

Project Quality Risk Identification and Assessment Strategy Analysis

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Abstract. In the current context of increasingly fierce market competition, project quality has become an important factor for modern enterprises to improve their own competitiveness, and whether the project is successful or not. But there are so many uncertainties— project quality risks—in all stages of the project's life cycle. Neglecting the identification and management of these risks may lead to severe, even irreversible consequences. This paper first explains the importance of project quality risk identification and evaluation. It then examines the theoretical foundations and limitations of existing mainstream project quality risk identification strategies and evaluation methods. Finally, this includes the introduction of big data analytics to enhance the accuracy of risk identification. It makes some improvements and optimizations to solve the shortcomings of mainstream exams. to improve the scientific nature, the adaptability, and the decision credibility of risk management, and to gradually form a more intelligent, dynamic, and integrative project's quality risk management system, provide assurance for project success.

Keywords: Project quality risk; identification and control; refinement and optimization; risk management.

1. Introduction

As market competition across the globe is getting stronger and more competitive, customers' requirements keep going up, so the quality of the projects that come out is a big part of whether a project will do well and make the company better at what it does. But projects have their own special characteristics and uncertainties, and there are many things involved in the project, like people, machines, materials, ways to do things, and places to work, which makes it hard to know when there might be problems with the quality. Failure to effectively identify and manage these risks can lead to rework, cost overruns, schedule delays, and even customer complaints, damage to brand reputation, or complete project failure [1]. Hence, thoroughly recognizing and scientifically assessing quality risk issues all throughout the project lifecycle, and at the same time creating proactive response strategies, has turned into a very important and immediately needed subject of study within contemporary project management.

Currently, scholars have established robust theoretical foundations in both project risk management and quality management. However, traditional risk management frameworks like those created by the Project Management Institute (PMI) in its PMBOK® Guide are structured in a detailed manner, covering the identification, analysis, and response procedures of risks. They tend to utilize these frameworks mainly for scheduling and cost. To quality, Risk is to be found rather sparsely, being mostly isolated in specific cases within an industry and lacking any common structure for integration into one big study [1, 2].

At the same time, the existing evaluation method mainly adopts the traditional probability-impact matrix. While this classic tool is concise and intuitive, it fails to adequately address key dimensions such as the “hidden” and ‘lagging’ characteristics of quality risks and their detectability [3]. The theory of “fitness for use” is put forward by Joseph M. Juran stresses that the essence of quality is ‘fitness for purpose’, many risks which affect Fitness for Use are also hidden and show themselves later on [4]. Furthermore, it is generally assumed that the effect of “variation” on project quality as explained by Genichi Taguchi's quality theory [5]. And do not take into account the complex relationships between all kinds of risks found by Kaoru Ishikawa's causal analysis [6]. Consequently,

the accuracy and effectiveness of risk assessments fall short, making it difficult to formulate precise, forward-looking preventive strategies.

Given this, this paper is designed to provide a systematic review of existing studies on project quality risk identification and evaluation. Through a review and study of relevant domestic and international literature, this paper will first summarize and compare various commonly used quality risk identification frameworks and tools, such as Failure Mode and Effects Analysis (FMEA), Work Breakdown Structure (WBS), etc., and analyze the applicability scenarios and limitations. And also, the paper will explore and evaluate the theoretical foundations of various mainstream risk assessments (such as the Risk Matrix and Analytic Hierarchy Process) as well as their project quality adaptations [7]. Finally, after a review of existing research paradigms, in order to provides the reader with information on current gaps in research and potential future directions for research. In order to offer a clear knowledge map and useful hints for both theoretical expansion and on-the-ground employment in the field.

2. Relevant Theoretical Foundations

2.1. Project Quality Management Theory

Project quality management refers to the fact that project quality management is considered one of the major areas of the Project Management Body Of Knowledge (PMBOK) knowledge domain that ensures a project and its products will satisfy the stakeholders' needs and requirements. It's not just checking if the "final product" is right, but a big process all through the project to stop things from going wrong. The project quality management has a theoretical core, which is called "get it right" the very first time. The main principles of project quality management contain six principles: customer focus, prevention, continuous improvement, management responsibility, data-based decision making, and process orientation. Project quality management carries out careful planning to optimize processes so as to deliver according to specification.

