УДК 65.011.14
DOI 10.47367/0021-3497_2025_4_356

THE ROLE OF AGILE PRACTICES IN IMPROVING TEXTILE PROJECT MANAGEMENT OUTCOMES

РОЛЬ ГИБКИХ МЕТОДОВ В УЛУЧШЕНИИ РЕЗУЛЬТАТОВ УПРАВЛЕНИЯ ТЕКСТИЛЬНЫМИ ПРОЕКТАМИ

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Agile practices, which have long been established in the field of software development, are gaining momentum in its application in the industrial sector due to its adaptability and performance enhancement capabilities. This study explores the adoption of Agile practices within the textile project management domain, focusing on the effectiveness of iterative planning, performance KPIs, and continuous improvement mechanisms to enhance efficiency and operational performance. Using modified Scrum principles as a foundation, a structured methodology was established that incorporated sprint cycles, mechanisms of real-time feedback and cross-functional collaboration. Advanced evaluative tools, including the Agile Velocity Index, Composite Agile Performance Index, and Agile Impact Quotient, were used to collect data from textile production teams and analyze these data. The output demonstrates a progressive enhancement in the efficiency of delivery, precision of quality control, stakeholder satisfaction, and cost-effectiveness across successive sprints. Post-implementation analysis highlighted the strategic utility of tactical interventions, with small resource reallocations translating into observable improvements on several fronts. This highlights how Agile frameworks can be adopted outside of the digital or software-based industry, especially in textiles, where variability and time sensitivity are high.

Гибкие методы (Agile-практики), которые давно зарекомендовали себя в области разработки программного обеспечения, набирают обороты в своем применении в промышленном секторе благодаря своей адаптивности и возможностям повышения производительности. В этом исследовании изучается эффективность внедрения Agile-практик в управление текстильными проектами, оценивается их влияние на качество итеративного планирования, показатели производительности и механизмы непрерывного совершенствования. С использованием модифицированных принципов Scrum в качестве основы создана структурированная методология, которая включала

циклы спринтов, обратной связи в реальном времени и кросс-функциональный анализ. Для сбора и анализа данных текстильного производства использовались передовые оценочные инструменты, такие как Agile Velocity Index, Composite Agile Performance Index и Agile Impact Quotient. Выявлено постепенное повышение эффективности планирования, точности контроля качества, удовлетворенности заинтересованных сторон и экономической эффективности в последовательных спринтах. Анализ результатов внедрения Agile-практики подчеркнул стратегическую полезность тактических вмешательств, при этом небольшие перераспределения ресурсов приводят к заметным улучшениям на нескольких направлениях. Это исследование показывает, что гибкий подход может быть полезным в процессах текстильной промышленности, где изменчивость и чувствительность ко времени высоки.

Keywords: agile project management; textile production; performance evaluation; sprint planning; continuous improvement; KPI modeling; manufacturing strategy.

Ключевые слова: гибкое управление проектами; текстильное производство; оценка эффективности; планирование спринта; постоянное совершенствование; моделирование KPI; производственная стратегия.

Introduction

With complex supply chains, shifting consumer demand, and fluctuating markets, the textile industry faces increasing pressure to embrace new approaches to project management. In contrast to traditional project management approaches, Agile methodologies have gained significant interest as a potential agile and flexible paradigm to transform the textile project management landscape [1, 2].

Historically developed exclusively for software development, Agile practices have gradually seeped into other industries. Agile methodologies as an approach have a set of foundational principles that work towards flexibility, collaboration and iterative process, which fits right into the problem definitions of the textile team. Agile thrust teams forward so they can set other, non-linear, strategies that help respond to changing trends in the market, customer feedback, and sudden interruptions in the supply chain [3]. Such flexibility is important in the textile business where production cycles are rapid and fashion trends can change overnight. Agile practices enhance the textile project's ability to be innovative and the teams sustainable in the long term with faster time-to-market and a heightened ability to meet customer needs as they arise.

Perhaps the most inspiring pillar of Agile methodologies is their focus on breaking down large, monolith projects into smaller increments that can be tackled in a short time. These iterative cycles facilitate ongoing assessment and enhancement, guaranteeing that every phase of the project serves the ultimate objective. This is especially true in the textile industry. Teams can experiment with new designs, refine production schedules and last-mile logistics in real-time, for example, instead of at the very end when the entire project is finished. Not only does this mean less risk, but it also leads to better overall efficiency of the project as problems are identified early on in the process [4].

