Model for risk assessment and agile method selection considering social factors in IT projects*

Vasyl Teslyuk[1,†], Iryna Gado[1,*,†] and Serhii Trevoho[1,†]

[1] *Lviv Polytechnic National University, 12 S. Bandera Str., Lviv, Ukraine*

Abstract
Modern IT projects operate under conditions of uncertainty and constant change, where traditional management frameworks often fail to address the combined influence of technical and social risks. Existing models for risk assessment and agile methodology selection typically consider these aspects separately, lacking an integrated perspective that accounts for team interaction, communication quality, and organizational culture. This study proposes a unified model that merges quantitative risk evaluation with formalized social indicators to support evidence-based selection of agile or hybrid project management approaches. The methodology employs a similarity-based decision function that links project characteristics with reference profiles of Scrum, Kanban, and Scrumban, incorporating both technical and social dimensions. Validation on a representative IT project demonstrates that the model provides transparent, analytically grounded guidance for methodology selection and effectively identifies hybrid approaches as more resilient in socially complex environments. The results highlight the potential of socially informed, risk-aware decision-support systems to enhance adaptability, communication, and overall project performance.

Keywords
risk assessment, agile methodology selection, decision-support systems, social factors, project management, Monte Carlo simulation, hybrid approaches [1]

1. Introduction

Contemporary IT project management is characterized by high dynamism, uncertainty, and the complexity arising from the integration of diverse technological and organizational components. Real-time requirement changes, the need for rapid responses to business and technical challenges, and heightened stakeholder expectations create conditions in which traditional project management methodologies often prove insufficient. In this context, agile and hybrid approaches have become particularly relevant, providing process flexibility, interactive team coordination, rapid adaptability to change, and enhanced risk management capabilities.

At the same time, contemporary research increasingly emphasizes that project success is determined not only by technical or procedural aspects but also by complex social and behavioral factors. Communication efficiency, team trust, psychological safety, participant experience, leadership style, and organizational culture can directly influence the likelihood of critical risks, decision-making timeliness, and estimation accuracy. Despite this recognition, most existing risk assessment and methodology selection frameworks treat social aspects primarily as contextual annotations rather than formal, measurable decision-making criteria.

Integrating risk-informed assessment with project methodology selection is therefore highly relevant. Formalizing social factors as quantitative and qualitative indicators of communication, collaboration, and team maturity enables the development of comprehensive models capable of predicting risks and guiding the informed selection of agile or hybrid methodologies according to team characteristics and organizational context.

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[1*] Corresponding author.
[†] These authors contributed equally.
vasyl.m.teslyuk@lpnu.ua (V. Teslyuk); iryna.v.nychai@lpnu.ua (I. Gado); serhii.m.trevoho@lpnu.ua (S. Trevoho)
0000-0002-5974-9310 (V. Teslyuk); 0000-0003-1615-6483 (I. Gado); 0009-0000-1921-5843 (S. Trevoho)

This approach gains further significance in the context of developing decision-support systems (DSS) for IT project management. Integrating technical, procedural, and social criteria allows the creation of more reliable and adaptive management models, potentially enhancing project performance, mitigating adverse risk impacts, and optimizing team interactions in dynamic environments.

Therefore, this study aims to develop and validate a model for agile methodology selection that integrates quantitative risk assessment with formalized social factors.

The main objectives of the research are:

- to formalize social and behavioral factors as measurable decision variables;
- to define a similarity-based function linking project characteristics and methodology profiles;
- to validate the model through experimental analysis and simulation.

Also, in practical IT project environments, methodology selection is rarely theoretical – it determines delivery speed, client satisfaction, and resource efficiency. Project managers often rely on subjective judgment when choosing between Scrum, Kanban, or hybrid setups. The proposed model aims to replace intuition with evidence-based decision-making by integrating measurable social dynamics (trust, communication efficiency) with quantified risk indicators. This ensures that methodology alignment is not just a procedural decision but a strategic one impacting project ROI and delivery predictability.

2. Related works

In contemporary research on IT project management, the integration of risk assessment models with the selection of agile or hybrid approaches has gained growing attention [13, 14, 16]. The modern perspective emphasizes not only technical and procedural dimensions but also social and human factors that significantly shape project risks and outcomes.

