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Pareto-based Multi-criteria Optimization of Risk Management Decisions in it Projects

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In practice, risk management in the implementation of IT projects comes down to selecting a set of preventive measures within a limited budget. The difficulty is that no single measure is unambiguously better than another: strengthening quality control reduces the probability of defects but extends the schedule; infrastructure redundancy improves reliability but increases the total cost of ownership; engaging external expertise reduces technological risk while simultaneously creating vendor dependency. The problem is therefore multi-criteria by its very nature.

A common way to circumvent this difficulty is scalarisation, that is, the aggregation of all criteria into a single integral indicator with predefined weighting coefficients. Such an approach is computationally convenient but has a substantial drawback: it conceals the very structure of the trade-off from the decision maker. Having obtained a single number, the project manager does not see what exactly was given up in choosing this solution, nor how sensitive the result is to subjectively assigned weights.

The aim of this work is to substantiate an approach to selecting risk management measures for IT projects that preserves information about trade-offs between criteria and presents the decision maker not with a single alternative, but with a justifiably narrowed set of non-dominated options.

The proposed approach comprises the following steps. First, the space of feasible solutions is formed: each alternative is described by a vector of indicators — the residual level of risk, the cost of implementing the measure, the impact on project duration, and the reliability of

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technological operations. Residual risk values are determined using a model of cause-and-effect relations between events constructed by means of fault tree analysis, which makes it possible to assess how a particular measure changes the probability of top-level events.

Next, the Pareto set is extracted from the space of feasible solutions — the collection of alternatives for each of which it is impossible to improve one indicator without worsening at least one other. This set is objective: it does not depend on subjective preferences and is determined entirely by the input data. All solutions outside it are discarded as knowingly inferior, which already substantially reduces the search space.

Since the Pareto set usually remains too broad for practical selection, the next step applies coefficients that establish the customer's weighting preferences. The fundamental difference from classical scalarisation is that the weights are introduced not to aggregate the criteria, but to order the already selected non-dominated alternatives, after which a check is performed on how closely the chosen solution approaches the Pareto front. The subjective component is thereby localised at the final step and may be revised without recomputing the entire model.

Separate consideration is given to the circumstance that the input probability estimates are obtained from limited statistical samples and are interval-valued in nature. Comparison of alternatives is therefore performed with regard to the confidence bounds of the indicators: if the intervals of two solutions overlap, they are recognised as indistinguishable given the available data, and this is recorded explicitly rather than concealed by rounding to point values.

An additional factor that alters the problem statement is regulatory requirements. Resolution No. 70 of the Board of the National Bank of Ukraine of 30 June 2026, effective from 1 July 2026, introduced third-party risk management requirements for banks. A portion of the measures has acquired mandatory status, as a result of which the space of feasible solutions is narrowed by regulation and part of the budget is spent compulsorily. A model that disregards this partition yields a systematically optimistic estimate of the attainable level of residual risk.

Conclusions. The proposed approach makes it possible to move from selecting a single optimal solution to a justified

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narrowing of the set of alternatives while preserving the transparency of trade-offs. Its practical value lies in the fact that the project manager receives not a recommendation, but a picture of the available options with the consequences of each choice explicitly indicated. Further research is directed towards the software implementation of the described procedure within a decision support system for managing the risks of IT project implementation.

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