Agile practices also foster a collaborative working atmosphere. Cross-functional teams—including designers, production managers, supply chain coordinators, and quality control specialists—work closely with one another, keeping everyone involved in the project on the same page and aware of developments. Agile frameworks promote transparency in a project, as they encourage communication and continuous feedback. This is increasing collaboration, leading to better resource allocation, accurate production forecasts, and quality outcomes [5]. In an industry as integrated as textiles, where each stage of production can inform the final product, the weight of having a well-informed and strategically siloed team cannot be overstated [6].

Agile methods are also great for bringing in customer engagement. The textile team regularly checks in with its clients and stakeholders and assesses how its end product lines up with their expectations. This feedback loop allows for regular communication between the developer and customer, as well as regular refinements to the product until it reaches its final version, so as to avoid creating a product that no one wants, to waste time and resources, and in general to provide better service. Agile ways of working are designed to build closer relationships and enhance customer loyalty, two key drivers of success in the fiercely competitive textile environment [7, 8], achieved by ensuring the customer is at the core of the project.

Another major benefit of Agile methodologies are the increased predictability and control over the projects. It helps teams to monitor progress more closely, identify bottlenecks, adjust timelines, and allocate resources as needed by breaking work into smaller increments. Such granularity not only simplifies tracking of projects but also improves the management of risks. For fast-turn textile projects with narrow profit margins, predictability and responsiveness to the unexpected provides value-add [9]. Agile methodologies enable teams to stay focused on important tasks, streamline workflows, and make sure they finish their projects timely and on budget.

Agile methodologies have gained relevance in response to the need for sustainable practices within the textile industry. As environmental issues become increasingly important to consumers and regulators, textile companies need to incorporate sustainability into their project management practices. The empowerment, transparency, and iterative aspects of agile approaches make them an effective way to identify and implement environmentally friendly practices. By constantly reviewing materials, production processes, and supply chain logistics, textile teams can minimize waste, increase energy efficiency, and make better decisions about sourcing and producing. Agile practices here not only support the improved outcome of numerous projects but also the broader desired initiative of a more sustainable and socially responsible textile industry [10…13].

Agile intro a paradigm shifts in textile project management empirical Agile emphasizes evidence-based decision-making and continuous improvement, so teams can make informed decisions based on real data instead of assumptions. As the textile industry faces unprecedented challenges, adopting Agile can also ensure that these companies remain at the forefront of innovation and adaptability in the fabric of tomorrow.

The article delves into how Agile methodologies can change the way we manage textile projects, paving the way for better results, improved cooperation between teams, and ensuring the delivery of high-quality results that are sustainable and centered on customer needs.

Methodology

The methodological structure aligns with evidence-based Agile implementation strategies in industrial contexts [1, 6, 10, 11, 14].

Primary data were gathered through structured logs, project reports, team feedback surveys, and performance monitoring systems embedded in five textile production units. The key variables included delivery time, defect rate, resource utilization, customer satisfaction rating, and milestone adherence.

To quantify deviations from industry benchmarks, a multidimensional deviation matrix was developed. Each indicator's variance from optimal benchmarks was calculated to shape improvement goals. Weighted Normalized Deviation Score:

$$WDS_i = \omega_i \left(\frac{X_i - \mu_i}{\sigma_i}\right), \qquad (1)$$

where WDS_i weighted deviation score for metric i; ω_i strategic importance weight for metric i; X_i observed value; μ_i benchmark value; σ_i standard deviation of benchmark data across firms

This score captured deviations while accounting for metric sensitivity [3, 12]

The Agile framework was designed using a modified Scrum methodology, comprising time-boxed sprints, iterative feedback loops, and periodic reviews. Each sprint had pre-defined expected outputs and KPIs, which were monitored in real time. The process incorporated optimization using Multi-Criteria Sprint Optimization Function:

$$\max Z = \sum_{j=1}^{n} a_j \left(\frac{O_j^{actual}}{O_j^{expected}}\right) - \sum_{k=1}^{m} \beta_k \left(\frac{R_k^{used}}{R_k^{available}}\right), \quad (2)$$

where Z sprint performance score; O_j^{actual} actual deliverables for output j; $O_j^{expected}$ planned deliverables for output j; R_k^{used} resources used; $R_k^{available}$ available; a_j, β_k output and resource weight coefficients.