Recent studies propose both quantitative and qualitative frameworks for risk evaluation in agile software projects. In [1], an Analytic Hierarchy Process (AHP) model was introduced to prioritize project risks under dynamic uncertainty, demonstrating that agile environments require adaptive and multi-criteria assessment rather than static checklists.Additional fuzzy-based approaches to multi-criteria risk prioritization were also reported in [15] and [17]. Similarly, the systematic review presented in [2] analyzed agile project management practices under uncertainty and identified the lack of integrated approaches that connect risk metrics with social aspects such as communication and team cohesion.

Social and human dimensions are increasingly recognized as critical drivers of project risk [18-20]. Empirical analyses in [3] revealed that communication quality, psychological safety, and leadership style directly affect the probability of project failure. Further research in [4] confirmed that team experience and collaboration quality correlate with estimation accuracy in agile environments, underlining the need for risk models incorporating social maturity indicators.

Parallel studies [7, 8, 12, 14, 16] explore the selection between agile, hybrid, and traditional methodologies depending on organizational and social contexts. These works conclude that organizational culture, stakeholder engagement, trust, and cross-team interaction are decisive factors determining whether agile or hybrid frameworks perform better in mitigating project risk.

An integrative perspective is presented in [11], which emphasizes risk-aware management practices aligned with team communication structures. The study proposes combining structured risk tools (such as probability–impact matrices and Monte Carlo simulations) with team-centric indicators, including collaboration level, communication delay, and conflict frequency.

The role of computational intelligence and decision-support models in agile risk management is also expanding. Studies [5, 6, 15] introduced fuzzy-logic and fuzzy-TOPSIS-based models for decision-making in agile environments, demonstrating that such techniques effectively handle uncertainty and expert bias while supporting reproducible framework selection.

Although substantial literature exists on risk management in agile contexts and on social and team factors in agile settings, several gaps remain. Research [9, 10] highlights that many frameworks still treat social and behavioral aspects as contextual rather than decision-driving parameters. Trust and communication efficiency are acknowledged as decisive for distributed agile teams, yet these dimensions are rarely incorporated into formal decision models.

Despite these advancements, significant research gaps persist:

1. Most studies focus either on risk assessment or on methodology selection, rarely integrating both.
2. Social and behavioral factors are often presented as qualitative annotations rather than formalized decision criteria.
3. Few empirical works systematically link social maturity, communication efficiency, and agile methodology suitability within a unified model [21].

This study addresses these gaps by proposing a risk-informed agile methodology selection model that formally incorporates social indicators – communication quality, collaboration efficiency, trust, and team maturity – as measurable variables influencing methodology suitability and risk mitigation.

3. Proposed methodology

3.1. General concept

From a project management perspective, this framework aligns with standard PMBOK and Agile practices. The risk identification and quantification stages correspond to the "Plan Risk Management" and "Perform Qualitative Risk Analysis" processes in PMBOK. Similarly, the similarity-based decision function supports Agile methodology tailoring within the "Process Tailoring" activity described in Disciplined Agile Delivery (DAD). Thus, the model bridges traditional governance and Agile adaptability, making it suitable for enterprise-level implementations where hybrid management is the norm.

The proposed approach aims to integrate risk assessment and agile methodology selection in IT project management while explicitly considering social factors that influence decision-making.

Formally, the proposed model can be represented as a tuple:

$$M = \langle V_p, V_m, \psi, Rint, fsim \rangle, \quad (1)$$

where V_p – a multidimensional project characteristics vector, V_m denotes reference vectors of agile methodologies (Scrum, Kanban, Scrumban), ψ represents normalized social indicators, R_{int} – the integrated risk index, and f_{sim} – the similarity-based decision function.

This formalization ensures that both technical and social dimensions are treated as measurable variables and combined into a unified analytical framework.

