**Sławomir Wawak** [1]

# ENHANCING PROJECT QUALITY THROUGH EFFECTIVE REQUIREMENTS MANAGEMENT

*Abstract: This study investigates the relationship between requirements management and project quality management, aiming to understand their combined impact on project success and provide insights for project teams and stakeholders. An empirical, cross-sectional study was conducted using an online survey to gather data from 510 respondents across various industries, projects, and experiences. Data analysis employed statistical techniques to reveal patterns and trends. The study found that the main types of requirements identified by respondents were business, stakeholder, and functional requirements. The importance of various requirements and sources varied across industries, team sizes, and budgets. Legal compliance, usability, and safety of use emerged as significant parameters for evaluating project outcomes. At the same time, deviations from schedule and budget, waiting time, and validation errors were crucial for assessing the quality of design processes. The study highlighted the importance of identifying and managing project requirements to ensure quality and success. This research contributes to the existing literature on requirements management and project quality management by comprehensively understanding the interplay between these two critical aspects of project success. The study offers new insights into industry-specific differences and the influence of factors such as team size, budget, and project nature on requirements management and quality management practices. The findings can help project managers, teams, and stakeholders improve their processes and increase stakeholder satisfaction.*

*Keywords: Requirements management, Project quality management, Project success, Stakeholder satisfaction, Survey research*

## 1. Introduction

This study examines the relationship between project requirements and quality management to better understand their combined impact on project success. The primary focus is to explore how effective requirements management can contribute to improved project quality and how project managers can utilise quality management

---

[1] Corresponding author: Sławomir Wawak
Email: wawaks@uek.krakow.pl

practices to enhance project outcomes. By addressing the gaps in the literature regarding the interplay between these two critical aspects of project management, this research seeks to provide insights and recommendations for project teams and stakeholders.

Requirements management plays a crucial role in project management by capturing, analysing, and tracking system requirements. It helps maintain the traceability and version control of documents, establish relationships between documents, and manage changes in requirements in the early stages of the project (Locatelli et al., 2014). Similarly, quality management is crucial in ensuring project requirements are met and stakeholder expectations are satisfied (Basu, 2014). Both requirements and quality management are fundamental aspects of successful project execution, influencing cost, schedule, and risk management (Flyvbjerg, 2013; Sarigiannidis & Chatzoglou, 2014).

Given the critical role of requirements and quality management in project success, this study addresses the following research questions:

- What types of requirements are identified in the projects?
- What is the importance of formulating requirements and tracking their fulfilment?
- What parameters are crucial for the quality of the results and processes related to their achievement?

The objectives of the study are to:

- Investigate the perception of the importance of quality management by project managers.
- Identify the challenges and best practices in requirements management.
- Provide recommendations for improving project management by integrating quality management practices.

This research contributes to the existing literature by comprehensively understanding the interplay between requirements and quality management in projects. The findings and recommendations from this study could help project managers improve their planning and execution processes, leading to increased stakeholder satisfaction, the development of a culture of quality, and the long-term improvement of project management practices.

The remainder of the article is organised into several sections. First, the Literature Review provides a detailed examination of the existing literature on requirements management, project quality management, and their interrelationship. Next, the Methodology section explains this study's research design, data collection, and analysis methods. The Results section presents the research findings. Finally, the Discussion and Conclusion sections summarise the main findings, practical recommendations for project managers, and concluding remarks about the study's implications.

## 2. Literature Review

Requirements management is critical in project quality management, as it addresses stakeholder expectations and ensures the project's success. This process involves capturing, analysing, and tracking system requirements while maintaining traceability, version control, and document relationships. Agile and waterfall projects employ requirements management, essential for effective project management, particularly in complex technological innovations (Locatelli et al., 2014, Lazic et al. 2023).

The specificity of project requirements can impact overall management efficiency. Overly detailed requirements may hinder flexibility, result in sub-optimal technology and tool utilisation, create complex solutions, and increase defects. In contrast, insufficiently defined requirements may neglect critical functions, inconsistencies, and conflicts during validation (Targiel, 2018).

A comprehensive understanding of project requirements is vital for effective project management, developing clear and detailed project plans, reducing uncertainties, and identifying potential risks. Decisions made during the conception stage have long-lasting effects and cannot be undone without significant costs (Akbar & Mandurah, 2014; Ko & Kirsch, 2017). Efficient management of stakeholder requirements is critical for project success, involving identifying and analysing connections between requirements, monitoring their fulfilment, addressing conflicts, and ensuring completeness (*BABOK...*, 2015; *IREB Certified...*, 2021; Zmitrowicz & Stańczak, 2018). Project management tools like Jira can streamline this process and reduce errors.

Maintaining the traceability of requirements can be challenging, particularly for inexperienced teams (Saiedian & Kannenberg, 2010). Establishing a single register of requirements and involving a multidisciplinary team can mitigate these issues. Requirements management contributes to more accurate time and cost estimates, avoiding unnecessary expenses from reworking and changes and ensuring project success (Fu et al., 2012; Pacagnella et al., 2019). Waterfall methodologies are considered weak in requirement management, while agile methodologies emphasise functional outcomes over documentation, sometimes neglecting non-functional requirements (Özturan et al., 2021; Shmueli & Ronen, 2017).

Project management standards recognise quality as a distinct area within project management, focusing on planning, assurance, and quality control (*Managing Successful...*, 2017). Quality management ensures project requirements are met by fostering good stakeholder relationships and aligning with quality standards. However, the relationship between requirements and project quality management lacks clarity in the literature (Basu, 2014; Tam & Le, 2007). Modern enterprises acknowledge that both the results determine project quality and how they are achieved. Basu identified three aspects of project quality: product quality, quality of management processes, and quality of the organisation (leadership, skills, communication). Other authors suggest that quality understanding varies depending on the project stage, introducing concepts such as design quality and process quality (Basu, 2014; DeLone & McLean, 1992; Juran & Godfrey, 1999; Turner, 2014; Wild, 2002). Thus, project quality can be defined as the ability to deliver results that meet stakeholder requirements and expectations through the synergy of organisational, design, and process quality aspects (Wawak, 2023).

