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IMPROVING STRATEGIC AND OPERATIONAL MANAGEMENT OF CONSTRUCTION PROJECTS IN UZBEKISTAN: A CONCEPTUAL ADAPTATION OF A HYBRID MODEL

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Abstract. A substantial proportion of major civil infrastructure projects experience cost overruns and schedule delays. To mitigate these adverse outcomes, management actions must be rigorously analysed at both the strategic and operational levels, because their effectiveness depends on how well the project's strategic vision is aligned with its operational details. Existing construction project management approaches often examine strategic and operational issues separately, creating potential inconsistencies between the two levels of analysis. To address this problem, this article proposes a hybrid simulation model that integrates system dynamics and discrete-event simulation, methods that are commonly used independently to analyse strategic and operational issues. A non-traditional repetitive earthmoving operation is selected and simulated as an illustrative case. The results indicate that systematically integrating strategic perspectives with operational detail helps identify improvement opportunities that conventional approaches may overlook. On this basis, the proposed hybrid model is considered to have strong potential to support the strategic and operational dimensions of construction project management simultaneously and to improve overall project performance.
Keywords: hybrid methods; simulation models; cost control; construction management; discrete-event simulation.

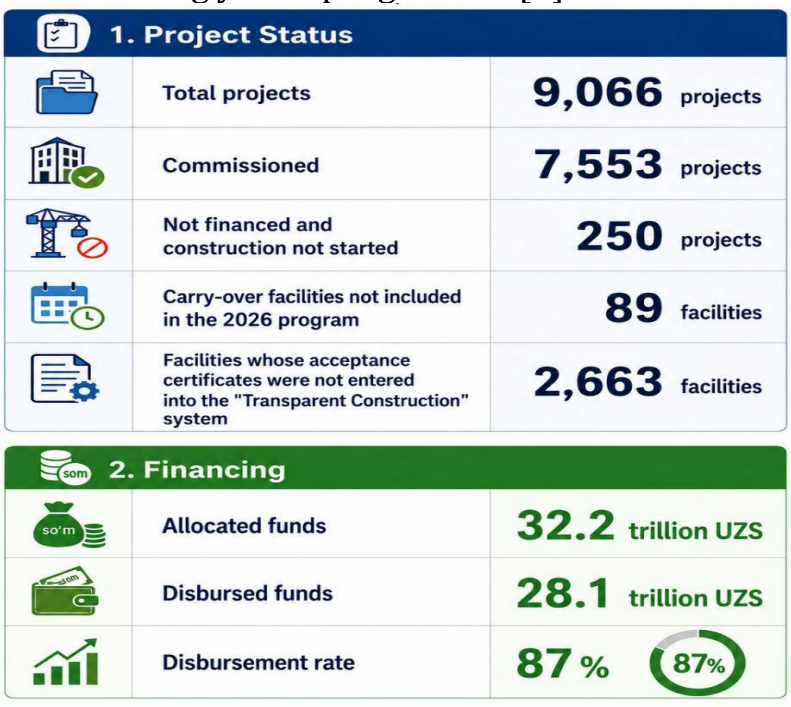
Annotatsiya. Yirik fuqarolik infratuzilmasi loyihalarida xarajatlarning smetadan oshib ketishi va ish jadvalining kechikishi keng tarqalgan muammo bo‘lib qolmoqda. Ushbu tadqiqotda O‘zbekiston qurilish loyihalarini boshqarishda strategik qarorlar va operatsion jarayonlarni integratsiya qilish imkoniyatlari o‘rganilgan. Tizim dinamikasi va diskret hodisalar simulyatsiyasini birlashtiruvchi konseptual gibrid model mahalliy institutsional sharoitlarga moslashtirilgan. Moliyalashtirish, ekspertiza, tender, resurslarni safarbar qilish, qurilish-montaj ishlari va foydalanishga topshirish bosqichlaridagi muhim kechikishlarni aniqlash uchun rasmiy statistika, audit natijalari, davlat xaridlari ma’lumotlari hamda obyektlarni qabul qilish hujjatlaridan foydalanilgan. Taklif etilgan model ushbu bosqichlarni qayta aloqa mexanizmlari orqali bog‘laydi va boshqaruv ssenariylarini amalga oshirishdan oldin baholash imkonini beradi. Xalqaro simulyatsiya natijalari faqat qiyosiy mezon sifatida qo‘llanilgan. Tadqiqot gibrid yondashuv kechikish xavfini erta aniqlash, resurslarni muvozanatli taqsimlash va loyiha muddati hamda xarajatlarini izchil nazorat qilishga ko‘maklashishi mumkinligini ko‘rsatadi, biroq uning O‘zbekiston sharoitidagi samaradorligini tasdiqlash uchun obyektlar kesimida simulyatsiya o‘tkazish zarur.
Kalit so‘zlar. gibrid simulyatsiya, strategik boshqaruv, operatsion boshqaruv, qurilish loyihalari, tizim dinamikasi, diskret hodisalar simulyatsiyasi, O‘zbekiston.

