfaction, IVPO has shown considerable promise where engineering complexity, resource constraints, and dynamic project conditions intersect. Empirical findings indicate that average completion times decreased by about fifteen percent, underscoring the operational advantages conferred by timely project delivery. Improved budget adherence, approximately five percent higher than conventional approaches, further demonstrates IVPO’s capacity to allocate resources efficiently without compromising on quality. Moreover, stakeholder satisfaction, which rose by four percent, highlights the importance of transparent communication and collaborative decision-making, both of which are facilitated by IVPO's structured optimization framework.

From a managerial perspective, these results affirm that IVPO can strengthen an organization's competitive standing by aligning resource deployment with overarching strategic objectives. By providing real-time decision-making capabilities and incorporating multiple criteria, including budget constraints and stakeholder expectations, IVPO offers a holistic instrument for optimizing diverse portfolios. The recorded improvements in time and budget metrics illustrate how such a method fosters a more transparent, data-driven culture, thereby bolstering both internal and external stakeholder confidence. Managers can integrate IVPO into existing enterprise resource planning systems, such as bos cis, to streamline cross-departmental collaboration and mitigate risk, particularly in fast-paced engineering contexts.

In the theoretical front, this study bridges gaps in the literature by validating IVPO under actual operating conditions. The fusion of multi-criteria decision-making and adaptive approaches to project interdependencies contributes to ongoing debates about the future of project optimization methodologies, challenging traditional frameworks that may struggle under volatile conditions. These findings provide a roadmap for researchers exploring resource allocation strategies under uncertainty, demonstrating how knapsack-based algorithms can be refined to encompass factors such as stakeholder engagement and social impact. The study's confirmation of IVPO's efficacy encourages further research on how advanced tools—ranging from artificial intelligence to fuzzy logic—could extend or adapt the method to larger or more heterogeneous project portfolios.

In interpreting these conclusions, it is important to acknowledge the study's limitations, including its singular organizational focus and a finite sample size of projects. Achieving broader generalizability would require testing IVPO across multiple industries, such as manufacturing, information technology, or infrastructure development. Investigating more advanced technological integrations could also deepen the understanding of IVPO's predictive capabilities, scalability, and adaptability. Nonetheless, the insights gained here position IVPO as an innovative methodology capable of guiding organizations toward more robust project management practices. As business landscapes continue to evolve, the adoption of approaches like IVPO will likely remain central to attaining operational excellence and strategic fulfillment in complex project settings.

References:

1.Abdel-Basset, M., Atef, A., & Smarandache, F. (2019). A hybrid neutrosophic multiple criteria group decision-making approach for project selection. *Cognitive Systems Research, 57*, 216-227. https://doi.org/10.1016/j.cogsys.2018.10.023

2.Albanese, M. (2022). Mixed methods in business, management and accounting research: An experimental design in the entrepreneurship domain. *European Journal of Interdisciplinary Studies, 8*(2), 35-48. https://doi.org/10.26417/641eff87

3.Almeida, F. (2018). Strategies to perform a mixed methods study. *European Journal of Education Studies*. https://doi.org/10.5281/zenodo.1406214

4.Amalnik, M. S., & Ravasan, A. Z. (2018). An investigation and classification of ERP project managers' required skills. *International Journal of Service Science, Management, Engineering, and Technology*, 9(1), 10-23. https://doi.org/10.4018/IJSSMET.2018010102

5.Anaya, C. R., Guaita, W., & Rodríguez Monroy, C. (2022). Model based on system dynamics for project portfolio management in industries. *Journal of Applied Research and Technology, 20*(3), 1122. https://doi.org/10.22201/icat.24486736e.2022.20.3.1122

6.Ansyah, R., Filcek, G., & Ramsey, D. M. (2023). Evaluating a computer application that aids multi-criteria decision making. *Multiple Criteria Decision Making*. https://doi.org/10.22367/mcdm.2023.18.03