Common causes of poor quality in projects include neglecting stakeholder expectations, poor communication, unclear contracts, difficult collaboration among parties, and poor stakeholder management (Heravi et al., 2015; Nyarirangwe & Babatunde, 2021). Inadequate attention to quality can lead to unmet customer requirements, increased costs, delayed implementation, and elevated risk (Flyvbjerg, 2013; Sarigiannidis & Chatzoglou, 2014). A comprehensive understanding of quality in projects is crucial to avoid negative impacts on performance indicators (Geraldi et al., 2011; Ngacho & Das, 2014).

Requirements must be identified, analysed, and negotiated with stakeholders before implementation to prevent bugs or incompatibilities. A Definition of Ready (DoR) is used in IT and other projects to ensure requirements meet specific criteria. Acceptance criteria enable a clear assessment of whether a requirement is met. The Definition of Done (DoD) helps evaluate the implementation, considering factors such as adherence to standards, documentation, and functional tests (Bygballe et al., 2016; Martinsuo, 2019).

Requirements management faces challenges, such as difficulty managing requirements, limited face-to-face communication, user

knowledge limitations, and changing user needs (Eichhorn & Tukel, 2018; Fellows & Liu, 2016). Rapid requirement changes can lead to frequent reworking, costing time and resources (Butler et al., 2020). The complexity of organising multiple components further complicates requirements management (Ahola et al., 2017; Li et al., 2011). Challenges in requirements management include also eliciting and managing requirements, rapid requirement changes, and ongoing redefinitions. These challenges are exacerbated by complexities in organising hardware, software, infrastructure, and personnel to facilitate business processes, as well as the use of jargon and determining the extent of adherence to good project management practices (Fu et al., 2012; Li et al., 2011; Stojic et al., 2024).

Organisations can balance the need for traceability and change control by implementing agile management practices that support self-control and autonomy (Nuottila et al., 2022; Recker et al., 2017). Best practices include early stabilisation of requirements, assessing change impact, utilising change control boards, and employing requirements management tools and techniques (Dennehy & Conboy, 2018; Locatelli et al., 2014; Shmueli & Ronen, 2017). Requirements management tools can improve the process by providing rigorous version control and facilitating document transformation. Effective strategies for managing user expectations are user involvement, leadership, and trust (Petter, 2008; Shmueli & Ronen, 2017). Computer-executable models can improve requirements management processes by capturing system requirements and reducing mistakes (Coners & Matthies, 2022).

The literature lacks strong evidence on the relationship between requirements management and project quality, even though the relationship seems intuitive (Basu, 2014; Davis, 2017; Lu et al., 2019). Project quality can be achieved by meeting customer needs, reducing non-conforming

tasks, keeping customers informed, and adapting to emerging requirements. Therefore, requirements management seems crucial for ensuring project quality (Tam & Le, 2007). However, researchers in project management seem less interested in quality management issues, which can be shown by relatively fewer publications in major scientific journals (Crawford et al., 2006; Wawak & Woźniak, 2020; Young & Jordan, 2008).

The existing literature reveals a gap in understanding the connection between quality management and various dimensions of project quality, as well as the implementation of operational excellence concepts within the realm of project management. Additionally, there seems to be a knowledge gap concerning the benefits of incorporating quality considerations in project management. These considerations extend beyond the quality theme defined by PRINCE2 or the domain of quality management described by PMBOK, and they include stakeholder requirements related to project outcomes and management processes. PRINCE2 and PMBOK standards directly reference the ISO 9001:2015 definition of quality, highlighting the significance of requirements as the cornerstone for effective quality management. Examining the interconnections within project management standards demonstrates that the formulation of requirements influences all aspects of a project. These relationships include corrective, preventive, and continuous improvement measures, quality costs, supplier selection and evaluation, outcome acceptance, issue reporting, competency requirements for project team members, and collaboration with stakeholders. As a result, these areas hold mutual importance for contemporary project management and quality management practices (Wawak, 2023).

# 3. Methodology

Previous research on project quality management has been fragmented, focusing on specific standards, methodologies, methods, or techniques. There is a lack of comprehensive studies showing how project managers and team members manage quality in a multidimensional way. Conversations with experienced project managers and literature reviews reveal that quality is often not treated as a critical aspect of project management. Comprehensive research on the attitude towards quality in projects has not been available. The results presented in this article are part of a larger research programme devoted to project quality management. Due to the broad scope of research, particular topics are presented in separate articles. This research is focused on assessing the extent to which stakeholder requirements management is applied in projects and identifying related criteria used for quality assessment.

The research was conducted in October and November 2022, targeting project managers and team members. The research sample's selection criteria ensured a diverse spectrum of industries, projects, and experiences. Criteria for differentiating respondents included project size, competencies, organisational size and location, and industry.

The research focused on respondents' perceptions of quality. Due to its scope, the number of questions, and the planned number of respondents, an online survey was chosen as the research tool. The survey contained 20 questions regarding requirements management, respondent characteristics, projects, and organisations.

To minimise respondent discouragement, four forms of questions were adopted: ranking, 7-point scale questions, yes/no questions, and open-ended questions. A potential threat to survey research is the limited possibility of verifying the provided answers. Verification methods included analysing completion time, comparing answers from respondents within the same organisation, and analysing response patterns. In very few cases of suspicious responses, respondents were asked to complete the questionnaire again.

Analysis of the results was carried out using proprietary scripts written in Python. The following packages were used: scipy.stats, scipy.spatial, pingouin, scikit_posthocs, math, statistics, pandas. The Alpha coefficient proposed by L. Cronbach was used to assess the internal consistency of the survey, resulting in a value of 0.8777, which is higher than the recommended minimum of 0.8 (Nunnally & Bernstein, 1994).

Since most of the questions used an ordinal scale, the research team carefully selected statistical techniques and measures for analysis and interpretation, including median, absolute deviation of the median, Spearman's rank correlation coefficient, $Chi^2$ test, Mann-Whitney U test, Shapiro-Wilk distribution test, Kruskal-Wallis test, Dunn test, Kendall's W coefficient, and cosine similarity measure (Cabała, 2012; Dunn, 1961; Kendall & Smith, 1939; Kruskal & Wallis, 1952; Mann & Whitney, 1947; Shapiro & Wilk, 1965). Using non-parametric statistics limits the possibility of presenting precise numerical values.