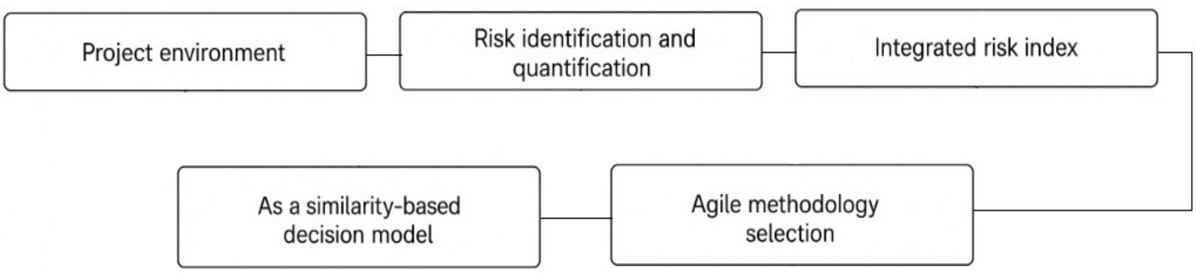

Figure 1: Conceptual framework of the proposed model.

The conceptual framework (Fig. 1) is based on the assumption that the effectiveness of project management depends not only on the technical characteristics of a project but also on team interaction, communication quality, and organizational culture.

At the first stage, input data describing the project environment are collected. These include project size, duration, complexity, and uncertainty level, as well as social parameters such as team experience, communication intensity, trust level, and adaptability. These characteristics form a multidimensional vector of project attributes.

The project characteristics are formally expressed as:

$$V_p = \{p_1, p_2, \ldots, p_n\}, \quad (2)$$

where $p_i \in [0,1]$ – normalized indicators describing the project's size, variability, schedule constraints, uncertainty level, team experience, communication intensity, and other relevant parameters. Normalization to [0,1] ensures consistent comparison with methodology reference profiles V_m.

The second stage involves risk identification and quantification. Risks are divided into technical and social categories. Technical risks relate to technology maturity, integration complexity, and task dependencies, whereas social risks arise from communication issues, unclear role distribution, or insufficient collaboration. Each risk is evaluated on a normalized scale according to its probability and potential impact.

At the third stage, the integrated risk index is calculated using weighted aggregation, allowing comparison between alternative project configurations. This stage provides the foundation for determining the optimal agile methodology.

The final stage involves applying a similarity-based decision model. The suitability of methodology M_i for the project is determined using a similarity function:

$$fsim(V_p, V_m^i) = 1 - \frac{\sum_{j=1}^{n} w_j \cdot |(p_j - v_{ij})|}{\sum_{j=1}^{n} w_j} \cdot \left(\frac{1}{1 + \alpha \cdot Rint}\right) \quad (3)$$

where v_{ij} — components of the methodology reference vector V_m^i, w_j — criterion weights, R_{int} — the integrated risk index, and α — a risk-sensitivity coefficient ($\alpha \geq 0$).

A similarity function compares the current project's risk and social parameters with reference patterns for Scrum, Kanban, and Scrumban methodologies. The result is a ranked list of approaches, where the highest similarity indicates the most suitable methodology.

This framework enables a balanced combination of quantitative risk metrics and qualitative social characteristics, thus bridging the gap between formal decision models and human-centric project management.

It also provides a theoretical basis for developing an intelligent decision support tool that can dynamically recommend agile approaches based on evolving social and risk factors.

3.2. Stages of risk-aware agile methodology selection

The proposed methodology is implemented as a sequence of six interrelated stages that provide a systematic process for evaluating project risks and selecting the most suitable agile approach. Each stage transforms specific input parameters into intermediate results, which are then aggregated into a final decision-support outcome.

At the first stage, risks specific to the project are identified based on expert judgment, previous project experience, and the organizational environment. These risks are classified into two main categories: technical (such as technology maturity, task dependencies, and system complexity) and social (such as communication barriers, lack of trust, and unclear role definitions). This classification establishes the foundation of the project's risk knowledge base.

The second stage involves both qualitative and quantitative assessment of the identified risks. Each risk is evaluated in terms of its probability of occurrence and impact on project objectives. Standard project management techniques – including Risk Score, Expected Monetary Value (EMV), and Monte Carlo simulation – are applied to quantify uncertainty and variability. The result is a normalized, weighted risk matrix that reflects the relative significance of each risk factor.