Project quality management is generally organized into three quality groups that are closely related. First is the planning quality management, which is responsible for finding the quality needs and standards for the projects and their products, and documenting how the project will meet the quality needed. The major output from planning quality is the Quality Management Plan, which gives a template on how quality will be controlled and confirmed during the project. The present study points out that it is very important to carry out better and better quality planning early on, closely related to the project scope and work breakdown structure, to avoid defects and overcosts in the project [8]. The second is about quality, which is also known as "quality assurance". It's an activity oriented toward process, which aims to check quality requirements and the outcome of quality control measurement. It ensures appropriate quality and operational terms so as to boost the overall project process performance. At the same time, new perspectives from academia indicate that the management of quality is very much a function of an organization's quality culture and not of the process itself. It's because a positive quality culture promotes being proactive with identifying problems rather than hiding them [9]. Thirdly, control quality is different from management quality in that it is a product activity. it checks and records quality activity results, assesses work, and gives suggestions for any needed changes. Quality control activities should be integrated into all parts of a project sooner and more frequently so as to find defects earlier and more often and have more effective corrections [8].

2.2. Project Risk Management Theory

Project risk management's key idea is to proactively and systematically determine, analyze, deal with, and oversee project risk so as to raise the possibility of project success and lessen the peril of project failure [10]. Modern project risk management theory holds that it should be an early stage, continuous, full participation, and fully involved process, not a response after an event has happened. Project risk management contains "Act proactive, rather than reactively", "Comprise over the entire project life cycle", "Relate with every stakeholder", "Cost and benefit considerations", "Transparency

and communication”. Academic research done recently shows that there is a strong positive connection between risk management that’s well developed and projects achieving success [11]. It shows that the proper application of risk management theory can greatly enhance the likelihood of project success for project teams.

Project risk management process is usually in a cycle. For risk identification, the project team has to use many methods like brainstorming, the Delphi method, check list to find out every possible source of uncertainties that might trouble project goals like money, time, and quality. Next comes risk analysis, which can also be divided into qualitative and quantitative analyses. Qualitative analysis sorts risks and assesses their chances and impact of occurrence, whereas Quantitative analysis employs Monte Carlo simulation, decision tree, and so forth to carry out numerical modeling of the top-priority risks to analyze their effect on the overall project goals [12]. After that are the risk response plans for different kinds of risks with different risk response strategies for these risks (avoid, transfer, mitigate, or accept them). Take a large threat risk impact as an example. Mitigation strategies are used to reduce the likelihood or consequences [13]. finally risk monitoring is alive loop process going through the whole of a project's life. Continually follow up on identified risks, continuously keep an eye on remaining risks, find new risks, and see if the measures it take to deal with risks are effective.

2.3. Specific Characteristics of Quality Risks

And the project quality risk is unique as well. First is that they’re concealed and delayed; a lot of quality defects escape detection during development and testing, only coming to light in later tests or after implementation is complete. It ends up with very limited time for replies and extraordinarily high rectification prices. Second is the transmission problem; one phase’s risk of quality will spread throughout the whole project chain and get bigger and bigger, creating a butterfly effect. Thirdly, it’s subjective and perceived quality; project quality consists of subjective elements. It’s possible that even if the final deliverable meets all written requirements, it could still be seen as a quality failure if it does not meet the ‘psychological expectations’ of the client/user. For example, if software implements every single feature that users want, but it’s extremely clunky and difficult to operate, people are still going to think this is bad software. And finally, irreversibility and costly remediation: if subpar, shoddy, or low-quality work is let go out there in the real world. Revising that stuff can be really hard and really expensive; the damage might even be permanent, the company’s reputation could get irreparably wrecked, and clients may turn their backs on the organization.

3. Research on Existing Project Quality Risk Identification Systems

3.1. Sources and Classification of Quality Risks

Quality risks don't come out of nowhere; they're born in all sorts of spots from the project's life cycle and all kinds of people who have a stake in it. These sources can be classified into 3 main categories: First, technical and process sources: These mainly include vague or unclear requirements, flaws in design, lack of technical methodology, poorly defined process steps, and the buildup of technical debt. Second, sources related to resources and people: mainly consist of personnel skill deficiency, staff turnover, physical and mental exhaustion, and problems related to materials and equipment. The third group is management and external sources: Overly optimistic projections, snafus with miscommunications, supplier risk, alterations to the outside environment, and insufficient supervision from managers.