# 4. Results

## 4.1. Sample

A total of 510 respondents from over 170 organisations participated in the survey. The gender distribution was slightly skewed towards male respondents (51%), with two participants choosing not to disclose their gender. Women were more frequently involved in projects with smaller budgets. In projects exceeding €500,000, women represented 35%, while in other categories, they accounted for 50-60%. This difference can be attributed to the educational background and the nature of the projects

investigated. Large-budget projects were predominantly related to engineering industries, where women comprised approximately 30% of those with engineering education. Female respondents were primarily found in organisations related to public administration, education, non-governmental organisations, culture, and financial services. Men were more prevalent in the construction and IT industries.

Nearly 70% of respondents were between 26 and 45 years old. Almost half had a total professional experience of up to 10 years, and an additional 32% had up to 20 years. Project work experience was typically shorter, with 79% of respondents having no more than ten years. Although project management has been developing for several decades, organisations have only recently begun to focus on project-based approaches. There has been a shift towards treating typical processes as projects in recent years. This trend is more prevalent among representatives of public administration, possibly due to the implementation of projects financed by the EU.

The survey targeted both project managers and team members. Some respondents held multiple roles across different projects, with 43% indicating they were managers in at least one project. Nearly 90% of respondents held a higher education degree, 9% had secondary education, and about 1% had a PhD or higher degree. The most common fields of education were technical (42%), economic and managerial (32%), humanities (7.5%), and IT (5.3%). Additionally, respondents reported backgrounds in pedagogy, sociology, administration, law, and other fields.

Over 170 organisations were represented in the survey. Among the surveyed teams, 35% had no more than five members, and 39% had up to 10 members. The industry and nature of the project primarily influenced the team size. A statistically significant relationship was found between budget and team size, but only for teams with up to 20 members ($p=0.003$). Larger teams were more common in large and very large organisations.

The budget distribution of the surveyed projects was relatively even across different ranges (less than €10,000, up to €20,000, up to €100,000, up to €500,000, beyond €500,000), with a slight dominance of projects exceeding €500,000. Most projects had a planned implementation time of 1-2 years, with a statistically significant relationship between budget size and implementation time ($p<0.001$). Among participating organisations, 28% were very large (over 1,000 employees), and 25% were small. Micro-enterprises and large organisations were less represented. The most common industries included IT, non-governmental organisations, cultural organisations, construction, energy, and public administration. Manufacturing companies constituted 40 of the surveyed organisations, with nine being from the automotive industry.

Respondents were asked about the project methodologies used in their work, allowing multiple answers due to potential experience across different projects and organisations. Over half of the respondents reported using their own methodology. Agile, Scrum, and Kanban methodologies were predominantly mentioned in the IT, automotive, and transportation industries. Waterfall methodologies were more common in consumer goods production and industrial sectors. The PCM methodology was mainly used in cultural institutions.

A lack of any project management methodology was most often reported by educational institutions (71%), consulting institutions (60%), and public administration (54%). Both the waterfall and agile methodologies were more frequently used by respondents working on longer projects with larger budgets. In large and very large organisations, methodologies were applied twice as often as in organisations with fewer than 250 employees.

**4.2. Survey outcomes**

Respondents were asked to indicate the types of project requirements identified in their projects using the model proposed in the Business Analysis Body of Knowledge (BABOK..., 2015, p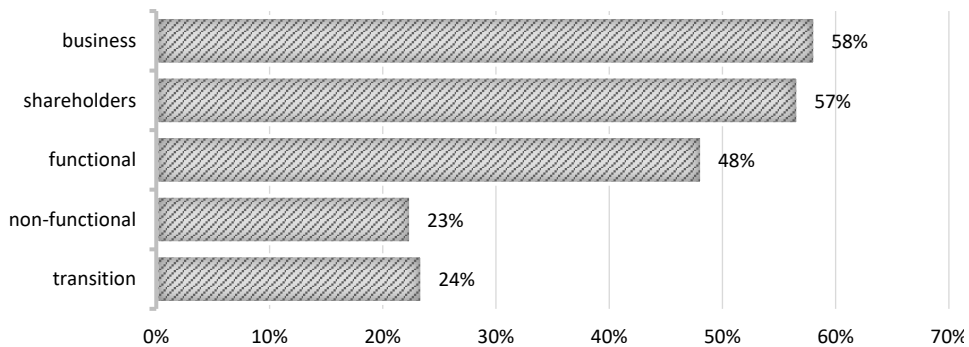. 16). As shown in Figure 1, the main requirements resulting from the goals and needs of the organisation and stakeholders are identified by more than half of the respondents. Quality and transition requirements are identified less frequently. Respondents with technical and IT education indicated identifying quality requirements almost twice as often as those with managerial or economic education.



**Figure 1.** Types of identified requirements

Most respondents identified the requirements primarily from the organisation's goals and stakeholders' interests. Slightly fewer respondents identified requirements that describe the functions and tasks of the intended outcome. Non-functional requirements and transition requirements were identified less frequently. Technical and IT-educated respondents reported identifying non-functional requirements almost twice as often as those with managerial or economic backgrounds. Transition requirements were mentioned by over a third of respondents in the construction industry. In consulting service firms, all respondents noted non-functional and transition requirements, suggesting that identifying these two types of requirements may depend on the specific nature of the projects.

More respondents reported identifying all types of requirements in teams with over 20 members and projects with budgets exceeding €100,000. There is also a relation between the number of identified types of requirements, the project duration, and the organisation's size. This is not surprising, as larger organisations, projects, and teams typically exhibit higher levels of formalisation, leading to a more detailed description of requirements.

The percentage of respondents indicating the identification of a business, stakeholder, and functional requirements increases with age among younger groups. However, among respondents aged over 45, there is a statistically significant decrease in indications by about ten percentage points ($p<0.01$). Project managers tend to focus more on identifying business and stakeholder requirements, possibly due to better access to information. A lack of requirements identification was reported by 6% of respondents.