Аннотация. Перерасход средств и нарушение сроков остаются распространёнными проблемами крупных проектов гражданской инфраструктуры. В исследовании рассматриваются возможности интеграции стратегических решений и операционных процессов в управлении строительными проектами Узбекистана. Концептуальная гибридная модель, объединяющая системную динамику и дискретно-событийное моделирование, адаптирована к местным институциональным условиям. Для выявления критических задержек на этапах финансирования, экспертизы, проведения тендеров, мобилизации ресурсов, строительно-монтажных работ и ввода объектов в эксплуатацию использованы официальная статистика, результаты аудита, данные государственных закупок и документы о приёмке объектов. Предлагаемая модель связывает эти этапы посредством механизмов

обратной связи и позволяет оценивать альтернативные управленческие сценарии до их реализации. Результаты зарубежного моделирования используются исключительно как сравнительный ориентир. Сделан вывод, что гибридный подход может способствовать раннему выявлению рисков, сбалансированному распределению ресурсов и более последовательному контролю сроков и стоимости проектов; однако для подтверждения его эффективности в условиях Узбекистана необходимо провести моделирование на уровне конкретных объектов.
Ключевые слова: гибридное моделирование, стратегическое управление, операционное управление, строительные проекты, системная динамика, дискретно-событийное моделирование, Узбекистан.

INTRODUCTION

Despite advances in construction technology and management methods, schedule delays and cost overruns have persisted in construction projects for many years. In Uzbekistan, a comprehensive open statistical database covering project duration and cost performance has not yet been fully established. Although the National Statistics Committee publishes data on unfinished construction, the volume of construction work, and commissioned facilities, opportunities to compare planned and actual construction periods, as well as initial and final project costs, at the individual project level remain limited. According to the Accounts Chamber, UZS 32.2 trillion was allocated to 9,066 projects under the 2025 social and production infrastructure development programmes; UZS 28.1 trillion was disbursed, and 7,553 facilities were commissioned (Figure 1). At the same time, funding had not been released and construction had not begun for 250 projects, while 89 carry-over facilities were not included in the following year's programme [1].



Source: Compiled by the author based on data from the Accounts Chamber of the Republic of Uzbekistan.

Figure 1. Implementation and Financing Status of the 2025 Social and Production Infrastructure Programmes

Delays of 10-69 days were identified in contractor-selection procedures for water-management facilities. The Accounts Chamber did not disclose the individual value of the delayed facilities. According to the Ministry of Water Resources, UZS 1.356 trillion was allocated to irrigation facilities in 2025, of which UZS 1.004 trillion was disbursed. These findings indicate that institutional problems at the stages of project preparation, appraisal, contractor selection, financing, and commissioning contribute to extended construction periods.