Each identified risk r_k is evaluated through its probability P_k and impact I_k, forming a basic risk score:

$$r_k = P_k \cdot I_k, \quad (4)$$

To aggregate individual risks into a single metric, an integrated risk index is computed as:

$$Rint = \Sigma w_k \cdot r_k, \; k = 1 \dots m, \quad (5)$$

where w_k are expert-defined weight coefficients satisfying $\Sigma w_k = 1$. The value $R_{int} \in [0,1]$ reflects the overall risk exposure of the project and acts as a moderating factor in the decision function.

During the third stage, the characteristics of the project and the assessed risk parameters are represented as a multidimensional characteristic vector (V_p). Each agile methodology, such as Scrum, Kanban, or Scrumban, is defined by its own reference vector (V_m). By including social attributes – such as communication frequency, collaboration intensity, and leadership style – these vectors capture both technical and human dimensions of project management.

The fourth stage consists of calculating a similarity function between the project vector and each methodology vector. The similarity measure, denoted as $f_{sim}(V_p, V_m)$, accounts for technical and social dimensions while being adjusted by the integrated risk index (R_{int}). A higher similarity value indicates a greater suitability of the given methodology for the specific project context.

In the fifth stage, the agile methodologies are ranked according to their suitability indices derived from the similarity coefficients. This ranking provides decision-makers with a rational basis for identifying the optimal approach while allowing the comparison of alternative frameworks under different risk conditions.

The sixth stage focuses on visualization and interpretation of the results. Outcomes are displayed through analytical charts or interactive dashboards integrated into the decision-support module. Visual analytics enable project managers to easily understand the relationship between risk exposure, social dynamics, and the relative suitability of each agile methodology.

To provide a concise and operational representation of the proposed framework, the sequential steps of the methodology selection process are summarized in Table 1.

Table 1
Steps of the risk-aware methodology selection procedure

Step	Description
1	Collect project and social indicators to construct the unified project vector V_p.
2	Identify project risks and compute individual risk scores.
3	Aggregate risk scores into the integrated risk index R_{int}.
4	Compute the similarity between the project vector and each methodology profile.
5	Rank all methodologies by descending similarity score
6	Select the methodology with the highest similarity score or consider several top alternatives if their values are close.

Together, these stages form a transparent and reproducible decision-making framework that integrates analytical rigor with managerial intuition, advancing the principles of the Social IT Project Management paradigm.

3.3. Representation of social factors in the model

Social factors play a decisive role in the success of agile projects. In the proposed model, they are not treated as external qualitative variables but are mathematically incorporated into the risk assessment process. Each social indicator can be represented as either an additional variable in the characteristic vector (V_p) or a modifier influencing the weighting coefficients of risk parameters.
Formally, social factors are defined as a vector:

$$\psi = \{\psi_1, \psi_2, \dots, \psi_l\}, \psi_j \in [0,1] \tag{6}$$

where ψ_j denotes measurable indicators of communication quality, trust, psychological safety, team maturity, leadership style, and collaboration efficiency. These indicators are incorporated either directly into V_p or used to adjust the weights w_k in the integrated risk model, allowing social dynamics to influence risk evaluation and methodology suitability.

The following social attributes are operationalized as measurable key performance indicators (KPIs) that can be extracted from project management tools or team feedback systems:

- Communication Quality – derived from average message response time, number of unresolved comments, and frequency of stand-up participation logged in Jira, Slack, or Microsoft Teams.
- Trust and Psychological Safety – assessed through periodic 360° feedback surveys and the team's Net Promoter Score (NPS), reflecting openness and confidence in leadership.
- Team Maturity – measured by sprint predictability, defined as the ratio of committed versus delivered story points per iteration, which represents planning accuracy and collaboration stability.
- Leadership Style – evaluated based on team feedback and a decision-making autonomy index that quantifies the balance between guidance and empowerment.

By embedding these measurable indicators, the model transforms subjective social dynamics into objective, actionable data. These parameters can be continuously tracked via a project dashboard, allowing project managers and PMOs to monitor team health and adjust management approaches proactively.

Empirical studies [3, 4, 8] confirm that deficiencies in these dimensions directly increase project risks and reduce the efficiency of agile methods. Therefore, integrating these metrics into the model ensures that social aspects are not just observed qualitatively but managed quantitatively as part of the overall risk framework.

This integration transforms the model into a hybrid structure that unites technical, managerial, and behavioral components – thereby aligning it with the broader context of Social Information Technologies.