The most common sources of requirements are project team members, organisation management, customer representatives, and intended users. Respondents less frequently utilise information from business partners, market research results, and internal and
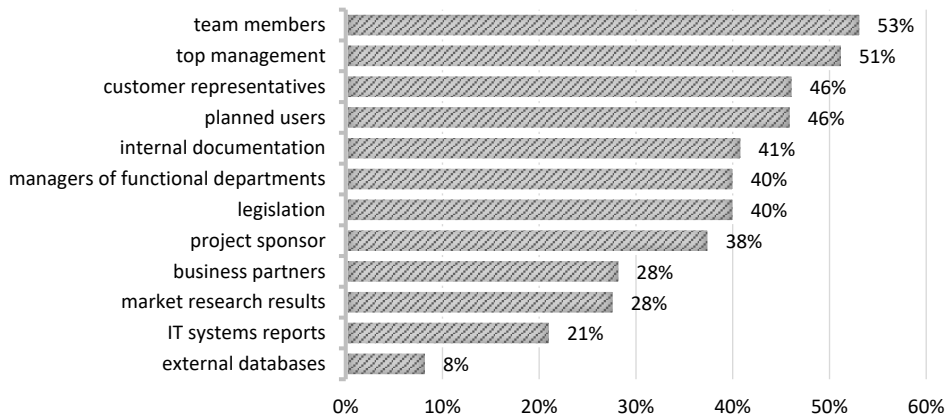
**Figure 2.** Requirements sources

**Table 1.** Factors affecting the detail of requirements

| Important impact | Moderate impact | Low impact |
|---|---|---|
| • strict guidelines from stakeholders, <br> • expectations of stakeholders as to the level of detail of requirements, <br> • extensive legal requirements or expectations regarding the application of standards | • using predetermined technologies, <br> • doubts about the definition of the problem by stakeholders | • little freedom left to solution designers, <br> • difficult or periodic communication with stakeholders, <br> • low competence of the project team |

external databases (Figure 2). The number of indicated types of sources and their indication frequency increases with team size. In teams with over 30 members, information from client representatives, team members, and sponsors was indicated much more often. Conversely, information from customer representatives and internal IT systems is used more frequently as the budget increases.

Some industry-specific differences can also be noted. Representatives of consulting, design, and transport companies producing consumer goods and providing financial services indicated more types of sources. Meanwhile, public administration, non-governmental organisations, and cultural and educational institutions reported using fewer sources.

Depending on the industry, specific sources are more prevalent. For instance, customers, legal regulations, and market research are frequently cited in design offices. In consulting, financial services, and the IT industry, users, management, and the team are given greater importance, while in public administration, legal requirements and intended users are prioritised. Intended users and business partners are significantly less important in the automotive industry.

The level of detail of the requirements formulated in the project is related to strict guidelines from the stakeholders and then to the expectations of stakeholders and legal requirements (Table 1). Answering this question proved challenging for some respondents, as the analysis of the previous question revealed that a large portion of them only identified requirements to a

limited extent. The responses to this question were less decisive, with more indications from the midpoint of the 7-point scale. Additionally, the distribution of responses utilised the full scale. In the case of the lowest-rated factor, the low competence of the project team, the answers were distributed evenly across the scale. This suggests that detailed requirements have not been thoroughly considered and may not

even be perceived as significant.

Tracking requirements is particularly crucial in projects with significant interdependencies, such as in software development. Nonetheless, in other types of projects, the relationship between requirements can influence the implementation approach. Participants were requested to evaluate the significance of requirements-tracking tasks (Table 2).

**Table 2.** Importance of requirements tracking tasks

| Very Important | Moderately important | Rather important |
|---|---|---|
| • monitoring the fulfilment of requirements,<br>• identification of conflicting requirements or the values of their parameters at which a conflict occurs,<br>• detection of relationships that force a specific order of requirements implementation | • identification of connections and analysis of the impact of meeting a given requirement on other elements of the project and the environment,<br>• ensuring constant synchronisation of requirements,<br>• identification of the possibility of reducing work by reusing once-developed elements,<br>• providing a correctness control mechanism to prove compliance with the requirements,<br>• analysis of the completeness of requirements coverage by other elements of the project,<br>• testing support by facilitating the detection of the causes of problems | • verification of the completeness of requirements coverage by lower-level requirements,<br>• verification of substantive inseparability of requirements of the same level,<br>• elimination of requirements not resulting from higher-level requirements |

There was a minor variation in the responses, with all tasks considered important but differing in the level of importance. Only the three lowest-rated tasks, mainly specific to IT projects, had noticeably lower scores. These tasks might not have been perceived as important by respondents from other industries. However, no statistically significant differences were found between industries.

The Definition of Ready (DoR) and Definition of Done (DoD) are typically associated with IT projects. This study aimed to explore whether similar techniques, perhaps under different names, are employed in other types of projects as well. Regarding DoR, nearly half of the respondents reported not using this technique (Figure 3). Among

those who use it, a significant portion considers the clarity of acceptance criteria and the establishment of quality parameters. Business value and labour intensity assessment are also important factors. Respondents were allowed to choose multiple answer options.

The analysis across various industries revealed that the highest percentage of declarations of not using DoR is observed in non-governmental organisations, education, and trade (approximately 80%), along with public administration and cultural institutions (approximately 65%). In other industries, this technique was utilised more frequently.

Respondents were also allowed to suggest additional criteria for assessing

implementation readiness. The following recommendations were proposed: understanding of the requirements by the team, absence of critical errors, no active blocking factors, consultations with management, clients, or experts, assigning tasks to contractors, and formal acceptance of the task definition by the client.
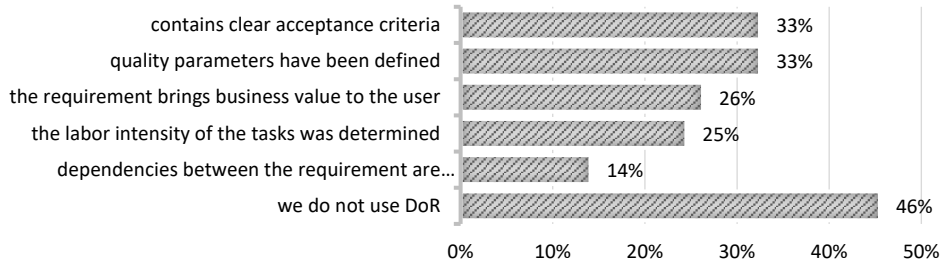