Table 1

Implementation, Existing Problems, and Financing Status of Selected Public and Infrastructure Projects in Tashkent Region

Initiative Budget Projects in Tashkent Region	Of the projects selected in 2025, 71% had been completed, while 136 projects were still ongoing as of 29 April 2026. Some projects were reported not to have been completed within the prescribed deadlines.	A total of UZS 594 billion was allocated for 470 projects in 2025. The official report did not provide a separate value for the 136 ongoing projects.
Agricultural Modernisation Project	A total of 136 projects had not been fully commissioned, and 13 projects had been suspended. Equipment delivered in 2024 for the seed production centre in Buka District had not been installed as of April 2026 because construction was incomplete.	The total project value was USD 659.3 million, and 75% of the loan funds had been disbursed. The unused equipment was valued at USD 1.2 million.
Infrastructure Facilities in Tashkent Region	Fifty-eight facilities commissioned in 2023-2024 were not transferred to the balance sheets of the end-user organisations on time. In addition, 36 facilities were not commissioned by the prescribed deadline.	The public report of the Accounts Chamber did not separately specify the amount of funding associated with these 36 and 58 facilities.

Source: Compiled by the author based on official information from the Senate of the Oliy Majlis and the Accounts Chamber of the Republic of Uzbekistan.

As Table 1 shows, project delays and cost overruns are common in Uzbekistan. To reduce these problems, management actions taken during project implementation must be rigorously analysed because they can significantly affect project outcomes. Depending on its effectiveness, a management action may have either a positive or a negative impact on project performance. Successful project control therefore requires a systematic assessment of the expected effects of management decisions. This analysis becomes particularly difficult in large projects because of their high degree of complexity.

LITERATURE REVIEW

Schedule slippage and cost escalation in construction projects are recognised as systemic problems worldwide. Previous studies identify interruptions in financing, delayed preparation of project documentation, inefficient resource allocation, limited managerial capacity among contractors, and weak coordination among stakeholders as major causes of delay. Flyvbjerg, Holm, and Buhl demonstrated that cost overruns in infrastructure projects are not random occurrences but are associated with optimistic planning estimates and systematic shortcomings in project governance [3].

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The Critical Path Method (CPM) and the Program Evaluation and Review Technique (PERT) are widely used in construction project management to determine activity sequences, critical activities, and estimated completion dates. However, because these methods generally assume relatively stable activity durations and resource availability, they do not fully capture management decisions, rework, resource interdependencies, or changes in the external environment. Rodrigues and Bowers emphasised that system dynamics enables the analysis of feedback loops and interactions among project components rather than focusing only on individual activities in complex projects.

To address these limitations, Peña-Mora and co-authors proposed a hybrid model integrating system dynamics with discrete-event simulation. The model makes it possible to assess resource demand throughout the construction process, adjust management decisions in a timely manner, and anticipate their effects on project duration and cost. However, because the model was tested using a non-traditional repetitive earthmoving operation, its applicability to other types of construction and public infrastructure projects requires further investigation[4].

Thus, the international literature has extensively examined construction delays, cost overruns, and hybrid simulation methods. Nevertheless, studies assessing the dynamic interrelationships among strategic management decisions, financing, resource allocation, and operational processes in the context of construction projects in Uzbekistan remain limited. This study seeks to address that research gap by adapting an integrated system-dynamics and discrete-event simulation approach to local institutional conditions.

METHODOLOGY

Quantitative, comparative, and simulation-based methods were used to assess the relationship between strategic management decisions and operational processes in construction projects in Uzbekistan. The empirical database was compiled from official statistical materials published on stat.uz, audit findings of the Accounts Chamber, the Transparent Construction and Open Budget information systems, public procurement contracts, and documents relating to the commissioning of construction facilities. Project performance was evaluated by comparing planned and actual indicators.

Construction project management may be divided into two broad approaches according to its principal managerial focus: strategic project management and operational project management (Lee et al., 2006). Strategic project management concerns how expected project outcomes can be achieved within the organisation's strategic objectives. Operational project management focuses on the specific stages and actions required to accomplish the project's objectives.

ANALYSIS AND RESULTS

The problems identified in Uzbekistan's construction projects are not confined to the construction and installation stage of the project life cycle. Delays

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in opening financing, approving design and cost-estimate documentation, conducting appraisal, and completing tender procedures arise primarily at the strategic management level. By contrast, disruptions involving labour, machinery, materials, coordination of construction activities, and facility commissioning belong mainly to operational management. Consequently, these problems cannot be addressed comprehensively through conventional schedule-planning methods alone.

