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The IJISPM publishes leading scholarly and practical research articles that aim to advance the information systems management and project management fields of knowledge, featuring state-of-the-art research, theories, approaches, methodologies, techniques, and applications.

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The journal content provides relevant information to researchers, practitioners, and organizations, and includes original qualitative or qualitative articles, as well as purely conceptual or theoretical articles. Due to the integrative and interdisciplinary nature of information systems and project management, the journal may publish articles from a number of other disciplines, including strategic management, psychology, organizational behavior, sociology, economics, among others. Articles are selected for publication based on their relevance, rigor, clarity, novelty, and contribution to further development and research.

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International Journal of Information Systems and Project Management (IJISPM)
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EDITORIAL

It is our great pleasure to bring you the fourth issue of the 14th volume of IJISPM. In this issue, readers will find important contributions on project management competencies, metrics in agile software development projects, digital platform concepts, and project managers' leadership.

Bridging competency gaps in project management through importance-performance analysis

Danijela Ciric Lalic, Mirjana Jokanovic Djajic, Miroslav Vujičić, Sanja Kovačić, Uglješa Marjanović

This research aimed to identify and address critical competency gaps in project management using Importance–Performance Analysis (IPA). The study explored key competencies essential to project success and assessed their current performance levels to provide actionable insights for improvement. A survey of 257 project management professionals evaluated the perceived importance and actual performance of various competencies. The IPA methodology was applied to analyze discrepancies and categorize competencies into IPA matrix quadrants. Descriptive statistics, reliability analysis, gap analysis, and a paired-sample t-test ensured robustness. Significant gaps emerged in areas such as informal communication, visual competencies, competence control, and methodological integration, indicating a need for targeted development programs. The IPA matrix offered a strategic framework for prioritizing resource allocation, identifying urgent improvement areas, and strengths. This study introduces a novel approach to optimizing resource allocation and improving project outcomes by integrating IPA into competency evaluation. The findings support practitioners and organizations in enhancing project management effectiveness through focused training and investment.

Adaptive metrics in agile software development projects

João Barata, Sharon Coyle

Multiple metrics are available for agile software development (ASD), but adapting them to its evolving conditions is a challenge. To be truly agile, the metrics must be goal-oriented, flexible, and aligned with the principles of people interaction. This paper presents the results of a multi-year action research project conducted in different companies adopting ASD. Our contribution describes the organizational routines and a framework (3View) to incorporate meaningful metrics supported in three main pillars: comparability with past projects, relevance to measuring project expectations, and adaptability to remain valid in dynamic project conditions. The proposed framework includes (1) a reference model to build metrics and (2) a process model to guide practitioners. Measures of all types of attributes in ASD can be evaluated differently, depending on the project stakeholders and lifecycle stage. Dynamic environments require adaptive metrics that guide interpretation and project development. Failure to adopt these recommendations may lead to ceremonial conformity to measurements that do not reflect practice. Our work extends the literature on ASD metrics, expanding their role as enablers of agile project assessment and transparent communication throughout the project lifecycle. It explains how ASD metrics can be tailored to align with stakeholders' perceptions while maintaining rigor and transparency in their reasoning.

Towards conceptual clarity in digital platform research: a systematic literature review

Ilyass Zeamari, Wim Laurier

The emergence of digital platforms has attracted considerable attention in economics and information systems, shaping scholarly discourse over the past few years. Digital platforms have been the subject of extensive research by scholars, who have examined them from various perspectives, including technical, economic, and socio-technical perspectives. However, despite the frequent use of the term' digital platform' in the literature, its definition covers a wide range of meanings. Scholars often use the term to mean distinct concepts, which creates semantic confusion within the scientific community. To clarify the different elements and perspectives that shape the definition of a digital platform, a systematic literature review was conducted. A total of 74 definitions from 58 scholarly resources were collected and analyzed through qualitative content analysis. This analytical process aimed to isolate and identify the fundamental elements used in defining digital platforms, as well as the multiple theoretical perspectives through which the term is

conceptualized. Furthermore, this study traces the evolution of the term's definition alongside the rapid development of digital platforms in recent years.

One man's meat is another man's poison: Assessing the role of variations in project managers' leadership and structures on the relationship between neoliberal governmentality and project performance

Muhammad Yousaf Malik, Linzhuo Wang, Fangwei Zhu, Muhammad Salman Latif

Variations in human aspects of governance and management, and in the structure of project-based organizations (PBOs), may synergize or contrast with one another, eventually impacting project performance (PP). To investigate these variations, the study develops a conceptual model using neoliberal governmentality (NG), transformational (TFL), and transactional leadership styles (TSL) of project managers, centralization of governance structures (CEN) with PP. The data for the study were collected from PBOs in the construction sector. Partial Least Squares-Structural Equation Modeling (PLS-SEM) was applied to assess the results. Later, the conceptual model was validated using an Artificial Neural Network (ANN) Approach. The results revealed that TFL positively mediates the relationship between NG and PP in PBOs characterized by decentralized governance structures (Low CEN). TSL shows partial mediation with NG and, hence, appears to be the least important predictor of PP in the studied context. Using contingency theory, the study extends the Sociological Perspective of Governance (SPG) to develop a cohesive model for understanding the variations of humans and structures for PP. Project owners, governors, and practitioners should hire synergetic project managers and provide them with training and communication opportunities during the project. NG requires decentralized decision-making to empower TFLs for better PP.

We would like to take this opportunity to express our gratitude to the distinguished members of the Editorial Board for their commitment and for sharing their knowledge and experience in supporting the IJISPM.

Finally, we would like to express our gratitude to all the authors who submitted their work for their insightful visions and valuable contributions.

We hope that you, the readers, find the International Journal of Information Systems and Project Management an interesting and valuable source of information for your continued work.

The Editor-in-Chief,

João Varajão

University of Minho

Portugal

João Varajão is a professor of information systems (IS) and project management (PM) at the University of Minho. He is also a researcher at the ALGORITMI/LASI research center. His main research interests are IS PM, IS Development, and IS Management (addressing PM success and the success of projects). Before joining academia, he worked as an Information Technology (IT)/IS consultant, project manager, IS analyst, and software developer, for private companies and public institutions. He has supervised over 140 MSc and PhD theses. He has published more than 300 works, including refereed journal articles, authored and edited books, book chapters, and conference presentations. He serves as editor-in-chief, associate editor, and editorial board member for international journals. He has served on numerous committees for international conferences. ORCID: 0000-0002-4303-3908

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RESEARCH ARTICLE

Bridging competency gaps in project management through importance-performance analysis

Danijela Ciric Lalic
Faculty of Technical Sciences, University of Novi Sad, Trg Dositeja Obradovica 6, 21000, Novi Sad, Serbia,
danijela.ciric@uns.ac.rs

Mirjana Jokanovic Djajic
Production and Management Faculty, University of East Sarajevo, Stepe Stepanovica b.b., 89 101, Trebinje, Bosnia and Herzegovina,
mirjana.jokanovic@fpm.ues.rs.ba

Miroslav Vujičić
Faculty of Sciences, University of Novi Sad, Trg Dositeja Obradovica 3, 21000, Novi Sad, Serbia,
miroslav.vujicic@dgt.uns.ac.rs

Sanja Kovačć
Faculty of Sciences, University of Novi Sad, Trg Dositeja Obradovica 3, 21000, Novi Sad, Serbia,
sanja.bozic@dgt.uns.ac.rs

Uglješa Marjanović
Faculty of Technical Sciences, University of Novi Sad, Trg Dositeja Obradovica 6, 21000, Novi Sad, Serbia,
umarjano@uns.ac.rs

Abstract
This research aimed to identify and address critical competency gaps in project management using Importance–Performance Analysis (IPA). The study explored key competencies essential for project success and assessed their current performance levels to provide actionable improvement insights. A survey of 257 project management professionals evaluated the perceived importance and actual performance of various competencies. The IPA methodology was applied to analyze discrepancies and categorize competencies into IPA matrix quadrants. Descriptive statistics, reliability analysis, gap analysis, and a paired-sample t-test ensured robustness. Significant gaps emerged in areas such as informal communication, visual competencies, competence control, and methodological integration, indicating a need for targeted development programs. The IPA matrix offered a strategic framework for prioritizing resource allocation, identifying urgent improvement areas and strengths. This study contributes a novel approach to optimizing resources and improving project outcomes by integrating IPA into competency evaluation. The findings support practitioners and organizations in enhancing project management effectiveness through focused training and investment.

Keywords
project management; competency gaps; importance-performance analysis (IPA); project success; skill development.

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1. Introduction

1.1. Research context and problem formulation

The evolving complexity of projects in various industries necessitates a nuanced understanding of the competencies required for project managers to achieve success. Projects inherently vary across numerous dimensions such as nature, industry, client involvement, technology, size, team composition, risk, environment, complexity, and required competencies. These variations necessitate tailored project management approaches specific to both the industry and the individual project, indicating the need for differentiated project types and diverse management styles (Shenhar, 2001; Bjelica et al., 2023). Given the diversity in project characteristics, project managers are challenged to select the appropriate methodologies that ensure successful implementation and goal achievement. Research has consistently highlighted the correlation between structured project management approaches and project success, suggesting that the application of systematic methodologies often results in more predictable and favorable outcomes (Ciric Lalic et al., 2022; Badewi, 2016; Carvalho et al., 2015; Inayat et al., 2014; Joslin and Müller, 2014; Joslin, 2019; Mir and Pinnington, 2014; Rolstadas et al., 2014). Effective project management practices are known to significantly enhance the likelihood of project success (Ciric Lalic et al., 2022; Savkovic et al., 2023; Munns and Bjeirmi, 1996).

Traditional frameworks for assessing project success, such as the "iron triangle," focus on cost, time, and quality. Projects that meet their defined scope, cost, and time parameters are typically considered successful. However, this model has evolved to incorporate broader criteria including stakeholder satisfaction, organizational benefits, and long-term environmental impacts (Maylor, 2001; Machado and Martes, 2015; Ribeiro et al., 2013). Understanding the factors that influence project success is a crucial area of research, particularly focusing on human resources such as project managers and team members. Project success is often defined differently by various managers, influenced by their experience, knowledge, and contextual factors. Some managers prioritize completing projects on time and within budget to achieve customer satisfaction, while others emphasize effective communication, collaboration, and stakeholder engagement (Ayat et al., 2021; Zozulya et al., 2021; Zuo et al., 2018; Baier et al., 2022).

While numerous studies explore project success factors and competencies, most studies tend to focus either on success criteria (e.g., time, cost, and scope) or qualitative assessments of competencies without offering a prioritization mechanism grounded in empirical data. Furthermore, there is limited integration of project manager and team member perspectives into a unified framework. To address this gap, this study introduces the Importance–Performance Analysis (IPA) methodology as a novel approach to project management competency assessment. While IPA is well-established in service quality and business performance research, its application to project management remains limited. By comparing the importance and performance of specific competencies within a unified framework, IPA provides actionable insights for targeted improvements.

1.2. Aim of the study and research questions

In light of these gaps, the scientific aim of this paper is to develop an empirically validated framework for identifying and prioritizing competency gaps in project management by integrating project manager and team member competencies into a unified model using the IPA method. This approach contributes to the project management body of knowledge by offering a diagnostic and strategic tool for competency development and resource allocation, validated through a structured statistical and methodological process.

Based on the defined aim, this study seeks to answer the following research questions:

- RQ1: Which project management competencies are perceived as most important by project professionals?
- RQ2: How do project professionals assess the actual performance of these competencies in practice?
- RQ3: Which competency areas demonstrate the largest gaps between importance and performance, and how can they be prioritized for improvement?

In operationalizing these research questions, the study sets out to: (1) empirically evaluate the perceived importance and performance of a broad set of project management competencies; (2) compare the perspectives of project managers and team members within a unified Importance-Performance Analysis (IPA) framework; and (3) identify priority areas for targeted competency development through quadrant-based analysis.

To address these objectives, a quantitative survey was conducted involving 257 project professionals from the Western Balkans region. The sample included both project managers and team members operating across various industries. A purposive sampling strategy was employed to ensure a wide distribution of professional roles, organizational contexts, and sectors. The data collection took place between late 2023 and early 2024, using a structured online questionnaire disseminated through local chapters of the Project Management Institute (PMI) in Serbia, Bosnia and Herzegovina, and Montenegro. Leveraging established PMI networks allowed access to a professionally active and engaged respondent pool, reinforcing both the timeliness and practical relevance of the dataset.

The survey instrument was structured around six competency clusters, each reflecting a key domain of project performance: communication competencies, technical competencies, managerial competencies, leadership style, project team input factors, and project team process factors. Respondents were asked to assess both the perceived importance and actual performance of each competency using a 5-point Likert scale, allowing for a systematic comparison between expectations and realities in project environments.

The collected data were analyzed using the IPA technique, which positions each competency into one of four strategic quadrants: *"Concentrate here," "Keep up the good work," "Low priority,"* and *"Possible overkill."* This mapping enables a clear visualization of where skill gaps exist and which competencies warrant immediate attention versus those that are already sufficiently developed.

Importantly, the heterogeneous composition of the sample—both horizontally (across sectors and organization types) and vertically (across levels of experience and responsibility)—enhances the external validity of the findings. This diversity ensures that the results are not only statistically robust but also broadly generalizable to varied organizational and project contexts within the region.