**Figure 3.** DoR assessment criteria

The DoD is more prevalent, with 27% of respondents not using it (Figure 4). However, in smaller teams, this percentage increases to 37%. Public administration units, non-governmental organisations, educational organisations, and cultural institutions reported a higher frequency of non-usage. Conversely, the most extensive range of criteria was declared by companies in the automotive industry and those producing consumer and industrial goods. Respondents were allowed to select multiple answer options.
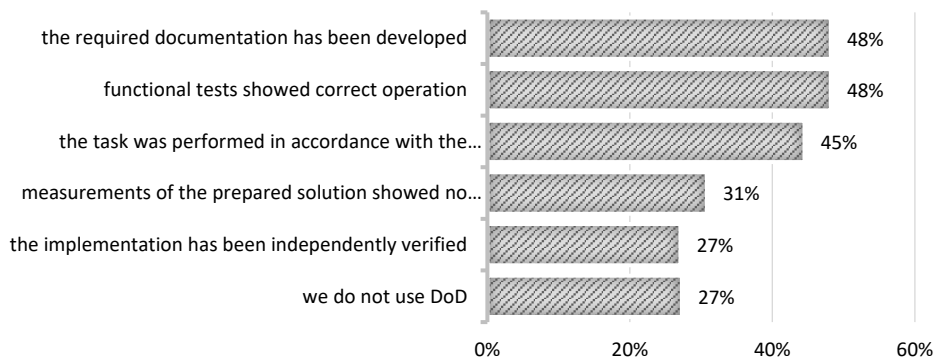


**Figure 4.** DoD assessment criteria

The utilisation of the DoD was more frequently reported by respondents working in teams of over 20 individuals and from large enterprises. Among participants with an IT education background, 73% employed functional tests, and 59% assessed compliance with standards. Conversely, individuals with technical education backgrounds more commonly indicated the development of documentation and functional tests. The less frequent mention of the absence of errors and independent verification may be attributed to the stronger association of these criteria with the specific nature of projects. Not every project requires extensive measurement or independent verification.

Respondents also identified parameters for evaluating the quality of project outcomes and processes. The parameters for assessing

160

the quality of results are more closely related to the characteristics of the implemented projects. The most significant parameters reported by respondents included legal compliance, usability, and use safety (Table 3). The known total cost of ownership, ease of maintenance, and social acceptance ranked lower but still above the scale's midpoint. This is an example of project teams giving less consideration to the long-term impacts of their activities. Social acceptance was rated higher by public administration units, non-governmental and educational organisations, and cultural institutions. Conversely, it received the lowest scores in transport and enterprises manufacturing industrial goods. This can be explained by the prevalence of B2B relationships in these two types of organisations.

**Table 3.** Parameters for evaluating the quality of project results

| Very important | Important | Rather important |
|---|---|---|
| • compliance with the law,<br>• functionality (usability),<br>• safety of use | • reliability,<br>• compatibility with standards,<br>• efficiency,<br>• durability,<br>• information security,<br>• ease of use | • ease of execution and delivery,<br>• flexibility,<br>• aesthetics,<br>• the known total cost of ownership (TCO),<br>• ease of maintenance,<br>• social acceptance |

The perception of the significance of result flexibility, defined as the capacity to adapt to various applications, declines as the project budget grows. This is consistent with expectations since flexibility is more crucial in experimental projects with undefined objectives, which are less prevalent in large projects. Interestingly, the importance of result aesthetics also decreases as the budget increases. This parameter was ranked higher by respondents with humanities education than those with economics backgrounds (p<0.01). Respondents with architectural, natural, and medical education also rated the importance of aesthetics higher; however, statistical significance was not confirmed due to the limited number of respondents. Regarding industries, aesthetics was rated higher by cultural institutions, consumer goods producers, non-governmental organisations, and construction companies.

Usability was rated marginally lower by representatives of public administration units. However, it was more important for respondents with extensive project experience. Interestingly, no association was found with age or overall experience. Thus, prioritising usability appears to be an attitude acquired during project implementation.

Information security was more highly valued by respondents from the trade, IT, automotive, and financial services industries. In contrast, result durability was less important for transport, IT, and consulting service representatives.

The criteria for evaluating the quality of results' design processes were deemed important or rather important. However, fewer respondents gave the highest rating than the previous question. The most significant factors were waiting time, deviations from the schedule and budget, and validation errors. Quality costs and the number of non-compliances were mentioned slightly less frequently (Table 4).

**Table 4.** Parameters for assessing the quality of results' design processes

| Important | Rather important |
|---|---|
| • waiting time to complete tasks, <br> • deviation from the planned time of task implementation, <br> • deviation from the planned cost of task implementation, <br> • number of errors detected during the validation of results, <br> • quality costs, <br> • number of non-conformances | • costs of waiting for suppliers, equipment, etc., <br> • degree of standardisation of tasks, <br> • the complexity of relationships between processes or tasks, <br> • the number of process instances that can be executed simultaneously in the project, <br> • percentage of repeated tasks, <br> • excess inventory costs, <br> • the percentage of tasks that allow more than one method of implementation |

Statistical analysis revealed minimal industry-specific differences. Concerning the energy and automotive industries, the number of non-conformities and errors during validation is deemed more crucial ($p<0.005$). On the other hand, representatives of consumer goods manufacturers considered deviations from planned costs to be more important ($p<0.01$), while construction and food production industries prioritised quality costs. Respondents from public administration units and transportation companies generally assessed the importance of all parameters lower by one level on average, suggesting a reduced emphasis on the process approach in these organisations.

## 5. Discussion

The study demonstrated that individuals with technical and IT education reported identifying quality requirements almost twice as often as those with managerial or economic backgrounds. Transition requirements were mentioned by over a third of respondents in the construction industry, while all respondents in consulting service firms noted quality and transition requirements. This suggests that identifying these requirement types may be influenced by the specific nature of projects and the educational backgrounds of project participants.

The results indicate that many respondents reported identifying all types of requirements in teams with over 20 members and projects with budgets exceeding €100,000. This implies that larger organisations, projects, and teams typically exhibit higher levels of formalisation, leading to a more comprehensive description of requirements.

The study found that the ability to identify business, stakeholder, and functional requirements improved with age among younger respondents. However, a statistically significant decrease in identifying these requirements was observed among participants over 45. This phenomenon could be attributed to several factors. Firstly, older respondents may have developed their project management skills in an era where the emphasis on requirements management was not as pronounced as today, leading to a reduced focus on these aspects. Secondly, experienced project managers might have developed an intuitive approach to requirements identification, relying less on formalised methodologies and more on their practical knowledge and understanding of project needs. This could result in an underreporting of identified requirements among older respondents. Overall, the data suggest that age and experience play a critical role in shaping the approach to requirement identification, with younger project managers possibly benefiting from a more structured and formalised education in project requirements

management.