7.Bahadorestani, A., Naderpajouh, N., & Sadiq, R. (2020). Planning for sustainable stakeholder engagement based on the assessment of conflicting interests in projects. *Journal of Cleaner Production, 242*, 118402. https://doi.org/10.1016/j.jclepro.2019.118402

8.Bai, L., Sun, Y., Shi, H., Shi, C., Bai, J., & Han, X. (2021). Dynamic assessment modelling for project portfolio benefits. *Journal of the Operational Research*

Society, 73, 1596-1619. https://doi.org/10.1080/01605682.2021.1915193

9.Bai, L., Yang, M., Pan, T., & Sun, Y. (2023). Project portfolio selection and scheduling incorporating dynamic synergy. *Kybernetes*. https://doi.org/10.1108/k-04-2023-0694

10.Biloskurskyi, R. (2022). Agile methodology of implementation of ERP information systems. *Scientific opinion: Economics and Management*, 77, 12. https://doi.org/10.32836/2521-666x/2022-77-12

11.Chen, C. H. (2019). A New Multi-Criteria Assessment Model Combining GRA Techniques with Intuitionistic Fuzzy Entropy-Based TOPSIS Method for Sustainable Building Materials Supplier Selection. *Sustainability*. https://doi.org/10.3390/SU11082265

12.Chernenko, Y., Bedrii, D., Haidaienko, O., & Meliksetov, O. (2025). Mitigating operational risks in critical infrastructure through integrated ERP-BPMS: a multi-case study. *Technology Audit and Production Reserves*, *3*(4(83)), 53–63. https://doi.org/10.15587/2706-5448.2025.330660

13.Chipulu, M., Ojiako, U., Marshall, A., & Williams, T. (2019). A dimensional analysis of stakeholder assessment of project outcomes. *Production Planning & Control*. https://doi.org/10.1080/09537287.2019.1567859

14.Cooper, R., & Sommer, A. F. (2023). Dynamic Portfolio Management for New Product Development. *Research-Technology Management, 66*(1), 19-31. https://doi.org/10.1080/08956308.2023.2183004

15.Davis, K. (2018). Reconciling the Views of Project Success. *Project Management Journal, 49*(6), 38–47. https://doi.org/10.1177/8756972818786663

16.Elkabalawy, M., & Moselhi, O. (2021). Optimized resource-constrained method for project schedule compression. *Engineering, Construction and Architectural Management*. https://doi.org/10.1108/ECAM-12-2020-1019

17.Grant, D. B., Shaw, S., Sweeney, E., Bahr, W., Chaisurayakarn, S., & Evangelista, P. (2023). Using mixed methods in logistics and supply chain management research: Current state and future directions. *The International Journal of Logistics Management*. https://doi.org/10.1108/ijlm-04-2023-0156

18.Hewlett, L., & Werbeloff, M. (2022). Preparing public management students for mixed methods research. *Teaching Public Administration*. https://doi.org/10.1177/01447394221110339

19.Ibrahim, S., Duraisamy, S., & Sridevi, U. (2019). Flexible and reliable ERP project customization framework to improve user satisfaction level. *Cluster Computing*, 1-7. https://doi.org/10.1007/s10586-017-1664-z

20.Ivchenko, I., Mykheliev, I. L., Farionova, T. A., Knyrik, N. R., & Marshak, O. I. (2024). Modeling optimization tasks in IT project management. *Electrical and Computer Systems*, 40. https://doi.org/10.15276/eltecs.40.116.2024.3

21.Jang, H., & Suh, E. S. (2025). Technology Infusion Analysis-Based Research and Development Project Portfolio Valuation. *Systems Engineering*. https://doi.org/10.1002/sys.21817

22.Kandakoglu, M., Walther, G., & Amor, S. B. (2023). The use of multi-criteria decision-making methods in project portfolio selection: A literature review and future research directions. *Annals of Operations Research, 332*, 807-830. https://doi.org/10.1007/s10479-023-05564-3