Quality risk can be categorized according to different classification dimensions. In this paper, it use the most commonly used dimension-risk nature-and they are divided into internal and external quality risks. Internal Risks: Design Flaws; Bugs in the Code; Poor Staff Skills, Processes, and Judgement By The Managers; And Poor Judgment of Your Managers. External risks: Changes to customer requirements at any moment, legislative or regulatory changes, changes in the market environment, natural disasters, and supplier failure to deliver or delivery of substandard items.

3.2. Applicability and Limitations of Existing Quality Risk Identification Methods and Tools

FMEA is a forward-looking, systematic, and structured risk management tool. Its core principle is "prevention rather than cure," addressing issues before they occur to avoid costly rework, ensure quality, and maintain safety. The characteristics of FMEA ensure comprehensiveness, minimising the risk of omissions while preventing issues from arising. Furthermore, its quantitative prioritisation (RPN) provides a sound basis for resource allocation decisions. However, FMEA is time-consuming and labour-intensive, with high implementation costs and a significant reliance on team members' experience and judgement. This subjectivity may introduce certain biases.

WBS+RBS is a powerful and systematic way of finding project risk. It's useful for large-scale, complex, new, and high-risk projects. The fusion of WBS and Risk Breakdown Structure (RBS) greatly decreases the possibility of major risks being overlooked during the risk identification phase, which is the main benefit. And even better is increased risk assessment accuracy and clearly defined responsibility allocation, so as to give an entirely objective and correct estimation of risk probability and impact, while avoiding circumstances in which risks have no one responsible for them. Although there are many advantages like this, it still takes a lot of time and labor, and has high dependence on the knowledge and expertise of the team, and also has relatively high maintenance costs.

4. Research on Existing Project Quality Risk Assessment Methods

4.1. Theoretical Foundations of Mainstream Risk Assessment Methods

Risk Matrix theoretical basis for the theoretical basis, it based on a two-dimensional risk model: "Risk = Probability of Event Occurrence × Consequences of the Event Occurred" Risk matrix translates these 2 abstract concepts into assessable dimension and visualize them on 2D-plane: Thus, for events with high impact but low probability or low impact but high probability, there is no inherent risk. A real high-risk event is something that is likely to happen and something that would be really bad if it did happen. The main idea of the Analytic Hierarchy Process (AHP) is to break down complicated decision-making problems into hierarchies. This is quantifying human subjective judgment using the pairwise comparison approach. It offers a solution that is a mix of qualitative and quantitative approaches to solve problems with multiple objectives and criteria.

4.2. Limitations and Improvement Recommendations for Mainstream Risk Assessment Methods

Traditional risk matrices exhibit certain shortcomings. Firstly, they suffer from subjectivity and inconsistency, as different assessors may yield significantly divergent evaluations for the same risk due to reliance on personal experience and judgment, lacking objective criteria. Secondly, traditional risk matrices overlook inter-risk correlations, treating each risk as an isolated entity while disregarding complex coupling, cascading, and feedback relationships between risks. Thirdly, they represent static risk assessments at a single point in time, failing to capture dynamic changes in risks over time, under varying conditions, or in response to mitigation measures.

To address these shortcomings, this paper proposes the following refinements. Firstly, refine the description of risk levels by providing more detailed and objective anchor points for probability and impact grades. For instance, define impact levels such as "major" or "severe" using concrete metrics like specific economic loss amounts, project delay days, or casualties, thereby reducing subjectivity. Secondly, integrating the traditional risk matrix with scenario analysis and stress testing. Rather than viewing risks in isolation, this approach constructs complete scenarios of "if X occurs, then how will Y be affected?" to analyse the chain reactions and overall impact of multiple risks within specific scenarios. Thirdly, linking the traditional risk matrix to a timeline or key indicators, whereby risk levels adjust dynamically in response to changes in relevant metrics.

The main restriction of the Analytic Hierarchy Process is the amount of work your mind has to do: AHP requires decision-makers to perform pairwise comparisons across multiple factors. When many factors exist, the number rises very quickly, adding a lot of mental pressure, which causes people to

be confused and unable to make good judgments. Second is the reversal problem, perhaps the worst thing in AHP's list of problems, where introducing (or removing) a single new decision scheme or option can reverse the entire initial relative order among all of the schemes. Thirdly, like traditional risk matrices, there is much subjectivity, with high susceptibility to personal preferences, knowledge levels, emotions, and group pressure.