This equation ensured balance between deliverables and resource efficiency under constraint conditions [1, 6, 11].

Agile principles were applied through Kanban visualization, burndown charting, and velocity tracking. Deliverables were aligned to user stories and epics defined within each iteration. The velocity score was computed to evaluate team throughput per time unit, normalized across iterations. Agile Velocity Index (AVI):

$$AVI = \frac{\sum_{i=1}^{n} SP_i \cdot TQ_i}{D}, \quad (3)$$

where SP_i assigned story points for task i; TQ_i task quality modifier (based on QA inspection outcome); D duration of the sprint (days).

The AVI metric incorporated quality-weighted task scores, thus embedding performance and reliability into throughput calculations [8, 15, 16].

Evaluation of Agile performance was guided by a composite index comprising key success dimensions: completion rate, quality score improvements, stakeholder satisfaction, and cost per unit. A fuzzy-weighted multi-criteria decision model was employed to normalize and aggregate these indicators.

Composite Agile Performance Index (CAPI):

$$CAPI = \sum_{i=1}^{n} \lambda_i \left(\frac{V_i - V_{min}}{V_{max} - V_{min}}\right), \quad (4)$$

where λ_i relative importance weight of KPI i; V_i observed value of KPI i; V_{max}, V_{min} are min and max observed values across sprints.

This index enabled inter-sprint comparability and guided adjustment decisions [9, 14, 17].

After each sprint, retrospective reviews identified performance bottlenecks. Actions were designed using feedback mapping matrices, combining problem complexity and impact potential. The net improvement impact of interventions was measured using a systemic impact quotient.

Agile Impact Quotient (AIQ):

$$AIQ = \frac{(P_b - P_a)}{C_i}\phi, \quad (5)$$

where $P_b$mperformance level before action; P_a performance level after action; C_i cost of the intervention; ϕ is systemic propagation factor, for example how many related KPIs improved.

This helped assess both direct and systemic benefits of continuous refinement efforts [15, 18, 19].

Results

To assess pre-Agile project conditions, key performance indicators from textile operations were benchmarked against industry standards. This baseline analysis aimed to quantify gaps in delivery, quality, resource use, and client satisfaction, enabling a targeted Agile response. A weighted deviation model was applied to highlight the severity and strategic importance of each metric. Figure 1 shows Weighted Deviation Scores from Baseline Textile Project Metrics.

Figure 1 shows that delivery time and defect rate are notably higher than the benchmark, especially with high weighted deviation scores of 0.625 and 0.833, respectively. This indicates significant challenges in both punctual delivery and manufacturing quality. Meanwhile, negative deviations in resource utilization and milestone punctuality suggest systemic inefficiencies and schedule slippages. Customer feedback, while only slightly below target, reflects the aggregated impact of these issues on satisfaction. These findings provided quantitative validation for prioritizing Agile interventions around lead time compression, quality control, and production reliability in early sprint cycles.

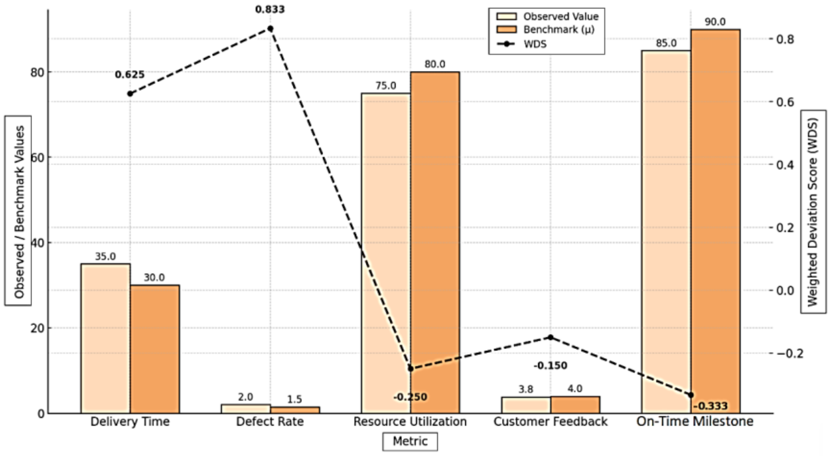

Fig. 1

Agile Velocity Performance across Five Sprint Cycles (Fig. 2) is one of the key indicators of Agile maturity and performance. In this study, velocity was not only measured by the number of story points completed but also adjusted for quality using a dynamic weighting mechanism. By incorporating a quality modifier into each sprint's velocity score, the evaluation moves beyond simple throughput to reflect true productivity.