The remainder of the paper is structured as follows. Section 2 presents the theoretical background, organizing project-related competencies into six validated clusters for empirical investigation. Section 3 outlines the research methodology, detailing the survey design, sampling strategy, and analytical procedures, including the application of the Importance–Performance Analysis (IPA). Section 4 presents the empirical results, structured around descriptive and inferential statistics and the quadrant-based IPA matrix, with an additional subsection explicitly linking findings to the research questions and objectives. Section 5 offers a discussion of key findings in the context of international literature, while Section 6 concludes with theoretical and practical implications, limitations, and directions for future research.

2. Theoretical background

2.1. Project manager-based competencies for achieving project success

The understanding of project success is incomplete without acknowledging the pivotal role of the project manager's competencies. Turner (1999) emphasized the human-centric nature of projects, highlighting the need to organize financial, material, and particularly human resources within specific constraints to achieve beneficial change. Over time, the role of the project manager has evolved to encompass strategic alignment, stakeholder engagement, and adaptive planning amidst increasing project complexity and uncertainty (Ahsan et al., 2013).

Effective project managers are distinguished not only by their capacity to apply technical knowledge but by their proficiency in communication, leadership, and coordination. Selecting and developing managers who can lead projects to successful outcomes despite resource limitations is thus a critical organizational challenge (Sabaa, 2001; Meredith & Mantel, 2006; Menon, 2024).

Communication competencies are frequently cited as critical success factors. These include both formal and informal communication mechanisms, active listening, and the use of verbal and visual communication to ensure clarity across diverse stakeholders. Montequin et al. (2016) identified communication among the top drivers of project success, echoed by others who emphasize the value of continuous updates, stakeholder dialogue, digital communication and responsive interaction (Fisher, 2011; Clarke, 2010; Heinz et al., 2006; Kolesnikov et al., 2016; Brill et al., 2006; Oh & Choi, 2020). Recent studies further stress the importance of soft competencies such as empathy, emotional awareness, and confidence-building in communication processes within agile and hybrid environments (Kearney et al., 2023).

Technical competencies remain indispensable, especially in tailoring methodologies—agile or traditional—to specific project contexts (Chow & Cao, 2008; Belassi & Tukel, 1996). These include effective planning, assessment, systems analysis, and adaptive use of digital tools (Durmic, 2020; Ramazani & Jergeas, 2015; Girish et al., 2019; Pinto et al., 2020, Đaković et al., 2020). Newer contributions propose refining these competencies into role-specific competency constructs, such as those developed for contractor project managers (Kassa et al., 2025), underscoring the evolving specificity in technical competencies sets across industries.

Managerial competencies further contribute to success by enabling project portfolio management, conflict resolution, and resource coordination (Maqbool et al., 2017; Đaković et al., 2020; Kurniady et al., 2022; Milenkovic et al., 2023). These competencies support efficient project oversight and integration of cross-functional knowledge. Recent literature emphasizes the link between managerial agility and the adoption of digital tools for collaborative decision-making, especially in resource-constrained or multicultural settings (Rosamilha et al., 2023).

Equally, leadership style has gained prominence as a core dimension of competency. Emotional intelligence, team motivation, sensitivity, and the ability to influence and empower are crucial leadership traits (Geoghegan & Dulewicz, 2008; Maqbool et al., 2017; Thite, 2000). Effective leaders inspire shared vision (Gundersen et al., 2012; Aga et al., 2016), reduce ambiguity, and establish inclusive environments that promote engagement and cohesion (Sunindijo et al., 2007; Newton, 2009; Nguyen & Hadikusumo, 2017; Kabore et al., 2021). Recent evidence suggests that developing critical thinking and decision-making competencies early in the project career pathway significantly strengthens leadership performance (Borg & Scott-Young, 2025).

These findings are synthesized in Table 1, which presents a comprehensive view of project manager competencies grouped into four validated clusters: communication competencies, technical competencies, managerial competencies, and leadership style.

Table 1. Project manager-based competencies for project success

Clusters	Factors	Sources
Communication Competencies	Frequent and clear communication; Quality communication; Strong verbal communication competencies; Strong graphical communication competencies; Spending more time in informal conversations; Active listening; Understanding communication among all project participants; Establishing formal communication channels; Appropriate communication with different audiences;	Montequin et al., 2016; Heinz et al., 2006; Fisher, 2011; Clarke, 2010; Newton, 2009

Clusters	Factors	Sources
	Establishing informal communication channels; Explaining and continuously communicating all project plan changes throughout the project lifecycle; Giving specific instructions to team members regarding each task.	
Technical Competencies	Effective planning; Efficient use of technology; Risk management; Technical competencies; Problem-solving; Ability to use project management methodologies (process analysis, system design, etc.); Focusing on critical elements of technical management (critical success factors, deadlines, financial reports); Adapting traditional and agile tools, techniques, and methods for each project; Thorough planning and prioritization; Managing project elements including schedule, costs, resources, risks; Establishing technological solutions for the customer; Controlling individual competency availability; Selecting and controlling subcontractors; Implementing and managing schedules and their execution; Assessing technical project risks; Setting deadlines; Understanding specific requirements.	Belassi and Tukel, 1996; Spalek, 2005; Taherdoost and Keshavarzsaleh, 2015; Durmic, 2020; Güngör and Gözlü, 2016; Loufrani-Fedida and Missonier, 2015; Ramazani and Jergeas, 2015; Girish *et al.*, 2019
Managerial Competencies	Managers capable of managing agile processes; Teamwork; Conflict management; Effective planning; Effective coordination; Efficient use of managerial competencies; Effective control and monitoring; Knowledge of available resources; Ability to manage agile processes; Project portfolio management.	Chow and Cao, 2008; Maqbool *et al.*, 2017; Belassi and Tukel, 1996; Spalek, 2005; Taherdoost and Keshavarzsaleh, 2015; Durmic, 2020; Güngör and Gözlü, 2016; Heinz *et al.*, 2006
Management Style - Leadership	Self-awareness; Team motivation; Human resource management; Human resource development; Sensitivity; Team empowerment; Project manager's influence on team members; Critical thinking.	Maqbool *et al.*, 2017; Taherdoost and Keshavarzsaleh, 2015; Nguyen and Hadikusumo, 2017; Newton, 2009; Thite, 2000; Geoghegan and Dulewicz, 2008; Taherdoost and Keshavarzsaleh, 2015

2.2. Project team members-based factors for achieving project success

Beyond the competencies of the project manager, the project team itself represents a strategic unit whose capabilities significantly affect project outcomes. Effective teams are characterized by alignment, cohesion, adaptability, and a balance of technical and soft competencies.

Literature distinguishes between input and process factors that shape team effectiveness (Liu & Cross, 2016). Input factors refer to contextual and structural preconditions such as team composition, leadership support, goal clarity, diversity, and rewards (Spalek, 2005; Chow & Cao, 2008; Belassi & Tukel, 1996). These establish the framework within which teams perform and directly affect early-stage planning and mobilization (Crawford & Nahmias, 2010; Oh & Choi, 2020).

Process factors capture the dynamic, interactive elements of team behavior: communication, learning, cohesion, problem-solving, commitment, and conflict resolution (Sudhakar, 2016; Wanjau et al., 2024; Montequin et al., 2016). Effective process mechanisms enable responsiveness, integration of diverse expertise, and sustained momentum throughout the project lifecycle. These dynamics are increasingly supported by innovative pedagogical approaches—such as game-based learning—that enhance motivation and collaboration in project team environments (Jääskä et al., 2022).

Team members' individual competencies—such as leadership potential, adaptability, stress resilience, and decision-making—are critical for functioning in multidisciplinary, volatile environments (Czainska, 2020; Songa, 2020; Khan et al., 2022). Strategic thinking, flexibility, and cross-functional collaboration amplify the impact of individual capabilities on collective performance. Moreover, competency frameworks tailored to specific project types help identify which competencies are most effective under varying conditions, as evidenced by recent comparative studies (Rosamilha et al., 2023).

Diversity, when managed inclusively, is a performance enabler rather than a challenge (Yoo et al., 2023). Furthermore, strong internal communication supported by structured feedback loops contributes to alignment, trust, and a culture of continuous learning (Manyara, 2020; Wanjau et al., 2024; Barmasai & Mbugua, 2020).

Table 2 categorizes team-based factors into input and process clusters, reflecting the theoretical grounding and practical relevance of team dynamics for project success.

Table 2. Project team members-based factors for project success

Clusters	Factors	Sources
Input Factors	Leadership; Management support; Rewards; Knowledge/competencies; Team diversity; Clearly defined goals.	Liu and Cross, 2016; Chow and Cao, 2008; Belassi and Tukel, 1996; Taherdoost and Keshavarzsaleh, 2015b; Durmic, 2020; Heinz *et al.*, 2006; Nguyen and Hadikusumo, 2017; Rota and Zanasi, 2011; Oh and Choi, 2020; Spalek, 2005; Taherdoost and Keshavarzsaleh, 2015a; Davis, 2016
Process Factors	Collaboration; Communication; Learning activities; Cohesion; Efforts; Commitment; Conflict resolution; Team climate; Performance.	Sudhakar, 2016; Liu and Cross, 2016; Belassi and Tukel, 1996; Montequin *et al.*, 2016; Rota and Zanasi, 2011; Oh and Choi, 2020; Zare *et al.*, 2016; Brill *et al.*, 2006; Belassi and Tukel, 1996; Durmic, 2020

2.3. Theoretical relevance of clustered competencies for empirical evaluation

The categorization of project-related competencies into four clusters for project managers (Table 1) and two clusters for project teams (Table 2) provides a theoretically grounded structure for the empirical model developed in this study. These clusters were derived by synthesizing findings from multidisciplinary literature and validated sources, allowing the study to operationalize a comprehensive set of competencies and behaviors relevant to project success.

The managerial clusters in Table 1 reflect distinct yet complementary domains: *Communication Competencies* ensure information exchange and alignment; *Technical Competencies* enable methodological precision; *Managerial Competencies* facilitate structural coordination and control; and *Leadership Style* addresses human dynamics and motivational climate. This decomposition allows for more precise identification of skill gaps and the design of tailored interventions, thereby directly supporting the paper's aim to prioritize competencies through Importance-Performance Analysis (IPA).

In Table 2, the dual classification into *Input Factors* and *Process Factors* reflects both the structural and behavioral dimensions of team effectiveness. This distinction enables the model to capture not only the presence of resources and capabilities at the outset of a project (input), but also the evolving dynamics and practices during project execution (process). By systematically relating these clusters to the performance gaps revealed in the empirical analysis, the study ensures that the theoretical framing aligns closely with the research questions and the overarching objective of guiding evidence-based competency development. Reinterpreting these in light of the IPA results offers deeper insight into which clusters drive project performance most effectively and which remain underdeveloped in practice.

3. Research Methodology

3.1. Questionnaire development

To systematically examine the competencies that contribute to project success, a structured questionnaire was developed based on a comprehensive literature review and validated measurement instruments. The questionnaire was designed to capture both the perceived importance and performance of project management competencies from the perspective of professionals involved in project work. The questionnaire consists of two main sections. The first section collects socio-demographic data (e.g., gender, education, years of experience, certification status) and organizational characteristics (e.g., presence of formal project management units, organization size), enabling deeper segmentation in data analysis.

The second section is structured around six competency clusters, each reflecting a critical domain of project performance: (1) Communication competencies (12 items); (2) Technical competencies (16 items); (3) Managerial competencies (9 items); (4) Leadership style (8 items); (5) Project team input factors (9 items), and (6) Project team process factors (8 items).

Each item was evaluated on a five-point unipolar Likert scale ranging from 1 ("complete disagreement") to 5 ("complete agreement"), assessing both the importance of the competency and its actual performance in practice. This dual measurement allows for the application of Importance–Performance Analysis (IPA), a strategic diagnostic tool for identifying skill gaps.

Importantly, the Project Manager Competencies Scale (PMSS) developed and validated by Jokanović Bajić et al. (2024) was adopted and integrated into the questionnaire to ensure psychometric rigor and content validity. PMSS is a novel and recently published instrument designed specifically to quantify the core competencies of project managers, offering a robust framework grounded in contemporary project management theory and practice.

To enhance the scope and relevance of the analysis, two additional clusters focusing on project team factors were included, thus extending the evaluation beyond the project manager and enabling a holistic, team-centered view of project competency dynamics. This structured design ensures that the collected data is suitable for robust quantitative analysis, enabling cross-role comparisons and strategic prioritization of training and development needs. The full version of the questionnaire used in the study is provided in Appendix A.

3.2. Data collection

Data collection was conducted using an online survey administered via the SurveyMonkey platform. The target group consisted of individuals with experience or involvement in projects, including both project managers and team members, to capture diverse perspectives on project management issues.

The online survey was distributed via the Project Management Institute (PMI) networks across Bosnia and Herzegovina, Serbia, and Montenegro in late 2023 and early 2024, ensuring the timeliness of data and relevance to current trends and challenges in project management. The distribution was carried out through validated respondent pools from the local chapters of the global PMI (Project Management Institute) network, ensuring access to engaged and professionally active

participants. This approach supported the inclusion of a wide spectrum of project professionals across sectors and industries.

Participants received instructions and a unique link to access the questionnaire, ensuring anonymity and preventing multiple submissions from the same device. Out of 281 completed questionnaires, 257 valid responses were included in the final analysis, excluding those with missing values or incomplete responses. This robust sample size, along with the geographical and professional diversity of respondents, ensures the reliability, validity, and representativeness of the findings and provides a solid foundation for the subsequent analysis.

3.3. Data analysis

The core objective of this research is to employ Importance-Performance Analysis (IPA) to evaluate project management competencies and identify critical areas for improvement. IPA, originally conceptualized by Martilla and James (1977), is a pivotal evaluative framework within management research. It juxtaposes the perceived importance of various competencies against their performance levels, thus identifying discrepancies and potential areas for enhancement.