To address these shortcomings, this paper proposes the following refinements. Firstly, clustering elements into subgroups to form multiple sub-hierarchies. Comparisons are first conducted within each group, followed by group-to-group comparisons between subgroups. This reduces the number of comparisons required, thereby alleviating the decision-maker's burden. Secondly, the ideal point method is introduced. When calculating the final weight of objectives at the scheme level, the optimal scheme score under each criterion serves as the benchmark for calculation. This prevents inversion caused by adding or removing new schemes or options. Thirdly, AHP is combined with an objective weighting method. This ensures the final result incorporates not only the decision-maker's intent but also the objectivity of the data itself, forming a final composite weight. This significantly reduces the influence of subjectivity on the final outcome.

5. Conclusion

Briefly speaking, project quality risks are one of the principal problems in project planning; it has special features concealed, delayed, and infected that create great problems for the end of a project. Such risks are usually hard to find at the very beginning of a project, and they lie dormant in the process of a project's progress. They will surface slowly during later stage testing, implementation, etc., and it will cost an extremely high rectification cost, or even serious irreparable losses. On the other hand, it has an effect as well; this one is continuously increased over time, and it reaches various stages of the project and causing a chain of effects that makes it harder the control. Furthermore, if one can't meet the subjective expectations of the user, then even meeting the documented specifications will be viewed as a failure. Therefore, the quality would seem low to the user. Current mainstream project quality risk identification and assessment method, such as FMEA, WBS+RBS, and the AHP method, have a certain degree of advantage in systematicness, structure, and quantitative priority. But the former approaches have many imperfections in practical application. From a cost perspective, most involve high expense, which is time-consuming and effortful, and also requires a high allocation level of the resources on the project; On the contrary, there are some existing methods that are quite dependent on what experts speak, and the results are a little bit subjective. Secondly, existing methods mostly use a static and independent way to assess risks; they do not consider the dependency between different risks, nor do they consider their dynamic characteristics. To improve these shortcomings, the paper introduces a modified rating criterion, scenario analysis, and the introduction of group comparison with the combination of subjective and objective methods. These changes are made in order to improve the science of risk management, its flexibility, and the certainty of a decision. Next try to establishing a smarter, dynamic, and comprehensive project quality risk management system will be an important goal for improving the overall level of project quality.

References

- [1] Project Management Institute. A guide to the project management body of knowledge (PMBOK guide) – Seventh edition and the standard for project management. Project Management Institute, 2021.
- [2] Wang Z, Shen J. Research on quality risk transmission models and simulation for construction projects. *Systems Engineering - Theory & Practice*, 2018, 38 (4): 1055-1066.
- [3] Chin K S, Chan A, Yang J B. Development of a fuzzy FMEA based product design system. *The International Journal of Advanced Manufacturing Technology*, 2008, 36 (7-8): 633-649.
- [4] Li W, Liang W, Zhang L, et al. A dynamic Bayesian network-based approach for modeling and assessing hidden risks in complex projects. *Journal of Management in Engineering*, 2021, 37 (5): 402-409.
- [5] Antony J, Lizarelli F L, Fernandes M M, et al. The effect of Lean Six Sigma practices on quality performance in the healthcare sector: a systematic literature review and future research agenda. *Total Quality Management & Business Excellence*, 2023, 34 (14): 1588-1612

- [6] Wang Z, Hu H, Zhou W, et al. A novel quality risk propagation model considering rework in complex product development projects. *Computers & Industrial Engineering*, 2023, 17 (5): 108852.
- [7] Crosby P B. *Quality is free: the art of making quality certain*. McGraw-Hill, 1979.
- [8] Rose K H. *Advancing project quality management: integrating planning and control for superior performance*. Project Management Institute, 2022.
- [9] Pinto J K, Müller R. The interplay of quality culture and process compliance in project quality assurance. *International Journal of Managing Projects in Business*, 2022, 15 (3): 455-473.
- [10] Zeng S X, Lou G X, Tam V W Y. Managing quality risk in supply chain to drive firm's performance: the roles of control mechanisms. *Journal of Business Research*, 2017, 80 (2): 188-197.
- [11] Selvaraj R, Muthuswami M. The impact of risk management maturity on project success in traditional industries. *Journal of Modern Project Management*, 2020, 8 (2): 88-103.
- [12] Taha H A. *Operations research: an introduction*. 11th ed. Pearson Education, 2022.
- [13] Zhang Y. Risk response strategies in construction projects: an empirical analysis of efficacy. *Project Management Journal*, 2021, 52 (1): 75-90.