Industry-specific factors influence the choice of requirement sources, which could, in turn, impact project quality. For instance, design offices often use customers, legal regulations, and market research as sources, while public administration prioritises legal requirements and intended users.

The study revealed a correlation between team size and the diversity of requirement sources. As the team size increases, the number of requirement sources and their indication frequency also grow. In larger teams with over 30 members, information from client representatives, team members, and sponsors is much more frequently cited. This can be attributed to the increased specialisation and the need for collaboration among various stakeholders in larger projects. On the other hand, smaller teams may rely on a more limited set of requirement sources, which could affect project quality due to the lack of diverse perspectives. However, it is important to note that an excessive number of information sources can lead to information overload and noise, which can have a negative impact on the project. Striking the right balance between diverse requirement sources and maintaining clear communication channels is essential for ensuring project quality and success.

In any project, stakeholder expectations and legal requirements play a crucial role in determining the scope and direction of project requirements. Adhering to strict guidelines set forth by stakeholders and complying with legal mandates ensures that projects are both viable and sustainable. Project teams must strike a delicate balance between satisfying stakeholder expectations and adhering to project objectives and constraints, which can sometimes be challenging. However, effective management of these expectations and compliance with legal requirements can significantly contribute to overall project quality. By fostering strong communication and collaboration with stakeholders, project teams can ensure their expectations are met while focusing on the project's primary objectives. This approach ultimately leads to projects that meet quality standards and satisfy the needs and expectations of all involved parties, resulting in successful and high-quality outcomes.

The study found that the highest percentage of non-users of DoR is observed in non-governmental organisations, education, trade, public administration, and cultural institutions. In contrast, other industries utilised this technique more frequently, which may indicate varying levels of emphasis on implementation readiness and its potential impact on project quality.

The study identified several factors influencing the adoption of the Definition of Done (DoD) in project teams. Larger teams and enterprises demonstrated a higher utilisation of DoD, suggesting that this concept is more prevalent in organisations with more team members and resources. The adoption of DoD also varied according to respondents' educational backgrounds, with those holding IT and technical degrees more likely to implement DoD in their projects. This can be attributed to IT and technical graduates working in agile projects, where the concept of DoD is widely recognised as a critical aspect of project management.

The importance of result flexibility declined as project budgets increased, which is consistent with expectations since flexibility is more crucial in experimental projects with undefined objectives, which are less prevalent in large projects. Interestingly, the importance of result aesthetics also decreased as budgets grew, suggesting that aesthetics may be a less significant factor in larger projects.

The study revealed that individuals with humanities education placed higher importance on aesthetics than those with economics backgrounds. This suggests that education may influence the perception of quality parameters in project outcomes.

Individuals with extensive project experience tended to prioritise usability more than those with less experience. This finding indicates that the importance of usability as a key factor in project quality becomes more evident as project team members gain hands-on experience in managing and delivering projects. Interestingly, the prioritisation of usability did not significantly correlate with age or overall professional experience, indicating that it is related explicitly to experiences gained during project implementation. This phenomenon highlights the crucial role of practical exposure to project work in shaping the attitudes and priorities of project team members, emphasising the need for organisations to invest in providing their employees with opportunities to gain valuable experience in managing projects and understanding the significance of usability in ensuring project success.

Statistical analysis revealed minimal industry-specific differences in the importance of design process quality criteria. However, representatives of consumer goods manufacturers considered deviations from planned costs more important, while construction and food production industries prioritised quality costs. This indicates that different industries may place varying importance on specific design process quality parameters.

The influence of organisational culture on the process approach to quality management requires further investigation, as the results of the current study do not provide sufficient explanation. Our research found a lower emphasis on the process approach in public administration units and transportation companies. The role of organisational culture in shaping the approach to quality management remains to be elucidated. Future studies should focus on identifying strategies for promoting a process-oriented culture in various industries, enabling organisations to understand better and manage the relationship between organisational culture and the

implementation of effective quality management processes. This will ultimately contribute to improving project outcomes and stakeholder satisfaction across different sectors.

Based on the study findings, it is evident that effective requirements management plays a critical role in project quality. Project managers and stakeholders should invest in proper requirement identification and tracking to ensure successful project outcomes and meet stakeholder expectations.

Effective requirement identification and tracking are essential for project success and quality management. Best practices include implementing a systematic approach to requirement identification and ensuring that all relevant aspects are considered and documented. This involves utilising a diverse set of requirement sources tailored to the specific industry and project context, such as project team members, organisation management, customer representatives, and intended users. However, project teams may face challenges related to requirement changes, communication, and stakeholder involvement. To overcome these challenges, it is vital to establish processes and practices that promote clear and transparent communication among stakeholders and manage requirement changes effectively. Moreover, leveraging technology and tools can significantly improve requirement tracking and management, enabling project teams to monitor progress and make data-driven decisions that ultimately contribute to project quality and success.

To improve project quality, project managers should focus on identifying a comprehensive set of requirements, including business, stakeholder, functional, quality, and transition requirements. They should also consider employing techniques such as the Definition of Ready (DoR) and Definition of Done (DoD) to assess implementation readiness and task completion. Understanding and utilising appropriate requirement sources based on industry and

project specifics can enhance project quality management.

# 6. Conclusions

The study explored the relationship between requirements management and project quality management, aiming to understand their combined impact on project success. Findings revealed that the main types of requirements identified by respondents were business, stakeholder, and functional requirements, with quality and transition requirements identified less frequently. The importance of various requirements and sources varied across industries, team sizes, and budgets. Factors such as legal compliance, usability, and safety of use emerged as significant parameters for evaluating project outcomes. At the same time, deviations from schedule and budget, waiting time, and validation errors were crucial for assessing the quality of design processes. The study highlighted the importance of identifying and managing project requirements to ensure project quality and success.