The IPA methodology has been widely applied across diverse management disciplines to ascertain critical competencies and their execution efficacy. For instance, studies by Azzopardi and Nash (2013) have underscored IPA's utility in delineating priority areas for managerial action, thereby optimizing resource allocation toward competencies that significantly impact project outcomes. This approach aligns with the findings of Slack (1994), who advocated for IPA's application in identifying service quality dimensions within operational contexts, a principle readily adaptable to project management scenarios.

Applying IPA in this research offers a nuanced understanding of where to direct improvement efforts for enhancing project outcomes. By categorizing essential project management competencies into quadrants like "Concentrate Here" (high importance, low performance) and "Keep up the Good Work" (high importance, high performance), IPA serves as a foundational tool in strategic skill development. This methodological framework provides actionable insights, enabling project managers and teams to focus on critical areas that require enhancement while maintaining strengths that contribute to project success.

3.4. Sample demographics

The sample for this study was diverse and representative, encompassing a wide range of demographic backgrounds, professional roles, organizational types, and levels of project experience. The gender distribution was nearly equal, with 128 males (49.8%) and 129 females (50.2%). All respondents were highly educated: 49.8% held a Ph.D., 30.4% had completed university-level studies, 12.8% had a master's degree, and 7% had a high school education. The relatively high proportion of Ph.D. holders reflects the composition of the professional landscape in the Western Balkans, where individuals with advanced degrees are frequently employed in complex project environments, including roles that require analytical, managerial, or cross-sectoral coordination capacities. In many organizations across the region—particularly in public administration, research-intensive institutions, and consultancy-oriented roles—project responsibilities are often assigned to highly qualified staff, which is reflected in the educational structure of the sample. In terms of organizational representation, 47.1% of respondents reported that their organizations had a dedicated project/program/portfolio management unit, while 52.9% indicated the absence of such a unit. Only 8.2% of respondents held a formal project management certificate, pointing to a potential gap in certification and training in the region. Regarding roles within project teams, 35.4% of respondents were project team members, 36.6% were project managers, and the remaining 28% held other roles related to project environments. Experience in project management varied significantly among respondents, ranging from less than 1 year (13.6%) to over 30 years (3.1%), ensuring that both junior and senior professionals were represented. Respondents worked in organizations of all sizes: 39.7% were employed in small companies (1–50

employees), 35.8% in medium-sized organizations (51–200), and the rest in larger enterprises, including those with over 1,000 employees.

This heterogeneous structure of the sample ensures both horizontal (across sectors and organization types) and vertical (across experience and roles) representation, justifying the sample's representativeness. The broad distribution of respondents enhances the external validity of the study and strengthens the generalizability of the findings across different organizational and project contexts in the Western Balkans region.

4. Results

This section presents the findings of the study structured around the research questions and sub-objectives defined in the Introduction. The analysis is conducted in three main stages: (1) descriptive statistics, reliability testing, and gap analysis to explore the perceived importance and performance of competencies; (2) inferential statistical analysis through paired-sample t-tests to assess the significance of identified gaps; and (3) the use of the IPA matrix to prioritize competencies and guide strategic interventions (addressing RQ3; SO3).

4.1. Descriptive statistics, reliability and gap analysis

The Results section offers a comprehensive and systematic analysis of the essential competencies attributed to both project managers and team members that are critical to project success. Utilizing a multifaceted methodological approach—comprising descriptive statistics, reliability analysis through Cronbach's alpha, and a weighted gap analysis—this study evaluates the alignment between the perceived importance and actual performance of these competencies.

The findings demonstrate that respondents assign consistently high importance to a broad spectrum of competencies, with average scores ranging from 3.88 to 4.71. These results suggest a strong consensus regarding the relevance of these competencies in achieving successful project outcomes. In contrast, the performance scores exhibit greater variability, ranging from 3.59 to 4.17, which indicates notable discrepancies in how these competencies are being applied in practice.

The reliability of the measurement instruments is confirmed by Cronbach's alpha values exceeding the 0.7 threshold for both importance and performance dimensions, underscoring the internal consistency of the constructs measured. This methodological robustness provides a solid foundation for interpreting the performance gaps.

Unlike a simple arithmetic difference (e.g., Importance – Performance), this study employs a weighted gap formula commonly used in Importance–Performance Analysis (IPA) to emphasize competencies that are both highly important and underperformed. The formula applied is: Weighted Gap = (5 - mean performance (p) *(mean importance (I) / 5). This approach accentuates the urgency of improving competencies that are deemed highly important yet show lower levels of performance, ensuring that both dimensions are taken into account. Accordingly, the gap column presented in Table 3 is labeled as "Weighted Gap" to reflect this methodological decision. The weighted gap values thus provide actionable insights into priority areas for competency development.

The results of the descriptive analysis revealed substantial discrepancies between the perceived importance and actual performance of several critical project management competencies. These gaps provide important insights into areas that warrant immediate strategic attention and intervention.

To begin with, among the communication competencies, the largest performance gap is associated with informal communication channels. While this skill was rated with an importance score of 3.88, the performance score was slightly higher at 3.90, yielding a gap of 0.874. This indicates a considerable shortfall in the informal communication dynamics within project teams—an area that is often overlooked yet crucial for real-time coordination and fostering trust. Similarly, visual communication competencies exhibited a notable performance gap. Although respondents assigned a relatively high importance score of 4.07, the performance was rated at 3.96, resulting in a gap of 0.737. This suggests

that while the utility of visual tools and techniques is acknowledged, they are underutilized in practice. Furthermore, verbal communication competencies displayed a gap of 0.529 (importance 4.35; performance 4.07), indicating that verbal clarity and expressiveness remain an area needing further enhancement to improve overall team interaction and information dissemination.

Table 3. Importance and performance of the key competencies and factors

	Importance		Performance		
	Mean	Std. Deviation	Mean	Std. Deviation	Weighted Gap
Communication competencies	*Importance (α=.909)*		*Performance (α=.958)*		
K1 - Frequent communication	4.64	0.74	4.06	0.863	0.292
K2 - Quality communication	4.66	0.674	4.04	0.885	0.275
K3 - Verbal competencies	4.35	0.803	4.07	0.892	0.529
K4 - Visual competencies	4.07	0.895	3.96	0.876	0.737
K5 - Active listening	4.4	0.831	3.96	0.935	0.475
K6 - Informal communication	4.09	0.934	3.98	0.899	0.724
K7 - Understanding communication	4.45	0.762	4.05	0.849	0.446
K8 - Formal channels	4.1	0.862	3.95	0.939	0.711
K9 - Informal channels	3.88	0.97	3.9	0.991	0.874
K10 - Stakeholder communication	4.28	0.846	3.91	0.895	0.563
K11 - Specific instructions	4.35	0.833	3.96	0.967	0.515
K12 - Communicate changes	4.47	0.845	3.96	0.962	0.42
Technical competencies	*Importance (α=.947)*		*Performance (α=.971)*		
T1 - Use of technology	4.33	0.838	4.07	0.853	0.545
T2 - Technological solutions	4.26	0.835	3.97	0.891	0.588
T3 - Competence control	4.16	0.856	3.88	0.866	0.652
T4 - Manage schedules	4.42	0.733	4	0.896	0.464
T5 - Risk management	4.31	0.859	3.95	0.911	0.545
T6 - Combine methodologies	4.11	0.909	3.97	0.908	0.707
T7 - Planning and managing schedule	4.56	0.724	4.01	0.934	0.353
T8 - Set deadlines	4.48	0.826	3.99	0.927	0.415
T9 - Assess risks, deadlines and costs	4.53	0.816	4.02	0.92	0.378
T10 - Manage risks	4.43	0.825	3.95	0.902	0.45
T11 - Understand requirements	4.44	0.809	4.14	0.842	0.464
T12 - Solve problems	4.54	0.737	4.17	0.852	0.384
T13 - Focus on critical technical elements	4.37	0.8	4.03	0.881	0.508
T14 - Adapt tools	4.18	0.849	3.96	0.886	0.649
T15 - Planning and prioritization	4.53	0.754	4.05	0.907	0.381
T16 - Integrate methodologies	4.39	0.8	4.08	0.857	0.498
Managerial Competencies	*Importance (α=.942)*		*Performance (α=.968)*		
UK1 - Conflict management	4.45	0.752	3.97	0.951	0.437
UK2 - Resource knowledge	4.4	0.772	3.92	0.944	0.47
UK3 - Portfolio management	4.21	0.89	3.96	0.971	0.626
UK4 - Effective planning	4.52	0.754	4.04	0.987	0.388
UK5 - Effective use of management competencies	4.42	0.81	4.06	0.974	0.471
UK6 - Control and monitoring	4.4	0.825	4.01	0.969	0.481
UK7 - Coordination	4.51	0.779	4.03	0.976	0.395

	Importance		Performance		
	Mean	Std. Deviation	Mean	Std. Deviation	Weighted Gap
UK8 - Manage agile processes	4.31	0.831	3.94	0.998	0.544
UK9 - Team management	4.6	0.704	4.07	0.991	0.326
Leadership *Importance (α=.886)*		*Performance (α=.969)*			
L1 - Human resources management	4.59	0.692	4	0.976	0.328
L2 - Employee empowerment	4.62	0.673	3.97	0.985	0.302
L3 - Employee development	4.5	0.768	3.86	1.055	0.386
L4 - Employee motivation	4.6	0.736	3.86	1.082	0.309
L5 - Influence on team	4.44	0.766	3.96	1.002	0.444
L6 - Self-awareness	4.48	0.742	3.92	1.035	0.408
L7 - Sensitivity	4.18	1.003	3.9	1.105	0.64
L8 - Critical thinking	4.43	0.803	3.97	1.059	0.453
Project Team Input Factors *Importance (α=.878)*		*Performance (α=.944)*			
UF1 - Leadership	4.29	0.878	3.91	0.897	0.555
UF2 - Management support	4.5	0.731	3.99	0.918	0.399
UF3 - Rewards	4.33	0.893	3.59	1.177	0.481
UF4 - Knowledge/competencies	4.62	0.658	4.04	0.85	0.307
UF5 - Team diversity	4.37	0.905	3.9	1.017	0.491
UF6 - Clear goals	4.6	0.75	4.03	0.873	0.322
UF7 - Management competencies	4.19	0.926	3.95	0.927	0.64
UF8 - Tools and techniques	4.44	0.672	4.08	0.85	0.457
UF9 - Personal competencies	4.5	0.752	4.01	0.881	0.401
Project Team Process Factors *Importance (α=.894)*		*Performance (α=.964)*			
PF1 - Cooperation	4.71	0.63	4.09	0.909	0.237
PF2 - Communication	4.73	0.607	4.02	0.88	0.217
PF3 - Learning activities	4.51	0.773	3.84	1.012	0.376
PF4 - Cohesion	4.48	0.733	3.93	0.943	0.409
PF5 - Commitment	4.32	0.873	3.9	1.027	0.53
PF6 - Conflict resolution	4.55	0.734	4	0.985	0.36
PF7 - Team climate	4.61	0.683	4	1.032	0.312
PF8 - Team performance	4.52	0.713	4.06	0.864	0.39

Turning to technical competencies, the gap in competence control is particularly significant. With an importance score of 4.16 and a performance score of 3.88, the resultant gap of 0.652 reflects a systemic deficiency in managing and tracking the competencies of team members. This points to an urgent need for capacity-building programs focused on competence-based project staffing. Additionally, the integration of methodologies showed a substantial gap of 0.707 (importance 4.11; performance 3.97). This highlights a critical shortcoming in the ability of project managers to combine traditional and agile approaches effectively, necessitating hands-on training in hybrid project methodologies. A related issue is the adaptation of project management tools, where the gap reached 0.649 (importance 4.18; performance 3.96), indicating a failure to tailor tools to meet specific project demands in dynamic environments.

Within the cluster of managerial competencies, the most pronounced gap was recorded in portfolio management. The importance score for this skill stood at 4.21, while its performance was only 3.96, leading to a gap of 0.626. This suggests challenges in managing multiple projects simultaneously, particularly in aligning them with strategic objectives and optimizing resource distribution. Furthermore, the ability to manage agile processes displayed a gap of 0.544 (importance

4.31; performance 3.94), reinforcing the need for more robust training in agile frameworks and their practical application in project settings.

In the domain of leadership competencies, the greatest gap was observed in sensitivity, a key component of emotional intelligence. With an importance rating of 4.18 and a performance score of 3.90, the gap of 0.64 suggests that project managers may struggle to perceive and respond appropriately to team dynamics and individual needs. Likewise, critical thinking revealed a performance deficit of 0.453 (importance 4.43; performance 3.97), highlighting the necessity to foster more reflective and analytical leadership practices. The ability to influence the team also showed a performance shortfall of 0.444 (importance 4.44; performance 3.96), pointing to the need for development in motivational and inspirational leadership strategies.

Regarding project team input factors, management support emerged as the area with the largest gap (importance 4.19; performance 3.95; gap 0.64). This reflects an organizational weakness in providing adequate guidance, resources, and endorsement to project teams, which can hinder progress and undermine morale. The leadership capacity of team members also exhibited a notable gap of 0.555 (importance 4.29; performance 3.91), suggesting that teams may lack internally embedded leadership figures who can drive execution. In addition, team diversity showed a gap of 0.491 (importance 4.37; performance 3.90), indicating that while diversity is appreciated, its potential is not being effectively harnessed—calling for more inclusive practices and training in intercultural team management.