4. Experimental validation and results

The proposed model was validated using data from a medium-scale IT project that combined software development and integration activities. The goal of the validation was to evaluate how the model supports the selection of an agile methodology considering quantified risks and social factors.

Risk assessment was carried out according to the PMBOK model, where the Risk Score is calculated as the product of the probability of occurrence and the impact of a given event as defined in Equation (4).

Table 2 presents the probability and impact values for both technical and social risks, along with the calculated Risk Scores.

Table 2
Probability, Impact, and Risk Scores for Technical and Social Risks

Risk	Probability (P)	Impact (I)	Risk Scores
Change in customer requirements	0,8	9	7,2
Insufficient team experience	0,5	7	3,5
Budget overrun	0,4	6	2,4
Delays due to integration	0,6	8	4,8

The evaluated probability – impact combinations reveal that "Change in customer requirements" and "Integration delays" represent the highest risk exposure.

To visualize the combined effect of probability and impact across all identified risks, Figure 2 presents a risk matrix illustrating their relative severity.

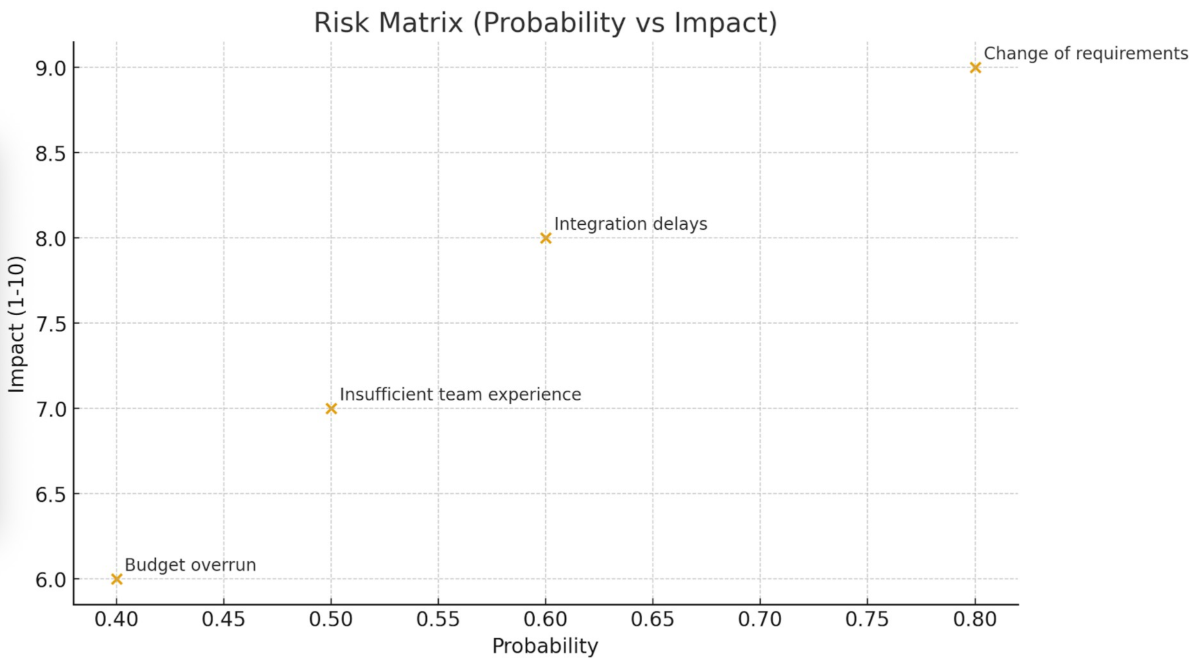

Figure 2: Risk matrix.

For quantitative evaluation, the Expected Monetary Value (EMV) method and a Monte Carlo simulation were applied. EMV is calculated as:

$$EMV = \sum P_i \cdot Impact \qquad (7)$$

Assuming the impact is expressed in thousand USD, the following sample calculations were made:

- Change in requirements: EMV = 0.8 × 50 = 40
- Insufficient experience: EMV = 0.5 × 30 = 15
- Integration complexity: EMV = 0.6 × 40 = 24

The total expected monetary loss equals 79 thousand USD.