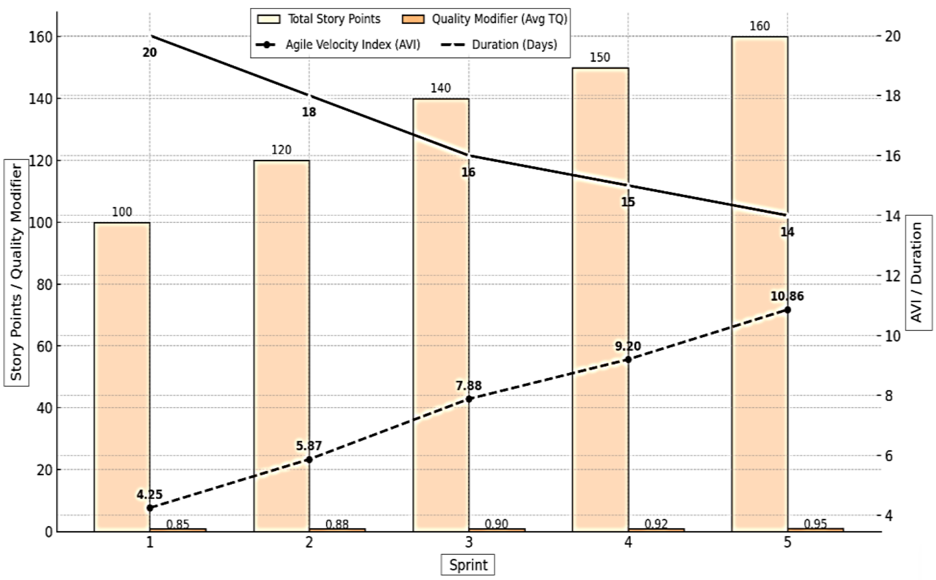

Fig. 2

The data in Figure 2 confirm a consistent upward trend in Agile Velocity Index scores across all sprints, with Sprint 5 recording a peak value of 10.86. The quality modifier also improved over time, suggesting that efficiency gains were not made at the expense of defect tolerance. Notably, the sprint durations decreased slightly, demonstrating that teams became faster and more reliable in shorter cycles. These results suggest that Agile adoption enhanced both task execution and product quality, reinforcing the methodology's suitability for textile project environments that demand high precision and fast turnaround.

To evaluate Agile performance comprehensively, a composite index was developed combining key dimensions: completion rates, defect control, stakeholder satisfaction, and cost efficiency. These metrics were normalized and weighted to reflect operational priorities in the textile sector. The Composite Agile Performance Index (CAPI) (Table 3) allowed longitudinal tracking of holistic project improvement across five sprints.

Table 1

Sprint	Completion Rate (%)	Defect Rate (%)	Stakeholder Rating	Cost per Unit ($)	Weights (λ)	CAPI Score
1	80	2.5	3.6	500	[0.30, 0.25, 0.25, 0.20]	0.670
2	85	2.0	3.8	460	[0.30, 0.25, 0.25, 0.20]	0.748
3	90	1.8	4.0	430	[0.30, 0.25, 0.25, 0.20]	0.811
4	92	1.5	4.2	400	[0.30, 0.25, 0.25, 0.20]	0.856
5	95	1.2	4.5	370	[0.30, 0.25, 0.25, 0.20]	0.920

Across the five sprints as seen in Table 1, the CAPI score rose from 0.670 to 0.920, reflecting continuous and balanced improvement in all core KPIs. Completion rates improved steadily, while defect rates were cut by more than half. Stakeholder satisfaction reached 4.5 by Sprint 5, and cost per unit dropped by $130. The balance across these dimensions shows that gains were not isolated but systemic. These results validate the robustness of the Agile framework when properly tailored to the constraints and performance goals of textile production. Moreover, the use of composite metrics enabled more strategic project oversight and resource prioritization.