Finally, within the project team process factors, the largest discrepancy was related to team commitment. With an importance score of 4.32 and a performance score of 3.90, the gap of 0.53 underscores a lack of full engagement with project goals among team members. Team cohesion also revealed a substantial gap of 0.409 (importance 4.48; performance 3.93), suggesting a deficiency in collective unity and shared identity—both of which are crucial for effective collaboration. These findings point to the need for structured team-building activities and long-term strategies aimed at strengthening internal trust and goal alignment.

The analysis of importance-performance gaps underscores a consistent pattern: the competencies and attributes considered most essential for project success are also those that currently underperform. These discrepancies demand a targeted and strategic approach to workforce development, with a particular emphasis on communication, agile management, leadership, and team integration competencies.

4.2. The paired-sample t-test: assessing the alignment between importance and performance

The application of a paired-sample t-test in this study revealed statistically significant differences between the perceived importance and actual performance of key project success competencies. To quantify the gap, a simple arithmetic difference was calculated between the mean importance and performance scores for each factor (Importance – Performance), and this value is reported as the "Gap" in Table 4.

Table 4. Paired-sampled T-test for the means of importance and performance levels of the key performances of the project success.

	Importance (mean)	Performance (mean)	Gap (I–P)	t-value	Significance (p)
Communication competencies	4.3280	3.9875	0.3405	7.128	$p < 0.001$
Technical knowledge	4.3834	4.0174	0.3660	8.434	$p < 0.001$
Management competencies	4.4211	3.9458	0.4753	8.876	$p < 0.001$
Leadership	4.4798	3.9366	0.5432	8.738	$p < 0.001$
Project team input process	4.4228	3.9458	0.4770	9.243	$p < 0.001$
Project team process factors	4.5574	3.9799	0.5775	9.335	$p < 0.001$

*Significant at the 0.01 level.

The t-test results demonstrate that these differences are statistically significant at the $p < 0.001$ level across all competencies. This indicates that the observed discrepancies are unlikely to be due to chance, and instead reflect meaningful gaps between what is considered critical for project success and what is actually being achieved in practice.

The largest gaps were observed in competencies related to project team process factors and leadership, signaling the need for focused interventions. In contrast, smaller gaps in communication competencies and technical knowledge may reflect existing training or more routine application in practice. Nonetheless, all competencies examined exhibit statistically significant gaps, which highlights the need for improved alignment between expectations and delivery in project work.

4.3. Key findings contextualized through Importance-Performance Analysis (IPA) matrix Importance-performance analysis (ipa) matrix

The IPA matrix further contextualizes these findings by categorizing competencies into quadrants, providing a strategic framework for action (Figure 1). By mapping various competencies across the four quadrants of the IPA matrix—Concentrate Here, Keep up the Good Work, Low Priority, and Possible Overkill—we have gained insightful perspectives on the current state of project management abilities. The results of the IPA analysis in IPA Matrix are presented in Figure 1.

The application of the Importance-Performance Analysis (IPA) matrix offers a structured framework for diagnosing and prioritizing project management competencies. By positioning each competency within one of four quadrants—based on its perceived importance and actual performance—this method enables a strategic evaluation of areas requiring development and those demonstrating operational excellence.

The "Concentrate Here" quadrant includes competencies deemed highly important but underperforming, thus representing critical priorities for intervention. Notably, this includes key leadership competencies such as employee empowerment, management of employee development, team motivation, influence, and self-awareness. These competencies are essential for fostering transformational leadership and maintaining team alignment with project goals. Similarly, process-oriented team factors—such as learning opportunities, team cohesion, and conflict resolution—appear in this quadrant, indicating the need for enhanced mechanisms that support collaborative team functioning and the resolution of interpersonal challenges. Also included are issues related to communication and managerial support, such as the ability to clearly communicate project plan changes and the extent of support provided to project team members. The placement of these competencies signals deficiencies in leadership infrastructure, learning culture, and stakeholder alignment.

The "Keep up the Good Work" quadrant reflects competencies that are both highly valued and well-executed. These include collaboration and communication within project teams, a positive team climate, high levels of team performance, and technical proficiencies such as planning, schedule control, and risk assessment. These competencies serve as anchors of stability and efficiency in project execution. Their presence in this quadrant suggests that organizations are successfully maintaining foundational competencies that contribute to the consistent delivery of project outcomes.

The contrast between these two quadrants illustrates the need for a dual strategic focus: one that preserves and nurtures existing strengths, while simultaneously addressing areas of strategic vulnerability. Such a balanced approach supports sustainable project performance and enables more effective capability development over time.

The "Low Priority" quadrant includes competencies with lower importance and lower performance. Examples include diversity management, formal recognition systems, and several team member management competencies. While not immediately critical to project success, these areas contribute to long-term organizational maturity and should not be entirely neglected. Also present are several communication competencies—such as visual communication, active listening, and informal communication—that, while fundamental to interpersonal effectiveness, appear to have limited perceived strategic impact within the study's context. These findings suggest a possible misalignment between communication strategies and perceived project needs, warranting further examination.

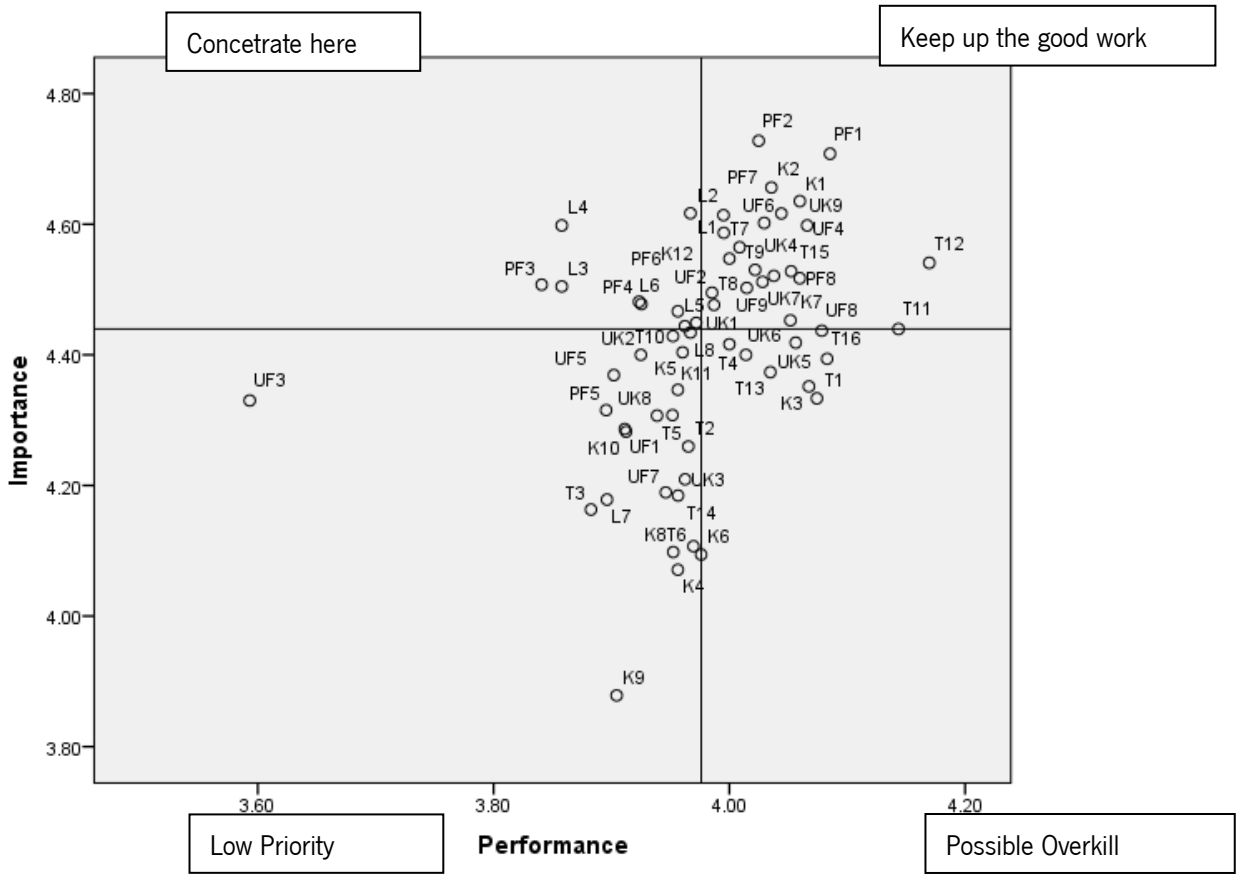

Fig. 1. IPA matrix

The "Possible Overkill" quadrant identifies competencies with strong performance but lower relative importance. These include technological fluency, advanced scheduling, integration of diverse methodologies, and control and monitoring competencies. While these competencies are operationally beneficial, the data suggest that organizations may be over-investing in areas that no longer represent the most pressing development needs. These insights call for a rebalancing of resource allocation to maximize return on training and development investments.

Through the IPA analysis, it becomes clear that specific areas require urgent attention to bridge performance gaps, while others indicate strong performance that should be maintained. This strategic approach facilitates targeted interventions, optimizing resource allocation, and enhancing the overall effectiveness of project management practices.

4.4. Summary of key results in light of the research questions and sub-objectives

The results of the conducted analyses directly address the study's three research questions and corresponding sub-objectives, offering a comprehensive interpretation grounded in empirical evidence.

Regarding RQ1 – Which project management competencies are perceived as most important by project professionals – the descriptive analysis showed that respondents consistently rated all six competency clusters as highly important, with average importance values ranging from 4.32 to 4.73. Particularly high scores were attributed to process-related team factors such as cooperation, communication, and clear goal setting, confirming the central role of interpersonal and team dynamics in contemporary project environments. These findings fulfill Sub-objective 1 by empirically identifying which competencies are perceived as most critical across industries and roles.

Regarding RQ2 – How do project professionals assess the actual performance of these competencies in practice – the data revealed substantial variation in performance scores (ranging from 3.59 to 4.17), indicating significant misalignment between perceived importance and day-to-day application of key competencies. This gap was especially evident in areas such as informal communication, leadership sensitivity, and competence control. The paired-sample t-test confirmed that the differences between importance and performance are statistically significant across all clusters ($p < 0.001$), thus validating the presence of measurable skill deficits in practice. These results address both RQ2 and Sub-objectives 1 and 2, as they not only measure but statistically compare the importance and performance across project roles.

Regarding RQ3 – Which competency areas demonstrate the largest gaps between importance and performance, and how can they be prioritized for improvement – the IPA matrix enabled the strategic categorization of competencies. The "Concentrate Here" quadrant identified high-priority gaps in leadership (e.g., employee empowerment, team influence), team process factors (e.g., cohesion, learning), and communication (e.g., communicating changes). These competencies are both highly valued and underperforming, making them urgent targets for intervention. Conversely, competencies such as planning, scheduling, and risk control were positioned in the "Keep up the Good Work" quadrant, confirming their continued relevance and effective implementation. These insights directly respond to RQ3 and achieve Sub-objective 3, by identifying which competencies should be prioritized for development based on quadrant-based analysis.

The triangulation of descriptive, inferential, and quadrant-based methods confirms the study's core argument: while project professionals widely agree on which competencies are most important, these competencies are not always executed effectively in practice. This evidence provides actionable insights for the design of competency-based training, team development strategies, and future research on skill-based project performance.

5. Discussion

The findings from the descriptive statistics, reliability analysis, and gap analysis offer deep insights into the current state of project manager and team member competencies required for successful project implementation. By employing the Importance-Performance Analysis (IPA) framework, this study provides a strategic understanding of which competencies are being effectively applied and which require urgent attention. The revised discussion explicitly connects these findings to the broader international literature, drawing clear parallels and contrasts with recent global research to emphasize both their contextual relevance and broader applicability.

5.1. Key findings and their alignment with international research

The analysis revealed substantial gaps in key competencies essential to project success, most notably in the areas of informal and visual communication. These findings reinforce existing global research that underscores communication as a foundational pillar of effective project management (Montequin et al., 2016; Fisher, 2011). Although the centrality of communication is widely acknowledged, recent research suggests that its practical significance can vary across different project contexts. For example, a systematic review of 173 competencies spanning 14 project types showed that communication, while universally important, may carry different weights depending on the specific project type (Rosamilha et al., 2023).

Among communication competencies, the gap in informal communication is particularly concerning. Informal exchanges are vital for enabling real-time collaboration and fostering trust within teams—especially in fast-paced, dynamic environments (Fisher, 2011). The underperformance in this area may indicate structural or cultural barriers that restrict open and spontaneous interaction. As suggested by Heinz et al. (2006), creating organizational cultures that actively promote informal dialogue—through initiatives like team-building activities or open-door policies—can enhance transparency and coordination. These conclusions are further reinforced by Kearney et al. (2023), who identified informal

and interpersonal communication as part of the five essential soft competencies for project managers in modern work environments.

Similarly, the underutilization of visual communication competencies—despite their high perceived importance—points to a need for greater emphasis on visual clarity in project management. This may stem from limited training in visual tools or an over-reliance on text-based communication. Addressing this gap requires intentional investment in visual communication training and the integration of visual aids into day-to-day project practices (Brill et al., 2006). In today's hybrid and remote project settings, the prominence of such competencies is only increasing, as emphasized again by Kearney et al. (2023).

Beyond communication, significant gaps were observed in technical proficiencies such as competence control and the ability to combine methodologies. These findings are consistent with Durmic (2020), who stressed the importance of continuous competence tracking to ensure team alignment with evolving project demands. Kassa et al. (2025) further reinforce this by demonstrating how top-performing project managers—particularly in the construction sector—are those who score highly in communication, leadership, and technical competencies. Their work supports a more individualized, development-focused approach to training, which our findings indicate is needed across sectors.