The findings of this study have several practical implications for project managers, project teams, and stakeholders. To improve requirements management practices, project teams should use a systematic approach, diverse sources, and technology to capture and track requirements effectively. Clear communication channels and stakeholder engagement are essential for accurately identifying and understanding requirements. Regarding quality management processes, project teams should focus on meeting stakeholder expectations and legal requirements and ensuring usability and safety of use. Additionally, implementing readiness techniques, such as the Definition of Ready (DoR) and Definition of Done (DoD), should be encouraged to ensure project success.

This study contributes to the existing literature on requirements management and project quality management by providing a comprehensive understanding of the interplay between these two critical aspects of project success. The research fills gaps in the literature by examining the types of requirements, their importance, and the crucial parameters for project quality. Furthermore, the study offers new insights into industry-specific differences and the influence of factors such as team size, budget, and project nature on requirements management and quality management practices.

While having a large sample size, this study may contain possible biases in the sample population and may not fully represent all industries and project teams. The study's cross-sectional nature also limits its ability to capture the dynamics of requirements management over time. Future research could benefit from incorporating interviews or deepened case studies to provide more insightful conclusions.

Future research in requirements management and project quality could explore the evolution of requirements management practices over time, examine the role of organisational culture and leadership, investigate the impact of technology and tools on the effectiveness of requirements management, and conduct comparative studies across different industries and project types.

Effective requirements management plays a critical role in ensuring project quality and success. Project teams must adopt a systematic approach to capturing and tracking requirements, engage with diverse sources, and employ technology to support their efforts. Ultimately, understanding and managing project requirements effectively will improve project quality, increase stakeholder satisfaction, and develop a quality culture within organisations.

## Referen.ces:

Ahola, T., Vuori, M., & Viitamo, E. (2017). Sharing the burden of integration: An activity-based view to integrated solutions provisioning. *International Journal of Project Management*, *35*(6), 1006–1021. https://doi.org/10.1016/j.ijproman.2017.05.002

Akbar, H., & Mandurah, S. (2014). Project-conceptualisation in technological innovations: A knowledge-based perspective. *International Journal of Project Management*, *32*(5), 759–772. https://doi.org/10.1016/j.ijproman.2013.10.002

*BABOK: A guide to the business analysis body of knowledge*. (2015). International Institute of Business Analysis.

Basu, R. (2014). Managing quality in projects: An empirical study. *International Journal of Project Management*, *32*(1), 178–187. https://doi.org/10.1016/j.ijproman.2013.02.003

Butler, C. W., Vijayasarathy, L. R., & Roberts, N. (2020). Managing Software Development Projects for Success: Aligning Plan- and Agility-Based Approaches to Project Complexity and Project Dynamism. *Project Management Journal*, *51*(3), 262–277. https://doi.org/10.1177/8756972819848251

Bygballe, L. E., Swärd, A. R., & Vaagaasar, A. L. (2016). Coordinating in construction projects and the emergence of synchronised readiness. *International Journal of Project Management*, *34*(8), 1479–1492. https://doi.org/10.1016/j.ijproman.2016.08.006

Cabała, P. (2012). *Planowanie scenariuszowe w zarządzaniu bezpieczeństwem strategicznym przedsiębiorstwa*. Wydawnictwo Uniwersytetu Ekonomicznego w Krakowie.

Coners, A., & Matthies, B. (2022). Perspectives on reusing codified project knowledge: A structured literature review. *International Journal of Information Systems and Project Management*, *6*(2), 25–43. https://doi.org/10.12821/ijispm060202

Crawford, L., Pollack, J., & England, D. (2006). Uncovering the trends in project management: Journal emphases over the last 10 years. *International Journal of Project Management*, *24*(2), 175–184. https://doi.org/10/fdhcvh

Davis, K. (2017). An empirical investigation into different stakeholder groups perception of project success. *International Journal of Project Management*, *35*(4), 604–617. https://doi.org/10.1016/j.ijproman.2017.02.004

DeLone, W. H., & McLean, E. R. (1992). Information Systems Success: The Quest for the Dependent Variable. *Information Systems Research*, *3*(1), 60–95. https://doi.org/10/b3fp23

Dennehy, D., & Conboy, K. (2018). Identifying Challenges and a Research Agenda for Flow in Software Project Management. *Project Management Journal*, *49*(6), 103–118. https://doi.org/10.1177/8756972818800559

Dunn, O. J. (1961). Multiple comparisons among means. *Journal of the American Statistical Association*, *56*(293), 52–64. https://doi.org/10.1080/01621459.1961.10482090

Eichhorn, B., & Tukel, O. (2018). Business user impact on information system projects. *International Journal of Managing Projects in Business*, *11*(2), 289–316. https://doi.org/10.1108/IJMPB-02-2017-0016

Fellows, R., & Liu, A. (2016). Sensemaking in the cross-cultural contexts of projects. *International Journal of Project Management*, *34*(2), 246–257. https://doi.org/10.1016/j.ijproman.2015.03.010

Flyvbjerg, B. (2013). Quality control and due diligence in project management: Getting decisions right by taking the outside view. *International Journal of Project Management*, *31*(5), 760–774. https://doi.org/10/f43ppc

Fu, Y., Li, M., & Chen, F. (2012). Impact propagation and risk assessment of requirement changes for software development projects based on design structure matrix. *International Journal of Project Management*, *30*(3), 363–373. https://doi.org/10.1016/j.ijproman.2011.08.004

Geraldi, J. G., Kutsch, E., & Turner, N. (2011). Towards a conceptualisation of quality in information technology projects. *International Journal of Project Management*, *29*(5), 557–567. https://doi.org/10/cn9ffr

Heravi, A., Coffey, V., & Trigunarsyah, B. (2015). Evaluating the level of stakeholder involvement during the project planning processes of building projects. *International Journal of Project Management*, *33*(5), 985–997. https://doi.org/10.1016/j.ijproman.2014.12.007

*IREB Certified Professional for Requirements Engineering*. (2021). International Requirements Engineering Board.

Juran, J. M., & Godfrey, A. B. (Eds.). (1999). *Juran's quality handbook* (5th ed). McGraw Hill.