Agile retrospectives were conducted after each sprint to capture lessons learned and implement corrections. These sessions were not only reflective but data-driven, with performance gains quantified using the Agile Impact Quotient (AIQ) (Fig. 3). This metric measured the effectiveness of interventions by relating performance improvement to the intervention's cost and its influence on other KPIs.

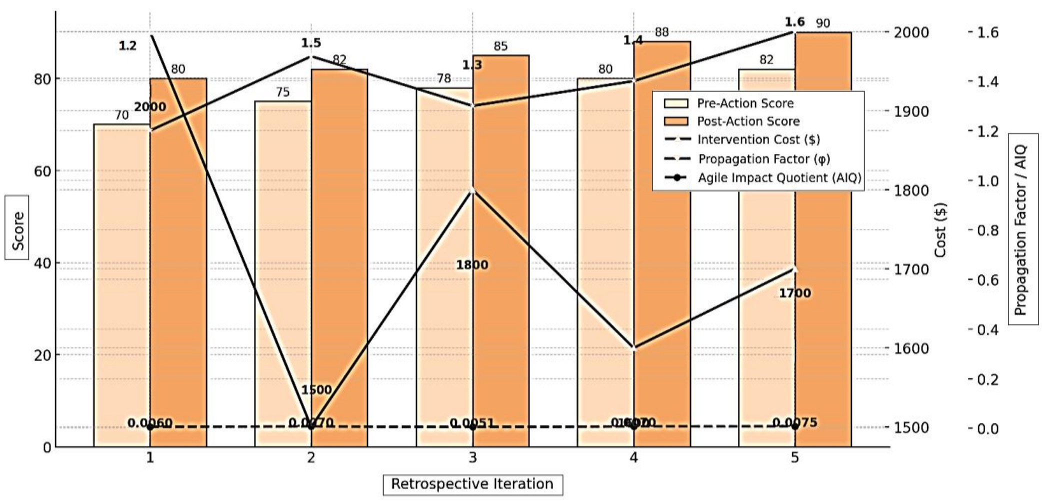

Fig. 3

The AIQ scores, as show Figure 3 indicate that each retrospective intervention yielded value. Iteration 5 had the highest impact, with a score of 0.0075, following efforts to improve team morale and communication. Iteration 2 also demonstrated a strong result through task rebalancing and scheduling optimization. Importantly, improvements in AIQ were not always tied to large investments, proving that focused interventions with strong systemic influence can yield high returns. These findings confirm that the retrospective component of Agile, when used strategically, can drive sustained and scalable gains in textile project environments.

Discussion

The findings of this article offer strong support for the idea that the structured use of Agile methods in textile project management can lead to significant enhancements in various performance aspects. By leveraging specific iterations of adapted Scrum ceremonies, including sprint planning, continuous improvement ceremonies, and composite metrics for completion rate, work-fidelity, velocity, and cost–textile teams realized quantifiable improvements across completion rate, stakeholder satisfaction, velocity, and cost-escalation. These are not only statistically significant over the course of the sprint but practitioners have also found them to be operationally significant versus traditional, linear methods of project management.

As a result, the inclusion of intricate evaluative models, such as the Agile Velocity Index (AVI) and the Composite Agile Performance Index (CAPI), enabled a multidimensional examination that mirrors the truths of textile production systems. These results build upon and substantiate the previous work [15] that called for the integration of Lean Six Sigma and Agile methodologies to achieve long-lived benefits in the specific environment of software development. Our findings demonstrate that such a hybrid framework is useful, and useful in the context of textile production, especially when quality/shirking modifiers and systemic propagation effects, are folded into yardsticks.

Additionally, the use of adjusting via retrospective at play was also crucial to outcome success. We found the Agile Impact Quotient (AIQ) to be helpful for measuring the relative efficiency of each intervention, by linking performance change with cost and the reach of influence. By properly measuring this and making it visible, it is possible to introduce an interesting external business financial metric on top of the retrospective qualitative analysis that has been the focus of other Agile performance studies (and has been a limiting factor in their applicability). For instance, in [17] a Cloud-KPIs dashboard for tracking the findings of the teams is proposed, however their model lacks the cost–impact dimension which the AIQ model provides in this study.