The necessity for tailoring training based on project type is also echoed in the systematic review by Rosamilha et al. (2023), who argue that competency requirements differ significantly between traditional, agile, and extreme project environments. This supports the idea that generalized training programs may be insufficient and that more targeted, context-sensitive development paths are needed (Camilleri, 2012). Embedding continuous, competency-based assessments into organizational routines could provide a structured way to identify these gaps and respond with tailored learning initiatives.

The observed difficulties in integrating diverse methodologies align with broader concerns in international literature. Ramazani and Jergeas (2015) highlight the growing need for flexibility in project environments, where project managers must draw upon a wide range of methods. Similarly, Menon (2024) emphasizes that project professionals should be equipped to manage various types of projects—traditional, agile, and extreme—requiring not only awareness of methodologies but also the ability to fluidly combine them. Our findings suggest a persistent gap in turning this theoretical knowledge into practical capability, a gap that Chow and Cao (2008) previously identified in their performance framework for agile project management. Kearney et al. (2023) and Jääskä et al. (2022) offer potential solutions: incorporating experiential learning, gamification, and hands-on exercises into project management training to better bridge the theory-practice divide.

Likewise, the gaps in portfolio management and agile process management underscore the need for improved strategic and adaptive capabilities. The former is crucial for aligning multiple projects with organizational strategy, a view long supported by Maqbool et al. (2017) and Güngör and Gözlü (2016). The latter—agile implementation—remains essential for navigating complexity and change (Belassi and Tukel, 1996; Chow and Cao, 2008). Our findings suggest that while agile principles are conceptually valued, many organizations fall short in embedding them into routine practice, necessitating more robust, practical training programs and continuous professional support.

When it comes to leadership competencies, deficiencies in areas such as sensitivity, critical thinking, and team influence highlight the enduring importance of emotional intelligence. As Maqbool et al. (2017) and Thite (2000) note, emotionally intelligent leadership is indispensable for managing diverse teams and sustaining morale. The gap in sensitivity uncovered in this study may point to inadequate preparation in managing interpersonal dynamics. Leadership development programs should thus incorporate modules focused on emotional intelligence and self-awareness.

Critical thinking, another domain where a significant gap was observed, is vital for effective decision-making in uncertain environments (Nguyen & Hadikusumo, 2017). However, recent international research points to a general lack of structured interventions for developing this skill. Borg and Scott-Young (2025), in their systematic review, argue that although critical

thinking is frequently cited as a top competency, its actual development remains poorly supported. They suggest practical interventions—such as mentoring, gamification, and targeted feedback—as promising pathways. Our findings support this and indicate an urgent need to translate these approaches into training practice.

The influence on team members is also critical for effective leadership. As Geoghegan and Dulewicz (2008) suggest, it is among the key predictors of project success. However, our results reveal that many project leaders may lack the capacity to inspire or mobilize their teams. Gundersen et al. (2012) advocate for transformational leadership models that engage team members more fully—an approach that could directly address the deficits identified in our study.

Finally, the findings related to project team input and process factors—such as management support, leadership within the team, diversity, and commitment—highlight persistent gaps in organizational support structures. These align with global evidence showing that strong management support is vital for project continuity and morale (Liu and Cross, 2016). The deficiency in intra-team leadership parallels results from Taherdoost and Keshavarzsaleh (2015b), who emphasize the importance of empowering team members with leadership responsibilities. Moreover, our findings on team diversity echo Yoo et al. (2023), who found that while diversity brings innovation potential, it often goes untapped due to poor integration practices.

Low commitment among team members may signal a lack of motivation or engagement, a challenge widely documented in international studies. Wanjau et al. (2024) stress the importance of clearly defined goals and recognition mechanisms for enhancing team commitment—strategies that could be readily adopted to close this particular gap.

6. Conclusion

This study offers a comprehensive empirical examination of project management competencies by applying the Importance–Performance Analysis (IPA) framework to identify critical gaps between perceived importance and actual performance. Based on responses from 257 project professionals across the Western Balkans, the analysis revealed pronounced discrepancies in areas such as informal and visual communication, methodological integration, competence control, portfolio and agile process management, and leadership sensitivity. These findings emphasize the persistent mismatch between what is considered essential for project success and the competencies currently applied in practice. By operationalizing theoretical competency clusters through empirical methods, this research confirms the diagnostic potential of the IPA matrix and contributes to building a context-sensitive, evidence-based framework for competency development.

6.1. Implications for theory and practice

The identified gaps have significant implications for both project management research and professional practice. Theoretically, the results reaffirm the value of competency-based frameworks while advocating for their evolution to better reflect soft competencies, such as emotional intelligence, adaptability, and communication—particularly in hybrid and agile environments. The IPA matrix proves useful as a strategic lens through which organizations can evaluate and prioritize competencies that yield the highest impact on performance.

From a practical standpoint, the findings suggest that many organizations are underinvesting in foundational, yet underperforming, competencies—most notably those related to informal communication, visual clarity, and competence monitoring. Training programs should be strategically redesigned to emphasize these areas, alongside agile management practices and transformational leadership. Leadership development initiatives should integrate experiential learning, mentoring, emotional intelligence training, and structured critical thinking exercises. The IPA quadrants also provide a tangible tool for resource allocation, allowing practitioners to distinguish between competencies that require urgent attention and those that may be currently overemphasized.

6.2. Main contributions and relevance

This study offers several contributions to the project management field. First, it introduces an empirically grounded, quadrant-based diagnostic tool for prioritizing competency development. Second, it addresses both individual-level and team-level factors, bridging a gap in existing literature that often isolates project manager capabilities from team dynamics. Third, it provides a replicable methodological framework applicable in both academic and organizational settings.

The results are particularly relevant to project managers, HR professionals, training providers, certification bodies, and researchers. Practitioners can use the IPA matrix to inform targeted upskilling initiatives, while organizations may benefit from the insights when designing training pathways, job profiles, and recruitment strategies. Certification agencies and policymakers may also draw on the findings to realign curricula and standards with real-world demands.

6.3. Limitations and future research directions

Despite the methodological rigor, this study is not without limitations. The reliance on self-reported perceptions introduces the possibility of social desirability or recall bias. Future research should consider triangulating data sources through peer assessments, 360-degree evaluations, or behavioral observations to enhance validity. Additionally, the study's regional focus on Bosnia and Herzegovina, Serbia, and Montenegro may limit the generalizability of the results to broader international contexts. Expanding the dataset to include a more diverse global sample would enhance external validity and facilitate cross-cultural comparisons.

Future research should also explore the longitudinal evolution of competencies—particularly how targeted interventions influence skill acquisition over time. Comparative studies across industries and project types could help isolate contextual factors that shape competency needs. Moreover, extending the IPA framework to emerging project roles (e.g., sustainability coordinators, agile coaches) could further enrich the theoretical and practical discourse on project success in contemporary settings.

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Appendix A. Project Management Competency Questionnaire

Section 1: Demographic questions

1. Gender:
   ☐ Male ☐ Female
2. Age: _____
3. Highest level of education completed:
   ☐ High School ☐ Bachelor's Degree ☐ Master's Degree ☐ PhD
4. Does your organization have a dedicated PM unit?
   ☐ Yes ☐ No
5. Do you hold a project management certification?
   ☐ Yes ☐ No
6. Your current role:
   ☐ Project Manager ☐ Project Team Member ☐ Other: _____
7. Years of experience in project management:
   ☐ <1 ☐ 1-2 ☐ 3-5 ☐ 6-10 ☐ 11-15 ☐ 16-20 ☐ 21-30 ☐ >30
8. Number of employees in your organization:
   ☐ 1-50 ☐ 51-200 ☐ 201-500 ☐ 501-1000 ☐ >1000
9. Number of projects your organization is currently implementing:
   ☐ 1 ☐ 2-10 ☐ 11-20 ☐ 21-30 ☐ >30
10. Organizational structure:
    ☐ Organic ☐ Mechanistic ☐ Mixed

Please rate each of the following items twice: first for Importance and then for Performance, using the scale below:

1 = Not important / Not performed at all

5 = Extremely important / Performed excellently

Section 2: Communication Competencies

Competency	Importance [1–5]	Performance [1–5]
Frequent communication		
Quality communication		
Verbal communication competencies		
Visual communication competencies		
Active listening		
Informal communication		
Understanding of communication		
Formal communication channels		
Informal communication channels		
Communication with stakeholders		
Giving specific instructions		
Communicating project plan changes		

Section 2: Technical Competencies

Competency	Importance [1–5]	Performance [1–5]
Use of technology		
Establish technological solutions		
Competence control		
Manage project schedules		
Risk management		
Combine project methodologies		
Planning and managing schedules		
Set deadlines		
Assess risks, deadlines, and costs		
Manage risks		
Understand project requirements		
Solve problems		
Focus on critical technical elements		
Adapt tools and techniques		
Thorough planning and prioritization		
Integrate traditional and agile methodologies		

Section 3: Managerial Competencies

Competency	Importance [1–5]	Performance [1–5]
Conflict management		
Knowledge of available resources		
Project portfolio management		
Effective planning		
Use of management competencies		
Control and monitoring		
Coordination		
Manage agile processes		
Team management		

Section 4: Leadership Competencies

Competency	Importance [1–5]	Performance [1–5]
Human resources management		
Empowerment of employees		
Employee development		
Employee motivation		
Influence on team members		
Self-awareness		
Sensitivity		
Critical thinking		

Section 5: Project Team Input Factors

Competency	Importance [1–5]	Performance [1–5]
Leadership		
Management support		
Reward systems		
Knowledge and competencies		
Team diversity		
Clear project goals		
Management competencies		
Tools and techniques		
Personal competencies		

Section 6: Project Team Process Factors

Competency	Importance [1–5]	Performance [1–5]
Cooperation		
Communication		
Learning activities		
Cohesion		
Commitment		
Conflict resolution		
Team climate		
Team performance		

Biographical notes

Danijela Ciric Lalic is an Assistant Professor at the Faculty of Technical Sciences, University of Novi Sad, where she leads undergraduate, master, and MBA programs in Project Management. She is also the Chief Project Officer at the European Academy, Brussels. Her research focuses on project management, digital transformation, project-based education, and competency development. She has coordinated or participated in over 60 EU-funded projects.

ORCID: 0000-0002-4834-6487

Mirjana Joknovic Djajic is a Senior Assistant at the University of East Sarajevo, Production and Management Faculty Trebinje in a field of Industrial engineering. She is the author of two books and approximately 40 articles, published in domestic and foreign scientific journals, as well as at national and international scientific conferences. Also, she has participated in a few projects.

ORCID: 0000-0002-8170-0601

Miroslav D. Vujicic is a Full Professor at the Faculty of sciences, University of Novi Sad, where he teaches several courses on all study levels and is program leader for PhD in Management and Business (Tourism). He is also Co-founder and Managing Director at Minds Europe Institute for research excellence and technological advancement. His research focus is on project management, tourism, impact assessment, decision-making process and mathematical and statistical methods in research. He has coordinated or participated in over 50 EU-funded projects.

ORCID: 0000-0003-0003-7869

Sanja Kovačć- is an Associate professor at the University of Novi Sad, Faculty of Sciences, Department of Geography, Tourism and Hotel Management. She teaches subjects such as Psychology in Tourism, Quantitative and qualitative methods in tourism, Tourism Product Development and Branding Strategies, and Brand Management in tourism. Her main research interests are related to the social and psychological aspects of tourism, application of mathematical and statistical methods in various areas, project and destination management and marketing. She has published over 100 research papers, and participated over 20 international and national projects.

ORCID: 0000-0002-7623-241X

Ugljesa Marjanovic is an Associate Professor of Engineering Management at the University of Novi Sad. His work focuses on project management, innovation, and application of information technology, with research published in journals such as Information and Management and Information Systems and e-Business Management. He has led numerous international projects and serves as Editor-in-Chief of the International Journal of Industrial Engineering and Management.

ORCID: 0000-0002-8389-6927

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RESEARCH ARTICLE

Adaptive metrics in agile software development projects

João Barata
University of Coimbra, CISUC/LASI, DEI, Pólo II - Pinhal de Marrocos, 3030-290 Coimbra, Portugal, barata@dei.uc.pt

Sharon Coyle
University of Galway, J.E. Cairnes School of Business & Economics, H91 TK33 Galway, Ireland, sharon.coyle@universityofgalway.ie

Abstract

Multiple metrics are available for agile software development (ASD), but adapting them to changing conditions of ASD is a challenge. To be truly agile, the metrics must be goal-oriented, flexible, and adhere to the principles of people interactions. This paper presents the results of a multi-year action research project conducted in different companies adopting ASD. Our contribution describes the organizational routines and a framework (3View) to incorporate meaningful metrics supported in three main pillars: comparability with past projects, relevance to measuring project expectations, and adaptability to remain valid in dynamic project conditions. The proposed framework includes (1) a reference model to build metrics and (2) a process model to guide practitioners. Measures of all types of attributes in ASD can be evaluated differently, depending on the project stakeholders and lifecycle stage. Dynamic environments require adaptive metrics that guide the interpretation and directions for project development. Failure to adopt these recommendations may lead to a risk of ceremonial conformity to measurements that do not reflect practice. Our work extends the literature on ASD metrics, expanding their role as enablers of agile project assessment and transparent communication throughout the project lifecycle. It explains how ASD metrics can be adapted to fit stakeholders' perceptions while maintaining rigor and transparency in their reasoning.