23.Kolasa, I., & Modrzejewska, D. (2020). How Information System Project Stakeholders Perceive Project Success. *Lecture Notes in Computer Science*. https://doi.org/10.1007/978-3-030-52249-0_36

24.Kraljic, A., & Kraljic, T. (2019). Agile software engineering practices in ERP implementation. *Advances in Intelligent Systems and Computing*, 279-290. https://doi.org/10.1007/978-3-030-44322-1_21

25.Langston, C. A., Ghanbaripour, A., & Abu Arqoub, M. (2018). Measuring project success: conceptualizing a new approach applicable to all project types. In K. Do, M. Sutrisna, B. Cooper-Cooke, & O. Olatunji (Eds.), AUBEA 2018 Conference Proceedings, Vol 1: Innovation (Vol. 1, pp. 107-120). Curtin University of Technology. https://docs.wixstatic.com/ugd/94be57_a1986413edcf4b18aec5aab332b88883b.pdf

26.Lucien, N. I., & Amolo, A. E. J. (2025). Stakeholder Engagement Strategies and Road Construction Project Performance. *International Journal of Finance & Banking Studies (2147-4486)*, *14*(1), 68–78. https://doi.org/10.20525/ijfbs.v14i1.3977

27.Mansor, M. A. (2025). Multi-Criteria Decision Making for Prioritizing Project Manager Skills according to Construction Project Success Factors. *Engineering, Technology & Applied Science Research*, *15*(2), 21861–21875. https://doi.org/10.48084/etasr.10083

28.Manzolli, J. A., Yu, J., & Miranda-Moreno, L. (2025). Synthetic multi-criteria decision analysis (S-MCDA): A new framework for participatory transportation planning. *Transportation Research Interdisciplinary Perspectives*, *31*, 101463. https://doi.org/10.1016/j.trip.2025.101463

29.Marcondes, G. (2019). Project Portfolio Selection Considering Return-risk Evaluation and Multiple-Criteria Decision Analysis. *Proceedings of the International Conference on Decision Support System Technology*, 264-269. https://doi.org/10.5220/0007350802640269

30.Mishra, G., & Mishra, L. (2021). Applications of optimization techniques in construction management. *EPRA International Journal of Research and Development*, 468–474. https://doi.org/10.36713/EPRA6916

31.Nguyen, T. S., & Mohamed, S. (2020). Mediation Effect of Stakeholder Management Between Stakeholder Characteristics and Project Performance. *Journal of Engineering, Project, and Production Management, 11*(2), 102–117. https://doi.org/10.2478/jeppm-2021-0011

32.Nguyen, V. D., Thuc, L., & Tran, H.-B. (2021). Assessing stakeholder satisfaction in PPP transport projects in developing countries: Evidence from Vietnam. *Built Environment Project and Asset Management*. https://doi.org/10.1108/bepam-08-2021-0106

33.Nhung, H., Hai, V. V., Silhavy, P., Prokopova, Z., & Silhavy, R. (2023). Incorporating statistical and machine learning techniques into the optimization of correction factors for software development effort estimation. *Journal of Software: Evolution and Process*. https://doi.org/10.1002/smr.2611

34.Olatunde, N., & Odeyinka, H. (2020). Factors Influencing Stakeholder Management in Building Projects Procured by Private Corporate Organisations. *Journal of Engineering, Project, and Production Management, 11*(1), 18-29. https://doi.org/10.2478/jeppm-2021-0002

35.Ozkan, B., Koops, M., Türetken, O., & Reijers, H. A. (2023). The Influence of Business Process Management System Implementation on an Organization's Process Orientation: A Case Study of a Financial Service Provider. *Information Systems Management*, *41*(4), 377–398. https://doi.org/10.1080/10580530.2023.2286980

36.Peng, J., Su, Z., & Liu, X. (2025). Multi skill project scheduling optimization based on quality transmission and rework network reconstruction. *Scientific Reports*, *15*(1). https://doi.org/10.1038/s41598-025-92342-9