The analysis indicates that an adaptive hybrid model combining system dynamics and discrete-event simulation is appropriate for the conditions of Uzbekistan.

Table 2

Data Required as Inputs to the Model

Data Category	Indicators to Be Entered into the Model
Time Parameters	Planned and actual start dates, duration of each stage, and commissioning date
Financing	Allocated funds, date on which funding became available, disbursed funds, and payment delays
Tendering and Appraisal	Date of document submission, review period, tender duration, and number of repeated tenders
Resources	Number of workers, machinery, equipment, and materials, together with their availability levels
Operational Indicators	Labour productivity, equipment idle time, queues, and rework
Outcomes	Days of delay, cost variance, resource-utilisation rate, and probability of on-time completion

Source: Developed by the author as part of the model-design process.

The strategic component of the model represents feedback mechanisms among financing, tender duration, resource-allocation policy, the volume of unfinished work, and management decisions. The operational component models the preparation of design and cost-estimate documentation, appraisal, tendering, resource mobilisation, construction and installation works, technical supervision, and commissioning as separate events.

Unlike current reactive management practices, the proposed model initiates a management response when the risk of delay first emerges rather than after the delay has already occurred. The gap between planned and actual rates of progress, financing delays, resource balance, equipment idle time, and growing queues are used as control indicators. When any indicator exceeds a predefined threshold, the model simulates scenarios involving the reallocation of resources, deployment of additional machinery or labour, revision of the financing schedule, or increased priority for the problematic stage.

The principal advantage of the hybrid approach is its ability to evaluate the operational consequences of strategic decisions before those decisions are implemented. For example, an excessive increase in the number of machines may shorten the schedule but raise idle-time costs. Conversely, allocating too few resources may initially appear to reduce expenditure, yet it can increase the

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overall duration and cost in later stages because of queues and process disruptions. By accounting for these opposing effects simultaneously, the hybrid model identifies a balanced option from both time and cost perspectives.

Results from an international application of the model support the effectiveness of this approach. Under the hybrid simulation, the average process duration decreased from 116.82 hours to 111.76 hours, while the average cost fell from USD 104,318 to USD 100,002. Statistical estimates indicated time savings of 4.22-4.45% and cost savings of 4.02-4.25%. These figures are not empirical results for Uzbekistan; rather, they serve as an international benchmark for assessing the potential effectiveness of the hybrid model.

For the model adapted to construction projects in Uzbekistan, the study proposes comparing baseline, strategic, operational, and hybrid management scenarios. Accelerating financing or tender procedures alone is not expected to eliminate resource mismatches at the construction site. Likewise, increasing operational resources alone is unlikely to produce strong results while financial and administrative constraints remain in place. Integrating strategic and operational decisions can reduce disruptions between project stages, balance resource utilisation, and enable an early response to the risk of delay.

Accordingly, the hybrid model is proposed as a management tool that integrates financing, tendering, resource allocation, construction and installation works, and commissioning within a unified feedback system for construction projects in Uzbekistan. To determine the model's practical effectiveness, the next stage of research should conduct computer simulations using project-level data on planned and actual schedules, initial and final costs, financing dates, resource quantities, and operational productivity.

CONCLUSION

The findings show that delays in construction projects in Uzbekistan are associated not only with deficiencies in construction and installation works but also with disruptions in financing, appraisal, tendering, resource mobilisation, and facility commissioning. Managing strategic decisions and operational processes separately is therefore insufficient. A hybrid model combining system dynamics and discrete-event simulation can identify interdependencies among these stages, assess the risk of delay in advance, and support the timely reallocation of resources.

International studies have found that the hybrid approach can reduce project duration and cost by approximately 4%; however, these results cannot be applied directly to Uzbekistan. The model's effectiveness under local conditions should be determined through practical simulation using project-level data on planned and actual schedules, costs, financing dates, and resource-utilisation indicators.

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