Keywords

agile software development; metrics; 3View; action-research.

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1. Introduction

Information Systems project management is constantly seeking out improvements. Becoming agile is an example, requiring an iterative process of stakeholder interaction to develop better-quality products in turbulent environments (Beck et al., 2001). Therefore, multiple metrics are available to establish and monitor agile project management quality (A. Agarwal et al., 2014; Hayes et al., 2014; Kupiainen et al., 2015). For example, some authors focus on tests and quality control (A. Agarwal et al., 2014; Janus et al., 2012), product-related metrics (Kupiainen et al., 2015; Mishra et al., 2012), defects (di Bella et al., 2013), auditing (Scharff, 2011), or stakeholder expectations (Boerman et al., 2015). Despite the plethora of metrics available, there are difficulties in adopting them in dynamic project management environments (such as agile).

Quality metrics can be defined as the degree to which a system or process holds specific quality attributes (IEEE, 1998; Kaner & Bond, 2004), and several studies have addressed this topic. However, quality metrics in the context of agile software development (ASD) projects are still evolving (Colakoglu et al., 2021; Jamieson & Fallah, 2012; Kupiainen et al., 2015; Mishra et al., 2012), and some authors suggest that additional research is necessary on "extensions of metrics and analytics to accelerate best practice" (Durbin & Niederman, 2021). The dynamic principles of ASD (Beck et al., 2001) are not aligned with the vision of ceremonial conformity, which attempts to minimize inspections that can result in complacency, whereby descriptions of a system are not aligned with ongoing practice (Biazzo, 2005; Iden, 2012; Meyer & Rowan, 1977). Moreover, project agility involves many factors besides mere practices or methods, for example, stakeholder involvement and collaborative value co-creation, empowerment, team culture, and organizational factors (di Bella et al., 2013; Li et al., 2017; Sheffield & Lemétayer, 2013).

Quality is an iterative and continuous endeavor in agile project management (Dybå & Dingsøyr, 2008), focusing on interactions between individuals and the ability to be proactive in the face of change (Beck et al., 2001; Ghobadi & Mathiassen, 2016; Kropp & Meier, 2015). By definition, agility also relates to the ability to create change (Dybå & Dingsøyr, 2008), which teams may strive to achieve in a positive, quality-centric manner. Nevertheless, current quality studies in ASD projects do not explain in detail how critical reflections of the ASD team can be conducted using metrics. Moreover, it is essential to combine quantitative evidence of ASD quality with qualitative assessments, the latter of which are critical to the core principles set out in the agile manifesto (Beck et al., 2001).

Project performance indicators are extremely popular (N. Agarwal & Rathod, 2006; Heston & Phifer, 2011). Nevertheless, Kupiainen et al. (2015) found that most metrics are non-inclusive of people which is an inherent gap given the *people over process* principle embedded in agile projects pointing out that nearly 40% of the identified metrics needed to be customized. It is surprising that "the utility and appropriateness of some of the metrics that contemporary SWQATs [software quality assessment tools] implement are highly debatable [, requiring to] support the user in defining and customizing the metrics used to measure software quality" (Pfeiffer & Aaen, 2024). Our literature review confirms that process-related metrics (e.g., velocity, story-cycle time, defects removed, test coverage) and product-related metrics (e.g., functionality, portability, reliability, usability) are well-identified (Gruschwitz & Schlosser, 2012). The central gap is *how* to use them in practice in an integrated framework that involves people in process and product measurement in a way that is both flexible and trustworthy.

In this research, we follow the description of 'metric' included in the IEEE 1061 standard (IEEE, 1998), pointing to quantitative measurements of specific quality attributes that need to be interpreted, namely a "function whose inputs are software data and whose output is a single numerical value that can be interpreted as the degree to which software possesses a given attribute that affects its quality" (IEEE, 1998). However, to be socially constructed (Berger & Luckmann, 1991), metrics must be adjusted by project stakeholders, which is a challenge in minimising the risks of opportunistic manipulation. Therefore, agile metrics are not restricted to mere observation of a fact because stakeholders must (1) have

power to change their structure and construction during the entire project and (2) do not limit their role in comparing the metric to an immutable and predefined goal. Therefore, two research questions are formulated for this research:

- RQ1: How do researchers and practitioners address quality assessment and improvement in ASD projects?
- RQ2: How can project development teams develop and adapt metrics during the entire lifecycle of ASD?

To answer RQ1, we survey the state-of-the-art in agile quality and investigate the outlook of experienced ASD practitioners around quality assessment and improvement. Canonical action research (CAR) was selected to address our second research question (RQ2), building and evaluating the proposed framework (3View) to use agile metrics in a real setting. Our main objective is to adapt quality metrics that adhere to the core principles of ASD projects, incorporating approaches drawn from people, process, and outcome-related sub-factors pertaining to the project and the product (e.g., software quality and end-user satisfaction).

The following section outlines our research approach. Subsequently, we present the background literature, including a review of 69 papers on the most relevant strategies to quality management and metrics in ASD projects. It is followed by pilot findings of semi-structured interviews with ASD experts. Subsequently, we explain the proposed framework to design adaptive metrics that are socially constructed and detail two complete canonical action research cycles (Susman & Evered, 1978) conducted with a leading Information Technology (IT) supplier of healthcare information systems (HIS) and a research and technology development (RTD) institute with the mission to assist Industry 4.0 developments. The discussion follows, and our paper closes with the main conclusions, our study's limitations, and future research opportunities.

2. Methods

Our research commenced by conducting an extensive literature review (Kitchenham, 2004; Webster & Watson, 2002) to address our first research question. Kitchenham (2004) and Okoli and Schabram (2010) provide a sequence of steps to conduct comprehensive reviews, namely to (1) identify the need for the research, (2) establish a review protocol, (3) search the literature, (4) study selection and screening, (5) assess quality, (6) extract and monitor data, (7) make a synthesis, and (8) write the review.

The review pertaining to agile quality management and its metrics included journals and conference proceedings using Google Scholar, EBSCOhost, Science Direct, Web of Science, and IEEE Xplore. We started with broad search terms and progressively refined the results (Boell & Cecez-Kecmanovic, 2014), screening the titles and abstracts obtained with the search terms "agile quality" and "quality in agile". Using different databases is advantageous: Google Scholar has a broader scope but presents the most extensive lists. Additionally, this provided an opportunity to iterate the "search and acquisition circle and the wider analysis and interpretation circle" (Boell & Cecez-Kecmanovic, 2014) by comparing databases. Subsequently, we tested a combination of related search terms, for example, "agile development" + "quality metric"; "agile project" + "quality metric"; "agile development" + "quality monitoring"; and "quality improvement" + "agile practice". We also performed citation analysis (Webster & Watson, 2002) to identify related works and tested keywords related to our study, namely "agile software development" + "composite metrics". Papers that did not address quality assessment or improvement within ASD contexts and practices were excluded. We did not include books, non-English papers, tool presentations, editorials, posters, patents, keynotes, or panel conclusions. A total of 69 papers were reviewed. The most essential concepts in the literature include quality assessment in agile and agile practices for quality improvement. We subsequently identified units of analysis within each concept: (1) quality assessment in agile included process, outcome, and metrics in the form of evidence, goals, and quality indices; and (2) agile practices for quality improvement included stakeholders' interaction within agile projects and the benefits and pitfalls of agile practices for quality improvement.

Secondly, exploratory qualitative interviews (Myers & Newman, 2007) were completed in two geographically dispersed organizations (Portugal and Australia). The goal was to identify how metrics are used in practice, ascertain quality

assessment difficulties, and obtain initial insights for improving metrics. We created a script for semi-structured interview sessions, including questions for (1) company identification, (2) experience and practices of agile, (3) forms of measuring quality, (4) metrics, (5) improving agile quality, and (6) expectations for a new framework for agile quality. The authors conducted in-depth interviews, averaging two hours. Afterward, answers were discussed with interviewees and subsequently compared with findings across literature to help generate rich data (Schultze & Avital, 2011) and insights for further development.

Thirdly, the canonical form of action research was followed with a dual aim (McKay & Marshall, 2001; Susman & Evered, 1978) of creating the 3View framework to implement agile quality management using adaptive metrics and solving concrete organizational problems in two organizations. Action research is conducted "collaboratively in an immediate situation using data feedback in a cyclical process" (Hult & Lennung, 1980). Canonical action research (CAR) is one of the most popular and well-documented (Davison et al., 2004), evolving in cycles with five phases (Davison et al., 2004; Susman & Evered, 1978):

- Diagnosing, identifying, or defining the situation in collaboration between researchers and practitioners. The project participants evaluate the phenomenon and formulate a hypothesis for the subsequent phases;
- Action planning, deciding possible courses of action to improve the situation;
- Action taking, implementing the selected course of action, and trying to generate improvements in the organization;
- Evaluating actions involving a critical joint reflection by the research team;
- Specifying learning and establishing the contribution to the body of knowledge.

According to Eden and Huxham (1996), action research results must be transferable to other contexts and not be restricted to solving the case company's problem. Moreover, theory must be produced and guide the development of possible tools or methods, as planned in our work. The principles suggested by Davison et al. (2004) were used to evaluate our research: Principle of the Researcher–Client Agreement; Principle of the Cyclical Process Model; Principle of Theory; Principle of Change through Action; and Principle of Learning through Reflection.

The research team considered alternatives to CAR, namely design science research (Hevner & Chatterjee, 2010), which is particularly suited for developing innovative artifacts. However, the primary focus of our work was the analysis of the social setting. Moreover, this approach has also recently been used and verified in the context of agile software development (Kuciapski & Marcinkowski, 2023). The opportunity to collaborate closely with the practitioners in ongoing ASD projects, studying changes introduced by the 3View, was an additional motivation to select CAR.

Two organizations participated in our action research. The HIS company puts quality management at the top of its priorities. Their global presence increases pressure for short development cycles and immediate feedback to their customers and partners. The RTD institute is the second case that we address. It is an interface institution created to support the ceramic and glass industries. In recent years, Industry 4.0 has been one of the sector's priorities, requiring innovative software developments for production and quality. The institute has private and public associates, and the software development team adopts agile. These organizations were selected due to the need to comply with quality standards and receive regular audits from customers and third-party assessors, their ASD practices focusing on several projects evolving in parallel, and their motivation to test a new framework developed in collaboration by researchers and practitioners.

CAR cycles may be conducted in parallel, with benefits for case comparison, or as a sequence, when one cycle complements or extends the previous one, as in our study. The first cycle started due to the challenges of the HIS quality manager in their audits and the commitment of their team to ASD practices. The lack of documentation was a problem, and KPIs were usually available later in the development lifecycle. It was also the starting point for the literature review to

understand the research landscape of ASD metrics and approaches for their adoption in practice. However, the team's access to details about their projects was limited due to confidentiality reasons. The first cycle was sufficient to propose a reference model. Still, it lacked the details of continuous work with the ASD practitioners, which was possible in the second cycle with the RTD institute. The initial findings of our work were published in top conference publications, ICIS and ACIS (Barata & Coyle, 2016; Coyle & Barata, 2016), and substantially extended and improved for journal publication. Additional details about the settings in both companies are presented in section 5.1, explaining the diagnosis phase of our CAR.

3. Literature review

3.1. Quality assessment in agile

There is a long tradition of studying metrics for ASD, but it is also recognized that practitioners' guidance is still underdeveloped (Maddox & Walker, 2021). Different approaches have been used for their selection. It is possible to import metrics from traditional software development (TSD) approaches (Concas et al., 2012). A recent study based on four case studies suggests templates and guidelines for KPI development, although recommending a top-down approach for the implementation (Fatima et al., 2024). Still, some authors argue that TSD metrics are insufficient to evaluate progress in an iteration, releases, or feature correction rates (Mishra et al., 2012). Other authors propose a combination of TSD and agile-specific metrics (Padmini et al., 2015). The number of metrics in the literature exceeds 130 (Maddox & Walker, 2021). For example, Kupiainen et al. (2015) found 89, most quantitative and related to lead time, defects, velocity, cycle times, and burndown/burnup, among others. They are used for "Sprint and Project Planning, Sprint and Project Progress Tracking, Understanding and Improving Quality, Fixing Software Process Problems, and Motivating People" (Kupiainen et al., 2015). Interestingly, these authors found that many ASD teams customize metrics (almost 40%), and most relate to outcomes and process. More recently, Natarajan and Pichai (2024) suggest a tailored framework with eight ASD metrics, particularly aiming at the process and product levels of analysis, suggesting a continuous refinement. Surprisingly, people-centric metrics are not a priority in the literature.

Several factors are crucial to evaluate the quality of an ASD project: people (Begier, 2010; Fernández-Sanz & Misra, 2011; Ghobadi & Mathiassen, 2016), process (Hayes et al., 2014; Kupiainen et al., 2015), product (Kupiainen et al., 2015), and outcome (N. Agarwal & Rathod, 2006). The Capability Maturity Model Integration (CMMI) embodied the argument that "the quality of a system or product is highly influenced by the quality of the process used to develop and maintain it" (CMMI, 2010). Metrics in ASD have also been studied for product evaluation (Kupiainen et al., 2015; Mishra et al., 2012), testing (A. Agarwal et al., 2014; Janus et al., 2012), and software defects (di Bella et al., 2013). Nevertheless, meeting stakeholder expectations is also essential, and research confirms that a comprehensive framework to evaluate quality in ASD supported by meaningful metrics is necessary. While many studies present the metrics that can be used (Kupiainen et al., 2015; Maddox & Walker, 2021) and their integration as a pillar of evidence-based quality awareness in ASD teams (Karhapaa et al., 2024), the gap found in the literature is the question of "how to use them" in adherence to agile principles.