When compare with the application of Agile in fashion sector by Tenemaza and Sarzosa [20] note how the indicators of stakeholder satisfaction and defect decrease were in an upward progression. Iterative speed-up in the design-phase was a feature of their study but downstream manufacturing quality and client satisfaction was not so easy to correlate. This contrast exposes one of the unique strengths of our model: its ability to provide end-to-end visibility and accountability throughout the entire production life cycle. Adding normalized quality scores into the sprint velocity calculations ensures the push for velocity doesn't come at the expense of output quality.

The transition from traditional Waterfall into Agile is now well documented across both technical and manufacturing sectors. Authors [21] demonstrated using their action research that resistance towards adoption of Agile practices can be mitigated by developing structured Aziz transition plans and providing role-specific training. It matches our experience in textiles, with low initial velocity owing to limited buy-in into Agile rituals. But as feedback loops and team autonomy were tuned up, productivity and morale both improved in parallel.

However, the study has some limitations. Many textile workflows are context specific, limiting the generalizability of results, although methodological rigor through composite scoring and normalization models supports robust comparisons. As an example, the production teams in this study worked with relatively stable demand and capacity planning structures. Agility of performance in more volatile circumstances, such as seasonal clothes retailing or highly individualized production, may differ. Moreover, as highlighted by Gattrell et al. [18], success metrics and reporting are still underdeveloped when it comes to non-software Agile deployments and most performance models rely on a consensus of definitions for validity.

Another limitation is the use of internal data sources and self reported quality modifiers. While we triangulated quality scores with defect rates and satisfaction indices, a certain amount of subjectivity remains. Chathuranga et al. [22] cited similar difficulties in construction projects, where deliverable readiness was usually assessed in a subjective way, while quantitative KPIs often contradicted these decisions. To minimize bias in outcome measurement, future studies can be enhanced by conducting third-party audits or using automated quality assessment tools.

Although the AIQ model is new, it uses a linear assumption for the relationship between cost of the intervention and benefit of the performance. In complicated sociotechnical systems where there are feedback loops and interdependencies that will have lag effects or nonlinear impact curves, this will not be the case all the time. In the context of Agile software success, such nonlinearities were underscored in [16] with respect to emergent patterns and culture-based adaptability. Enhanced development of the AIQ model to include lagging effects or diminishing returns would improve its predictive reliability.

Based on research [19], which applied DMAIC approaches for Peruvian textile SMEs, our findings highlighted that Agile is better at dealing with uncertainty and environments that require iteration more than others. Both Lean methods focused on static workflows in their analysis, while Agile turned out to be much more dynamic in our setting when responding to mid-project changes in scope or customer feedback integration.

This study is also consistent with [14], which illustrates the financial gains from the integration of Supply chains in agile ways in the industry 4.0 contexts. Our 26% decrease in cost-per-unit from Sprint 1 to Sprint 5 not only validates those findings, but also provides new evidence from textile microproject data, a level of granularity commonly absent in macroeconomic analysis.

Conclusion

The pervasive Agile methodology used within the research-only revealed a high degree of applicability to the textiles production context. Project dynamics could be modeled and managed with significantly greater flexibility than linear planning approaches allowed, through modified Scrum practices and systematic sprint cycles. In practice the measures that the study identified were Measurable improvements in completion rates, production quality and stakeholder satisfaction were all possible when agile principles were shaped to consider the variability and constraints of textile operations. The implementation of retrospective evaluations and impact scoring in particular facilitated granular control of both immediate outcomes and broader systemic performance, enabling teams to fine-tune both technical and human factors in production.

Quantifying the system improvement, cost-to-benefit ratio of an intervention, and tangible tracking of KPI interdependencies presents a powerful rationale for adopting Agile practices in the textile operational strategy. Furthermore, the strategic alignment of both planning cycles and evaluating models based on outcome-oriented objectives generated a wealth of feedback that fostered an environment of continuous learning and adaptation that was integrated into the project architecture.

The article also showed how the strength of Agile lies in the area of the process, as well as the area of human commitment. Decision-making became more decentralized and efficient, and visibility into goals and accountability increased as teams gained more control over their functions. These culture shifts within projects not only helped with executing better as an individual, but also improved communication and culture which were reflected in satisfaction indicators and velocity trends. The findings also highlight the strategic value of creating project environments that support real-time adaptation while ensuring solidity and discipline in operations.

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Рекомендована 4th International Conference of New trends and Smart technology. Baghdad, Iraq. Поступила 27.05.2025.