Kendall, M. G., & Smith, B. B. (1939). The problem of m rankings. *The Annals of Mathematical Statistics*, *10*(3), 275–287. https://doi.org/10.1214/aoms/1177732186

Ko, D.-G., & Kirsch, L. J. (2017). The hybrid IT project manager: One foot each in the IT and business domains. *International Journal of Project Management*, *35*(3), 307–319. https://doi.org/10.1016/j.ijproman.2017.01.013

Kruskal, W. H., & Wallis, W. A. (1952). Use of ranks in one-criterion variance analysis. *Journal of the American Statistical Association*, *47*(260), 583–621. https://doi.org/10.1080/01621459.1952.10483441

Lazic Z., Grujic M., Skoric V. & Milicevic S. (2023). Impact of global crisis on supply chain management quality: case studies. Journal of Engineering, Management and Information Technology, 1(3), 111-118. https://doi.org/10.61552/JEMIT.2023.03.002

Li, Y., Yang, M.-H., Klein, G., & Chen, H.-G. (2011). The role of team problem solving competency in information system development projects. *International Journal of Project Management*, *29*(7), 911–922. https://doi.org/10.1016/j.ijproman.2010.09.004

Locatelli, G., Mancini, M., & Romano, E. (2014). Systems Engineering to improve the governance in complex project environments. *International Journal of Project Management*, *32*(8), 1395–1410. https://doi.org/10.1016/j.ijproman.2013.10.007

Lu, P., Cai, X., Wei, Z., Song, Y., & Wu, J. (2019). Quality management practices and inter-organisational project performance: Moderating effect of governance mechanisms. *International Journal of Project Management*, *37*(6), 855–869. https://doi.org/10.1016/j.ijproman.2019.05.005

*Managing successful projects with PRINCE2®* (Sixth edition, 2017 edition). (2017). TSO.

Mann, H. B., & Whitney, D. R. (1947). On a test of whether one of two random variables is stochastically larger than the other. *The Annals of Mathematical Statistics*, 50–60. https://doi.org/10.1214/aoms/1177730491

Martinsuo, M. (2019). Strategic Value at the Front End of a Radical Innovation Program. *Project Management Journal*, *50*(4), 431–446. https://doi.org/10.1177/8756972819853438

Ngacho, C., & Das, D. (2014). A performance evaluation framework of development projects: An empirical study of Constituency Development Fund (CDF) construction projects in Kenya. *International Journal of Project Management*, *32*(3), 492–507. https://doi.org/10.1016/j.ijproman.2013.07.005

Nunnally, J. C., & Bernstein, I. H. (1994). *Psychometric theory* (3rd ed). McGraw-Hill.

Nuottila, J., Aaltonen, K., & Kujala, J. (2022). Challenges of adopting agile methods in a public organisation. *International Journal of Information Systems and Project Management*, *4*(3), 65–85. https://doi.org/10.12821/ijispm040304

Nyarirangwe, M., & Babatunde, O. K. (2021). Megaproject complexity attributes and competences: Lessons from IT and construction projects. *International Journal of Information Systems and Project Management*, *7*(4), 77–99. https://doi.org/10.12821/ijispm070404

Özturan, M., Gürsoy, F., & Çeken, B. (2021). An empirical analysis on the effects of investment assessment methods on IS/IT project success. *International Journal of Information Systems and Project Management*, *7*(4), 33–52. https://doi.org/10.12821/ijispm070402

Pacagnella, A. C., da Silva, S. L., Pacífico, O., de Arruda Ignacio, P. S., & da Silva, A. L. (2019). Critical Success Factors for Project Manufacturing Environments. *Project Management Journal*, *50*(2), 243–258. https://doi.org/10.1177/8756972819827670

Petter, S. (2008). Managing user expectations on software projects: Lessons from the trenches. *International Journal of Project Management*, *26*(7), 700–712. https://doi.org/10.1016/j.ijproman.2008.05.014

Recker, J., Holten, R., Hummel, M., & Rosenkranz, C. (2017). How Agile Practices Impact Customer Responsiveness and Development Success: A Field Study. *Project Management Journal*, *48*(2), 99–121. https://doi.org/10.1177/875697281704800208

Saiedian, H., & Kannenberg, A. (2010). Why Software Requirements Traceability Remains a Challenge. *Journal of the Quality Assurance Institute*, *24*(2), 4–7.

Sarigiannidis, L., & Chatzoglou, P. D. (2014). Quality vs risk: An investigation of their relationship in software development projects. *International Journal of Project Management*, *32*(6), 1073–1082. https://doi.org/10/f573zt

Stojic, N., Delic, M., Bojanic, T., Jokanovic, B., & Tasic, N. (2024). Integrated model of risk management in business processes in industrial systems. *International Journal of Simulation Modelling*, *23*(3), 412–423. https://doi.org/10.2507/IJSIMM23-3-689

Shapiro, S. S., & Wilk, M. B. (1965). An analysis of variance test for normality (complete samples). *Biometrika*, *52*(3/4), 591–611.

Shmueli, O., & Ronen, B. (2017). Excessive software development: Practices and penalties. *International Journal of Project Management*, *35*(1), 13–27. https://doi.org/10.1016/j.ijproman.2016.10.002

Tam, V. W. Y., & Le, K. N. (2007). Quality improvement in construction by using a Vandermonde interpolation technique. *International Journal of Project Management*, *25*(8), 815–823. https://doi.org/10.1016/j.ijproman.2007.03.009

Targiel, K. S. (2018). Ewolucja Wymagań W Projektach Technicznych. *Scientific Papers of Silesian University of Technology. Organization & Management / Zeszyty Naukowe Politechniki Slaskiej. Seria Organizacji i Zarzadzanie*, *118*, 617–624. https://doi.org/10.29119/1641-3466.2018.118.47

Turner, J. R. (2014). *Gower handbook of project management* (Fifth edition). Gower.

Wawak, S. (2023). *Zarządzanie jakością w projekcie*. PWE.

Wawak, S., & Woźniak, K. (2020). Evolution of project management studies in the XXI century. *International Journal of Managing Projects in Business*, *13*(4), 867–888.

Wild, R. (2002). *Operations management*. Cengage Learning EMEA.

Young, R., & Jordan, E. (2008). Top management support: Mantra or necessity? *International Journal of Project Management*, *26*(7), 713–725. https://doi.org/10.1016/j.ijproman.2008.06.001

Zmitrowicz, K., & Stańczak, R. (2018). *Jakość w agile*. Wydawnictwo Naukowe PWN.

**Sławomir Wawak**
Krakow University of
Economics,
Krakow, Poland
wawaks@uek.krakow.pl
ORCID 0000-0001-6206-4489