There are important quality measures for the outcome and process of ASD. For example, one of the few examples that address the transition from TSD to ASD is presented by Olszewska et al. (2016), who explain significant changes when shifting from a "plan-driven" way of working to agile. Product and process quality were the focus of Rauch et al. (2008) and Gruschwitz and Schlosser (2012), while Bansiya and Davis (2002) proposed an integrated index. Their model includes product-related attributes such as (among others) effectiveness, extendibility, reusability, or flexibility (Bansiya & Davis, 2002) and defines properties that can affect the attributes (e.g., complexity), defining weights for each one and its influence on each attribute. For example, higher complexity reduces understandability. Additionally, the model includes design metrics (e.g., number of methods) and required components. As before, these metrics are also quantitative, and it is now known that agile practices have social implications for the team (Koch et al., 2023). For example, the works of Alami et

al. (2022) and Machuca-Villegas et al. (2021) conclude that commitment is one of the most relevant human factors in productivity assessment and the achievement of technical excellence, the ninth principle of the agile manifesto.

Agile quality has several challenges (Alsaqaf et al., 2019); metric selection is only part of the problem (Kārkliņa & Pirta, 2018). Is it reliable even when data is available, and are we using it correctly? A study by Ram et al. (2018) identified 132 metrics, most of which were for process and product—for example, velocity, development speed, testing performance, or estimation accuracy. The authors found three main challenges for metric adoption, namely, (1) lack of data or tools to produce it, (2) changes in the process to produce required data for metrics, and (3) "lack of actionable input" or the difficulty in using metrics for decision making. Moreover, "for highly iterative or agile systems, the metrics will not remain effective forever [... with practical limitations] throughout several software iterations as the software matures and the dynamic nature of the software development process subsides". Challenges in information quality, team, or practices are well-known causes of failure in ASD estimations, and few studies exist to support practitioners in the estimation efforts. New solutions for the effective use of metrics are therefore needed.

Stakeholder interaction in ASD is important to understand the impact of improvement actions and the acquisition and sharing of tacit knowledge (Ryan & O'Connor, 2013) during communication and the implementation of agile practices (Hummel et al., 2015). More "social metrics" like "team capabilities" or "user involvement" are needed to assess and improve quality in ASD. These metrics can address people's behavior and assess communications or aspects of interactions (Dorairaj et al., 2012; Gren et al., 2015; Ibrahim et al., 2010; Wiese et al., 2014). Examples include technology awareness and customer collaboration, empowerment, personal skills, or motivation (di Bella et al., 2013; Tseng & Lin, 2011). Several years ago it was stated that "[t]here is an obvious need for more scientific evidence and further research to understand the requirements of agile quality [operating] in different cultural and social contexts" (Siakas & Siakas, 2007), but companies are still looking for an integrated solution for agile quality management (Jain et al., 2016).

Quality in ASD is a continuous endeavor from the early phases (such as requirements identification and risk analysis), during the development, and after the software delivery. However, metrics do not have the same importance in each phase of the development process (Almeida & Carneiro, 2023), and "more work is needed to reach the point where a maturity model with quantitative data can be said to validly measure agility, and even then, such a measurement still needs to include some deeper analysis with cultural and contextual items" (Gren et al., 2015).

3.2. Agile practices for quality management and improvement

Quality management includes social and technical aspects. A vigorous quality culture is based on customer focus, evidence-based decisions, the involvement of people, and continuous improvement, which is aligned with agile (Stålhane & Hanssen, 2008). For example, the belief in continuous improvement is rooted in retrospective meetings (Babb et al., 2014; McHugh et al., 2012). In highly regulated projects, however, different quality standards and improvement frameworks (like ISO 9001 or ITIL) are adopted in agile environments (Torrecilla-Salinas et al., 2019). For example, Stålhane and Hanssen (2008) highlight documentation difficulties when combining agile and ISO 9001. There exists an inherent tension between growing pressures to adopt agile while simultaneously and harmoniously trying to align such explorative agile practices with highly regulated, often quantitatively focused practices.

There are essential approaches for integrating quality in agile practices. For example, the model presented by Hongying and Cheng (2011) includes 20 key areas for quality assurance in ASD. They identify best practices for each area and a maturity model. The 3C proposal combines metrics and continuous integration (Janus et al., 2012), while Sidky et al. (2007) propose two components for agile quality, namely, (1) an agile adoption index for the principles of "Embrace change to deliver customer value", "Plan and deliver software frequently", "Human centric", "Technical excellence", and "Customer collaboration", and (2) an agile adoption process starting with the identification of factors that can prevent agile success, conduct a project and organizational readiness assessment, and reconciliation to ensure that the required practices are implemented for the project.

End-user feedback can be obtained in different phases of the ASD lifecycle (Hayes et al., 2014). In addition, Baxter and Sommerville (2011) support that the product owner "needs to be extended to consider a broader set of system stakeholders". Nevertheless, ASD and traditional approaches are dissimilar: "the traditional approach of tracking progress against a pre-made plan and measurable goals conflicts with the Agile value of embracing the change [... and its] rather comprehensive set of metrics, which does not align well with the Agile principle of simplicity" (Kupiainen et al., 2015). Research has indicated that when comparing a "waterfall" process to "agile", development performance and product quality are far superior in agile (Tarhan & Yilmaz, 2014), highlighting attempts by agile methodologies to embed quality efforts into processes that are iteratively evaluated.

Agile methodologies may improve quality (Boerman et al., 2015; Jamieson & Fallah, 2012; Torrecilla-Salinas et al., 2019). However, there are different views of quality to consider: (1) quality as excellence, usually requiring a standard; (2) quality as value, including the cost-benefit analysis of quality; (3) quality as conformance with specifications; and (4) quality as meeting or exceeding the expectations of stakeholders. In ASD, "quality as conformance" addresses software quality metrics and requirements satisfaction. However, there are also quality principles and standards ("quality as excellence") and the potential benefits provided by utilizing agile techniques ("quality as value"). Nevertheless, as Kaner and Bond (2004) stated, "there are too many simplistic metrics that do not capture the essence of whatever it is that they are supposed to measure." They are also used "after the fact" and are difficult to apply in iterative and adaptive environments.

Retrospective meetings are an essential ASD practice, pushing continuous improvement. However, development pressures can make this task difficult in practice (Babb et al., 2014; McHugh et al., 2011). Artifacts and guiding steps for retrospective meetings have advantages (Péraire & Sedano, 2014), supporting the reflection about previous iterations and future practices. For example, dashboards can be a valuable tool to present metrics to ASD teams (Boon et al., 2023). Hayes et al. (2014) emphasize quality practices in the early project phases and the potential for the later stages to include documenting and user stories. Quality concerns appear in the early stages of agile projects, proceed in the complete documentation of user stories, and "can be supplemented with a more direct measure of customer-perceived value—using customer satisfaction feedback" (Hayes et al., 2014). There is a need to incorporate adaptive quality practices with traditional techniques that are relevant and suitable for ASD projects (Salo & Abrahamsson, 2007). Fig. 1 presents the main quality touchpoints in ASD.

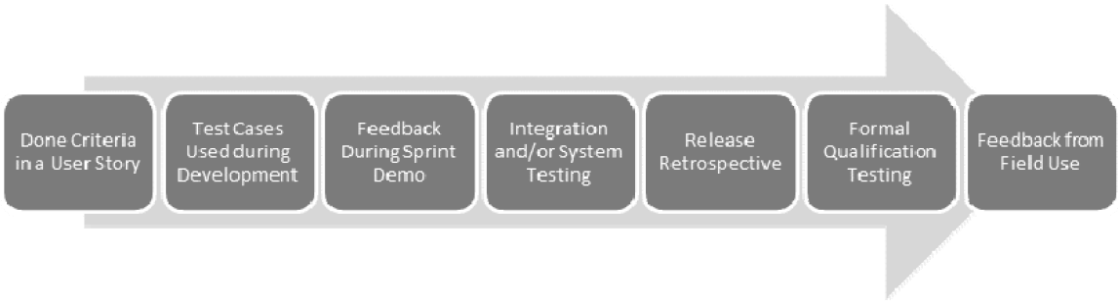


Fig. 1. Important touch-points for quality in agile projects (adapted from Hayes et al. (2014))

As Baxter and Sommerville (2011) put it, it is necessary to extend the notion of requirements ownership to multiple stakeholders in ASD. Moreover, constant pressures can make reflection and analysis difficult (Babb et al., 2014; McHugh et al., 2011), and ASD projects present different challenges when compared to traditional approaches, namely, "the traditional approach of tracking progress against a pre-made plan and measurable goals conflicts with the Agile value of embracing the change [... and its] rather comprehensive set of metrics, which does not align well with the Agile principle of simplicity" (Kupiainen et al., 2015). Measuring defects or functionality issues is insufficient in agile projects (Hayes et al., 2014).

Backlogs and quantitative metrics are essential for assessing past projects or tasks, but are limited in supporting a proactive stance or efforts for continuous improvements. In fact, in "an ever-changing world, such an approach [methods that only focus on analysing and evaluating past actions] bears the risk of producing pictures of a moving target without providing a substantial orientation for change" (van der Aalst et al., 2018). Moreover, agile teams must be able to autonomously interpret metrics and use them in ongoing decision-making processes. In ASD projects, there are daily opportunities to do this due to intense stakeholder interactions among developers, facilitators, testers, and end-user representatives. Ghobadi and Mathiassen (2016) suggest this approach when addressing knowledge-sharing barriers in agile projects and stress that different roles must be considered to overcome communication gaps and promote a common understanding in the team. Despite this, we could not find any literature guidelines for fostering quality assessment and evaluation techniques in ASD projects that incorporate ongoing qualitative criteria with quantitative measures such as defects, velocity, or cycle time.

4. Preparing a frame of reference for action research: pilot interviews

The research team conducted semi-structured interviews (Myers & Newman, 2007) in two organizations (anonymized) adopting ASD, selected from our contacts list. The HIS company indicated an interest in improving its quality metrics, and the consulting company had extensive experience in delivering agile projects. The case companies are presented in Table 1.

Table 1. Qualitative interviews

	HIS company	*Consulting company*
Industry	Healthcare Information Systems	Software Consultancy
Employees	60	230
Interviewee	Quality manager	Senior Developer
Agile practices	Scrum	Scrum; Kanban
Quality Standards	ISO 9001:2015; NP 4457 for innovation management; multiple healthcare standards	None specified

The HIS company is a European software provider of healthcare for hospitals and clinics, founded more than 30 years ago. They serve over 100.000 users and 25 million clinical processes. When we interviewed their quality manager, she was preparing the external audit for ISO 9001. According to the quality manager, the company "has numerous indicators; however, only a few are valid for agile quality". Sometimes, "the numbers are highly dependent on the context and must be carefully interpreted". In other cases, "[she] does not think it fair to establish goals, for example, regarding the number of defects or features implemented; these metrics depend on multiple factors". Agile quality is challenging because "40% of our major customers [representing 80% of the income] require quality indicators and evidence for each iteration, due to the critical nature of healthcare IT".

A lack of suitable implementation of retrospectives contributed to "difficulties in creating improvement on our project and without appropriate communications we are not sharing the knowledge which is a critical aspect of our business due to the complexity of product lines". The interviewee also pointed to the importance of being able to change metrics for each project or team in an "agile way". Quality metrics can be used to build appealing dashboards, "but we need to assess

and improve quality [...not] metrics that do not correspond with practice". Even worse, "template" metrics "and unrealistic goals can reduce the team's commitment to quality during agile projects".

Interestingly, when discussing social metrics, the answer was that: "in my previous work, our motivation was evaluated by top managers on a quantitative scale ranging from 1 to 5... How could they know my motivation or the factors affecting it? I hated to be evaluated that way". When we asked how user intervention might assist in constructing metrics, she stated how "this would be a very useful, inclusive approach and has the potential to address our main issues of knowledge sharing, obtaining quality evidence for our team and external audits, re-invigorating our retrospectives, providing support for weekly meetings and customer request, and "provide meaning" to our agile numbers, according to the team's perspective".

Founded fifteen years ago, the Consulting company is a geographically dispersed firm that helps clients develop innovative software projects. Our interviewee has over eight years of experience working on ASD projects across many sectors in the consulting industry and stated that when it comes to measuring quality in agile, "the biggest and most important test is what the user thinks", highlighting the importance of user involvement in quality evaluation. In particular, this research participant described three quality metrics. The first relates to setting benchmarks for quality at the start of the project, which is "extremely difficult to do when you have nothing to compare it to", but in his opinion, "mature teams (in performing stages) are much better at doing this". The second relates to "comparison exercises that we do; so we compare the latest increment against the previous one", and finally, "our centralized continuous integration server runs automated tests, which is a very good way of measuring software quality". However, the interviewee stressed that "even when each of those metrics shows us very positive results, if the user is not happy, then we still have not reached our quality pinnacle". This shows that quantitative-driven assessments alone are not complete quality indicators for agile projects.

When we asked about social metrics, they "could see this making a lot of sense and a huge difference for our agile projects, but then...how we apply those metrics in the context of teams during storming or norming stages is the challenge because these teams often have misaligned observations for quality assessment". This highlights the challenges of our research effort, but also the importance and benefits of including adaptive metrics for assessing quality in ASD teams while simultaneously raising quality awareness.

5. Implementing agile quality management: insights from action research

This section follows the steps proposed by Susman and Evered (1978). Next, we describe the starting point in each case and the action plan, followed by field results. The action research evaluation in section 5.3 alludes to the guiding principles proposed by Davison et al. (2004).