A Monte Carlo simulation with 1000 iterations was conducted, varying parameters P and I within predefined distributions. The output shows a most probable outcome around 80 thousand USD and a range of 60 – 100 thousand USD depending on uncertainty scenarios. The resulting distribution of simulated losses is presented in Figure 3.

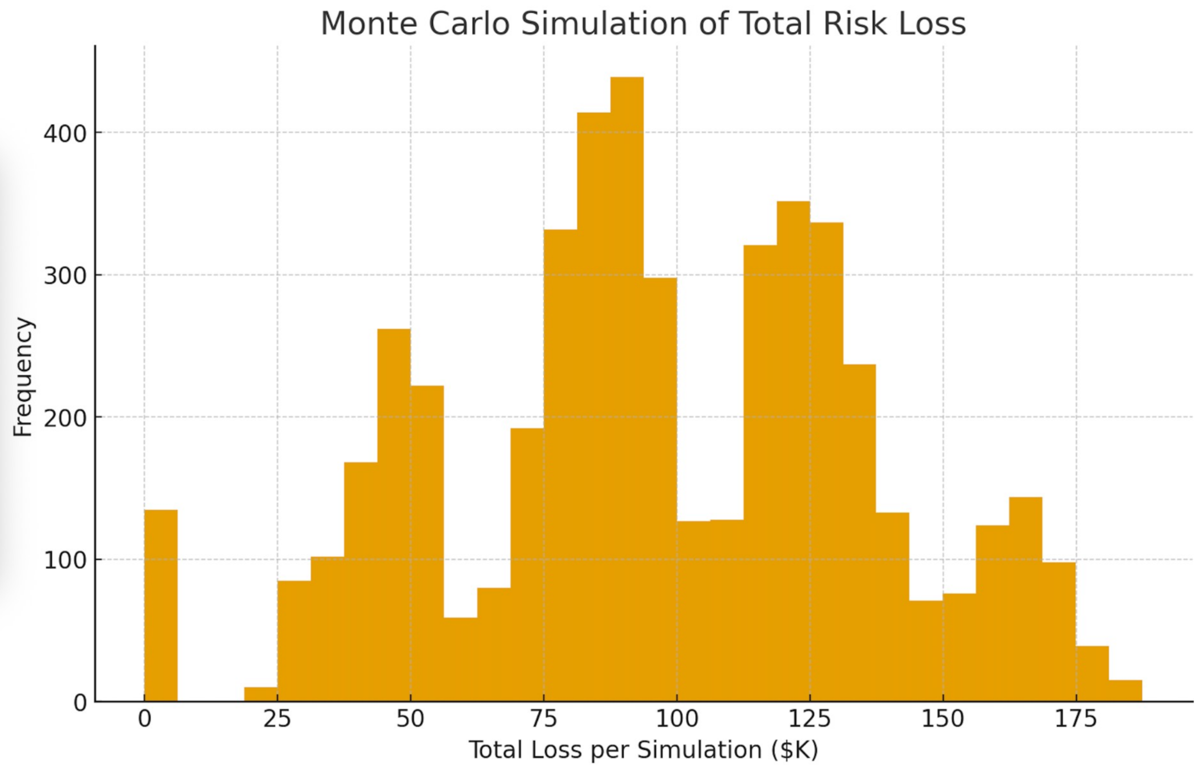

Figure 3: Monte Carlo Simulation Results.

Based on the evaluated risks, the methodology selection was performed using the similarity function introduced in Equation (3), which incorporates both project parameters and the aggregated risk index R_{int}.

From a management standpoint, the similarity index directly translates into methodology selection confidence.

For example, a difference greater than 0.1 between two methodologies (e.g., Scrumban = 0.91 vs. Scrum = 0.84) represents a substantial difference in suitability, suggesting that hybrid frameworks better absorb social complexity.

This interpretation provides project managers with quantitative justification for methodology selection, helping avoid subjective bias and ensuring transparency during project initiation.

Table 3 presents an illustrative example of similarity values computed for three agile approaches: Scrum, Kanban, and Scrumban. These values should be interpreted as a hypothetical demonstration of the suitability scores produced by the similarity function in Equation (3), rather than as results of a full-scale empirical evaluation.