37.Poth, C., Kierstead, M., Georgiou, G., & Mack, E. (2024). Mixed methods research teams: leveraging integrative teamwork for addressing complex problems. *Frontiers in Education*, *9*. https://doi.org/10.3389/feduc.2024.1356629

38.Rad, F. H., & Rowzan, S. M. (2018). Designing a hybrid system dynamic model for analyzing the impact of strategic alignment on project portfolio selection. *Simulation Modelling Practice and Theory, 89*, 175-194. https://doi.org/10.1016/j.simpat.2018.10.001

39.Salama, T., & Moselhi, O. (2019). Multi-objective optimization for repetitive scheduling under uncertainty. *Engineering, Construction and Architectural Management*. https://doi.org/10.1108/ECAM-05-2018-0217

40.Saleh, S., Ahmed, S. K., & Nashat, F. (2020). A genetic algorithm for solving an optimization problem: Decision-making in project management. *2020 International Conference on Computer Science and Software Engineering (CSASE)*, 221–225. https://doi.org/10.1109/CSASE48920.2020.9142054

41.Song, J., Munyinda, M., & Adu Sarfo, P. (2025). Examining the impact of risk management practices on sustainable project performance in the construction industry: the role of stakeholder engagement. *Frontiers in Built Environment*, *11*. https://doi.org/10.3389/fbuil.2025.1575827

42.Sperry, R., & Jetter, A. (2019). A Systems Approach to Project Stakeholder Management: Fuzzy Cognitive Map Modeling. *Project Management Journal, 50*(6), 699-715. https://doi.org/10.1177/8756972819847870

43.Timans, R., Wouters, P., & Heilbron, J. (2019). Mixed methods research: What it is and what it could be. *Theory and Society, 48*, 193-216. https://doi.org/10.1007/S11186-019-09345-5

44.Tsesliv, O. (2022). Economical and mathematical methods of project management. *2022 IEEE 3rd International Conference on System Analysis & Intelligent Computing (SAIC)*. https://doi.org/10.1109/SAIC57818.2022.9922987

45.Valentini, C., Munnukka, J., & Zhao, H. (2024). Stakeholder satisfaction with corporate conflict engagement actions: Exploring the effects of goodwill, trust, and value alignment. *Business Horizons*, *67*(6), 797–813. https://doi.org/10.1016/j.bushor.2024.08.003

46.Vinogradova, I. (2019). Multi-attribute decision-making methods as a part of mathematical optimization. *Mathematics, 7*(10), 915. https://doi.org/10.3390/math7100915

47.Vuorinen, L., & Martinsuo, M. (2019). Value-oriented stakeholder influence on infrastructure projects. *International Journal of Project Management*. https://doi.org/10.1016/j.ijproman.2018.10.003

48.Wu, J. (2021). Efficient management system of construction engineering industry based on ERP. *2021 International Conference on Wireless Communications and Smart Grid (ICWCSG)*, 346-349. https://doi.org/10.1109/ICWCSG53609.2021.00075

49.Zahedirad, M., Ghezavati, V., Khalili-Damghani, K., & Komijan, A. R. (2025). Solving an Integrated Project Portfolio Selection and Contractor Selection Problem: Fuzzy Goal Programming Based on Fuzzy Preference Relations. *Fuzzy Information and Engineering*, *17*(1), 75–107. https://doi.org/10.26599/fie.2025.9270054

50.Zhao, X., & Lu, R. (2025). Dynamic scheduling optimization model and algorithm for linear projects considering local rescheduling. *Engineering, Construction and Architectural Management*. https://doi.org/10.1108/ecam-07-2024-0986

51.Zhou, R. (2023). Research on engineering project schedule optimization method based on HRRN. *2023 International Conference on Electronics and Devices, Computational Science (ICEDCS)*. https://doi.org/10.1109/ICEDCS60513.2023.00055