Hypothetical project:

- Team: 10 members
- High requirement variability (p1 = 0.9)
- Medium budget (p2 = 0.5)
- Tight schedule (p3 = 0.8)
- Team experience – medium (p4 = 0.6)

Table 3
Methodology profiles (example)

Methodology	Variability (v1)	Budget (v2)	Schedule (v3)	Experience (v4)
Scrum	0,9	0,6	0,8	0,7
Kanban	0,8	0,7	0,6	0,6
Scrumban	0,85	0,65	0,75	0,65

Criteria weights: w = (0.4, 0.2, 0.3, 0.1), Integrated risk (R): average 0.65, Risk adjustment factor: $\alpha = 0.2$

Suitability calculation:

- Scrum: S = 0.91
- Kanban: S = 0.78
- Scrumban: S = 0.87

The obtained suitability indices demonstrate clear differentiation between methodologies.

Scrum shows the strongest alignment with the analyzed project characteristics, followed by Scrumban and Kanban.

Figure 4 visualizes this comparative ranking, summarizing the relative suitability of each agile approach.

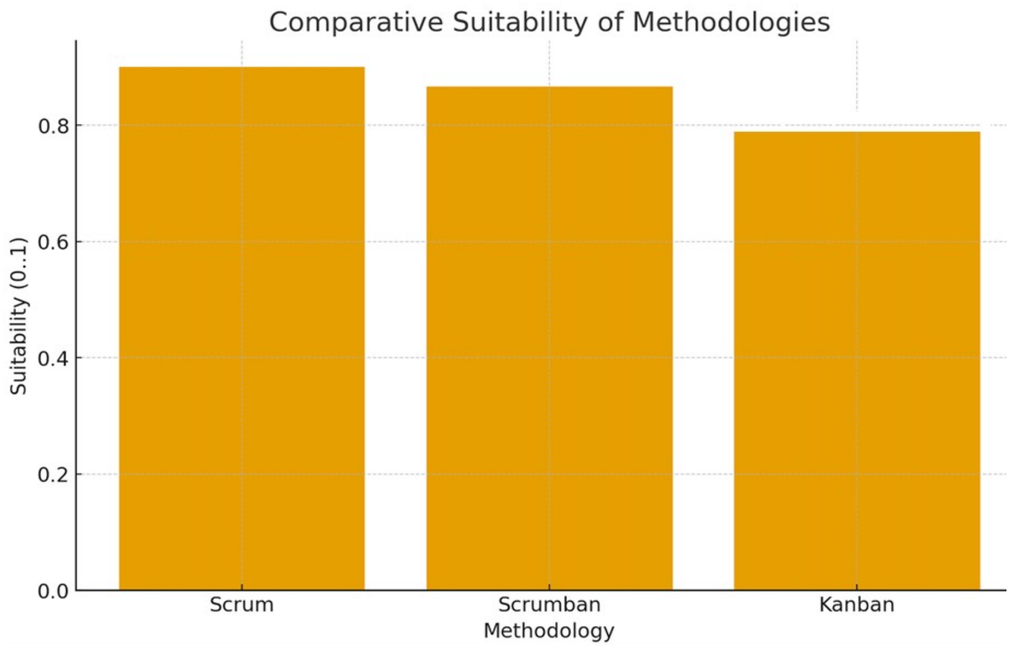

Figure 4: Agile methodology suitability ranking.

The experiment confirmed that the proposed model effectively integrates quantitative risk assessment with agile methodology selection while explicitly accounting for social parameters such as communication quality, team experience, and trust. The results show that Scrum provides the best alignment with the analyzed project context, offering high adaptability and stable performance compared to Kanban or hybrid approaches like Scrumban, given the specific risk and social parameters of the project. Although the model demonstrates promising results, several limitations should be acknowledged. The experimental validation was based on a single medium-scale project, which restricts generalization. Future research should expand empirical testing across multiple organizations and employ machine learning and fuzzy linguistic modeling to capture non-linear dependencies between risk and social parameters. Such extensions will improve predictive accuracy and enable the creation of a self-learning decision-support module integrated into project management platforms such as Jira or Odoo.

The scientific contribution of this study lies in the further development of an integrated approach for selecting IT project management methodologies that combines quantitative risk assessment with socially oriented team interaction metrics. Within a risk-oriented framework, social factors such as communication efficiency, trust, and team maturity are considered active variables, influencing both comprehensive risk evaluation and the alignment of methodologies with project-specific characteristics. This approach facilitates the continued refinement of socially sensitive methodology selection models and supports the development of decision-support systems within the framework of Social IT Project Management.

By formalizing social aspects alongside traditional risk assessment methods, this development enables the integration of team interaction indicators into methodology selection, creating opportunities for more adaptive decision-making and improved management of complex IT projects.

5. Discussion

The experimental results confirmed the effectiveness of the proposed model, which integrates a risk-oriented approach to IT project management with the formal consideration of social factors. This integration enables a shift from intuitive decision-making to an analytically grounded process in which technical, organizational, and behavioral aspects are treated as interdependent components of a single management framework.

Combining quantitative risk assessment with parameters of team interaction expands the boundaries of traditional risk management, which typically focuses on financial or temporal metrics, by incorporating the influence of communication, trust, and psychological safety. The results are consistent with findings in [3] and [4], which emphasize that team maturity and interpersonal communication quality critically affect the risk profile in Agile environments. Within the developed model, these factors are represented as quantitative variables that influence both the integral risk indicator and the similarity function between project characteristics and management methodologies.

In comparison with studies [5] and [6], the proposed approach demonstrates methodological consistency while introducing an important distinction: instead of focusing solely on technical adaptability, it embeds social variability as an explicit part of the decision structure. This socially sensitive integration enhances predictive accuracy and ensures transparency in methodology selection. Monte Carlo simulation confirmed the model’s stability and provided quantitative insight into uncertainty ranges, with risk levels corresponding to realistic mid-risk project conditions.

From a practical standpoint, the model can be implemented as a decision-support component within existing project management platforms such as Jira or Redmine. This enables automated methodology recommendations that reflect both the actual risk profile and the social state of the team. Such implementation strengthens communication between managers, clients, and developers and ensures consistency between risk projections and team characteristics, improving overall decision alignment.

Certain limitations, however, should be acknowledged. The experimental validation was conducted on a single medium-scale project, so broader empirical testing is required for statistical generalization. The current model assumes linear relationships between risk and social parameters, which may not fully capture the non-linear dynamics of team behavior. Future studies should employ machine learning techniques to reveal complex dependencies and integrate fuzzy logic to process linguistic assessments of social factors.

Overall, the results suggest that the integration of quantitative risk assessment with formalized social indicators represents an important step toward enhancing adaptability in IT project management. The proposed model extends existing approaches by incorporating measurable social dimensions into the analytical process and shows potential for further development into a self-learning decision-support system that adjusts weighting coefficients based on accumulated project data. This advancement contributes to the evolution of socially informed risk management systems and supports the formation of the emerging Social IT Project Management paradigm, where social and behavioural dimensions are recognized as formal, quantifiable elements complementing technical and procedural variables.

6. Conclusions

This study summarizes the development and validation of an integrated model for risk assessment and the selection of agile project management methodologies that formally incorporates social factors. The proposed approach enables a transition from intuitive methodology selection to a formalized, analytically grounded decision-making process that unites technical, risk-oriented, and behavioral dimensions of project management.

The scientific novelty of the study lies in the formalization of an integrated decision-making model that combines quantitative risk assessment with measurable social indicators incorporated into the project vector V_p. For the first time, a risk-adjusted similarity function is introduced to evaluate the suitability of agile and hybrid methodologies, enabling the aggregated risk index R_{int} to influence the selection process directly. This provides a mathematically grounded and reproducible alternative to existing multi-criteria and expert-based approaches, while extending them by formally embedding social and behavioral project factors into the methodology recommendation procedure.

The proposed decision model incorporates both structural and social project factors through the unified project vector and the aggregated risk index, allowing the similarity-based selector to account for team dynamics and social complexity.

The practical significance of the results lies in the model's applicability within modern digital project management platforms and its contribution to advancing the Social IT Project Management paradigm, which harmonizes analytical precision with an understanding of human and communicative factors of success.

Declaration on Generative AI

During the preparation of this work, the authors used ChatGPT for grammar and spelling checks, as well as for improving the clarity of certain passages. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the publication's content.

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