5.1. Diagnosing and action planning

The diagnosis in the HIS company included the interview with the quality manager described in Section 4, document collection, and meetings with the IT infrastructure manager. Our literature review proceeded throughout the research to identify best practices for ascertaining quality and metrics (Section 3).

The cycle in the RTD institute started one year later, and the first version of the framework was already available. We interviewed a small team of three software developers and a manager of the software development unit. The context of this case is radically different because software development is only one of the priority areas in the case organization (which also includes laboratories, management consulting, and research and development, with several ongoing European co-funded projects). Only a few metrics exist, and according to the most senior software developer, "we have a vast background in using the balanced scorecard, risk-based thinking, and agile metrics; however, measurements are only one part of the equation (...) how do you use them to improve our work? Who evaluates what is good or not – in some cases, she adds, the people who look at the metrics do not understand the numbers. What are the consequences – especially if

only some of us are contributing to the results?". Moreover, the team told us that it was challenging to keep their quality platforms updated (project documentation, version control, customers' meetings), so they prefer only a few metrics but "with a script that allows others to read them properly and produce real results".

The first CAR cycle (CAR#1) with the HIS company included the activities of model creation for metrics adaptation, identification of measures that could be applied for each metric type (people, process, outcome), and defining how metrics should be calculated. According to three dimensions of (1) evidence from practice, (2) stakeholders' expectations, and (3) stakeholders' evaluation, a valuable tool for daily meetings, retrospectives, and audits can be developed.

The limitations found in the first cycle were a starting point for planning the next. It was also an opportunity to test and refine the proposed framework in a different setting. Secondly, we wanted to include other stakeholders in our study (as the first cycle only involved the researchers and the selected company managers), namely, auditors, partners, and customers. Therefore, the second CAR cycle (CAR#2) with the RTD institute started one year later, when the first version of the 3View framework had already been created. Our action plan in this case was to:

- Evaluate the 3View framework in different settings with other types of software products and organizational structures;
- Produce data that organizations can use to (self-) evaluate their quality in ASD and the efficacy of improvement actions by comparing how the indicators change over time;
- Investigate the changes (e.g., knowledge transfer, team motivation) involved in adopting the metric in daily meetings, retrospectives, and audits.

5.2. Action taking: a collaborative framework for agile quality management

The next section presents the final version of the proposed 3View framework, followed by a description of its development in CAR#1 (5.2.2) and CAR#2 (5.2.3).

5.2.1 The 3View framework for agile quality management

For our research, a metric is socially constructed when stakeholders can alter its structure and critically evaluate its results. In this context, stakeholders' perceptions are innate to metric construction. Unlike traditional approaches, which compare against predefined goals (e.g., number of defects below X% when compared to lines of code), stakeholders are not extracted from the process or only included at the end. They are involved in metric construction.

Two main artifacts were created to support the practitioners in 3View adoption, namely, (1) a reference model explaining the quantitative assessment and (2) a process model. The 3View reference model includes three dimensions in adaptive metrics for ASD, namely (1) evidence from practice, (2) stakeholders' expectations, and (3) stakeholders' evaluation. It is non-prescriptive about the types of measures that can be socially constructed. Therefore, it may potentially apply to any measurement selected by agile teams. Quantitative data must be enriched with contextual and cultural issues (Gren et al., 2015). On the one hand, we follow numerous authors (Bansiya & Davis, 2002; Janus et al., 2012; Sidky et al., 2007) in the quest to obtain metrics for quality assessment as an essential step of ASD quality improvement. On the other hand, we show how to assess and discuss improvements in ASD projects simultaneously. Metric construction should be a moment of critical reflection in ASD teams (Hodgson & Briand, 2013) and can potentially increase team commitment in ascertaining quality.

The insights obtained in our literature review, pilot interviews, and the CAR action suggest that a comprehensive assessment of agile quality requires three main types of metrics, represented to the left of Fig. 2, people-oriented, process-oriented, and outcome-oriented, summarizing the 3View reference model. Fig. 3 depicts the process.

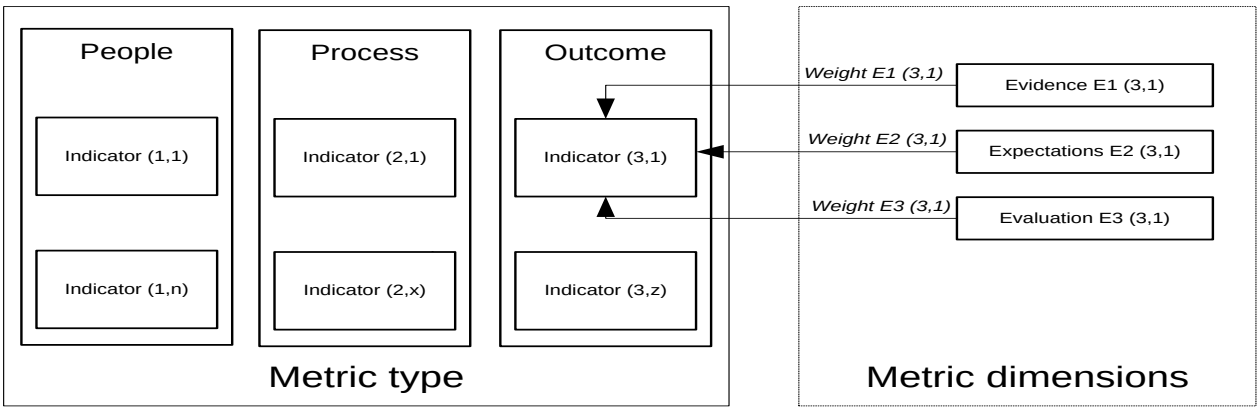


Fig. 2. The 3View reference model

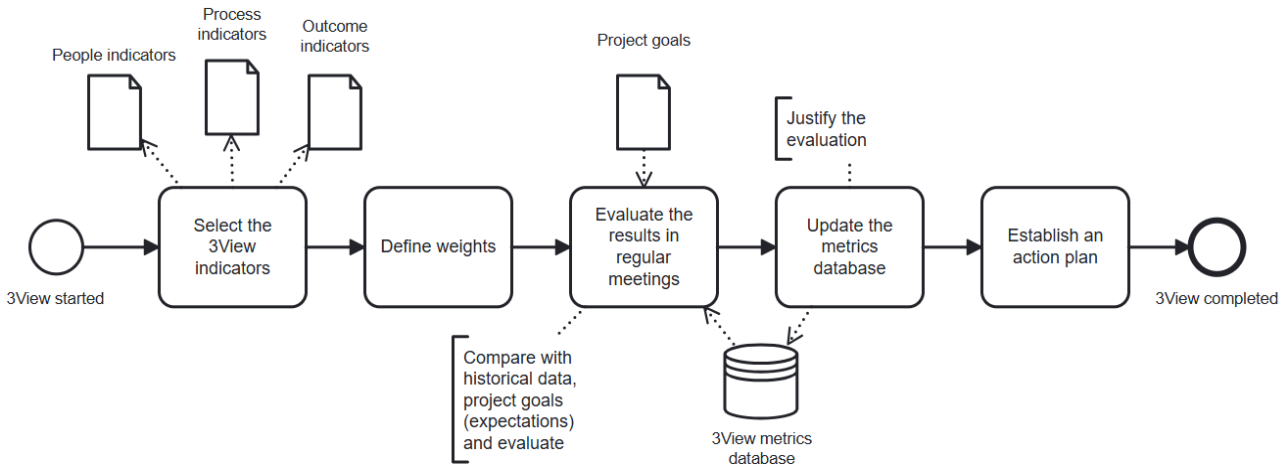


Fig. 3. The 3View process model

The process starts with stakeholders selecting the indicators (step 1). Identifying specific indicators for use in each type is outside the scope of this research. The creation of adaptive metrics occurs in step 2. Each one is weighted according to the three dimensions of (E1) evidence, (E2) expectations, and (E3) evaluation. The resulting value for the indicator is a weighted average (step 3). It will include a comparison with past results to identify if improvement occurred (E1), with the expected result according to the stakeholders' initial plan (E2), and a critical analysis performed by the agile team (E3). The reasons for grading need to be recorded, and a database of metrics, or "metadata," about the assessment and the decisions taken needs to be created.

These steps aim to sketch a pattern for action to encourage a reference framework for a metrics program (Oza & Korkala, 2012). Nevertheless, "it is not sufficient to merely collect all possible metrics, but driving the culture of continuous measurement is imperative" (Oza & Korkala, 2012). Socially-constructed metrics integrate project evidence or a comparison with predetermined goals while adding context-bound interpretation, critical reflection, and evaluation provided by the stakeholders. The project participants decide the weights of each dimension (W1 to W3). Each weight can vary from 0 to 1, and the three weights total (W1+W2+W3) must be calculated.

Fig. 4 presents an example of grading an indicator of "customer complaints" during an ASD project.

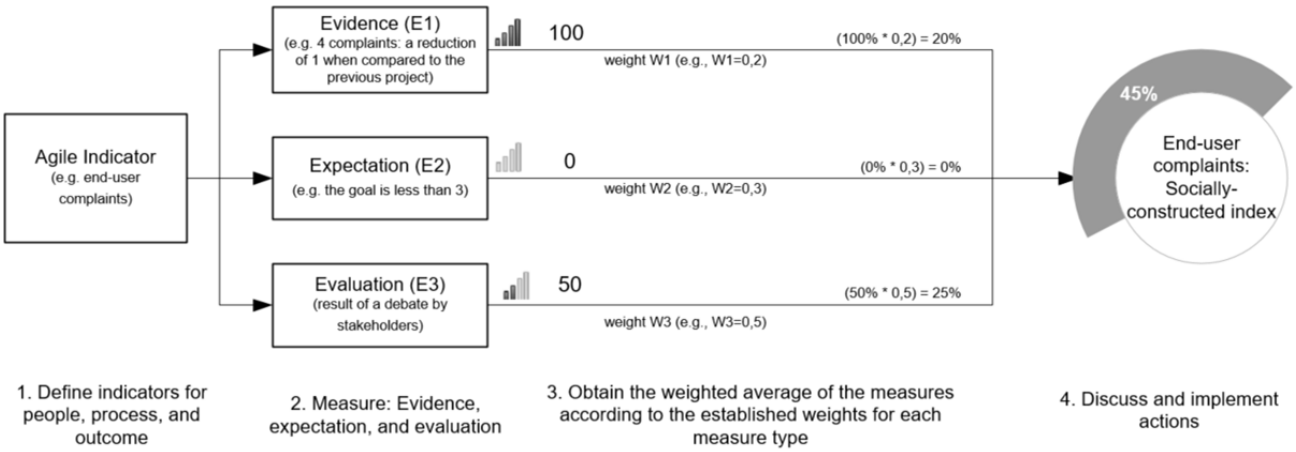


Fig. 4. Example of an adaptive metric for customer complaints

In the case we illustrate in Fig. 4, the team considered that complaints are highly variable according to multiple factors, including the project type. Therefore, they decided that for the weights W1 (evidence) = 0.2; W2 (expectation) = 0.3; and W3 (evaluation) = 0.5, the result would be evidence (100%*0.2) + expectation (0%*0.3) + evaluation (50%*0.5) = 45% as represented. We used the suggestions in Table 2 to weigh the dimensions of each selected indicator, while Table 3 describes evaluation guidelines.

Table 2. Three dimensions of adaptive metrics for ASD and guidelines for weighting

	Definition	Potential ways to consider weightings	How it was calculated in Fig. 4
Evidence	Quality is based on facts. Evidence represents the indicator's practical improvement compared to the backlog.	The weight can be higher if the indicator is not significantly affected by uncontrolled aspects.	According to the indicator's history, if the current project has 4 complaints and the previous 5, then the indicator is 100% (improvement occurred).
Expectations	In agile development, there are goals to achieve. These include technical goals (e.g., reducing defects), social goals (e.g., improving motivation), and others.	The weight can be higher if stakeholders' decisions mainly influence the indicator.	The team defines less than 3 complaints as a goal. In this case, it was above (4), so the expectation indicator would have the value "0%" (did not improve). We use 3 grades (success 100%, more or less 50%, unsuccessful 0%), but it could be a continuous scale.
Evaluation	Agile quality requires reflection and debate (e.g., about the meaning of the data) and the identification of lessons learned.	The weight can be higher if the indicator is not consensual or highly variable according to external factors.	The team agrees that the end-user was difficult, so 4 complaints in this case are a success (the reverse could also occur). However, they agree that improvement is necessary. They allocate 50% to evaluation.

Table 3. How to calculate the dimensions of each Indicator

	0 (regression)	50 (no improvement)	100 (clear improvement)
Evidence	Worse than the last measurement	Similar to the previous result	Better than the previous measurement
Expectations	Below expectations	Within expectations	Better than expected
Evaluation	Negative opinion	Neutral opinion	Positive opinion

Combining the three forms of grading that need to be justified by the team, we reach a balanced index that includes evidence comparing past results of similar projects, conformance to expectations (goals), and ensures debate and critical evaluation of the results. Moreover, it is participative, aiming to build adaptive metrics that can be tailored in the early phases of ASD. These are helpful during project execution and provide valuable insights for retrospectives.

5.3. Results in CAR#1

The 3View framework introduced in Section 5.2.1 was initially tested during this cycle. Therefore, our priorities were designing the weighting reference model, building and creating tools to adopt it in practice, and evaluating its applicability. Figs. 5-7 present the tool developed for adopting 3View in practice.

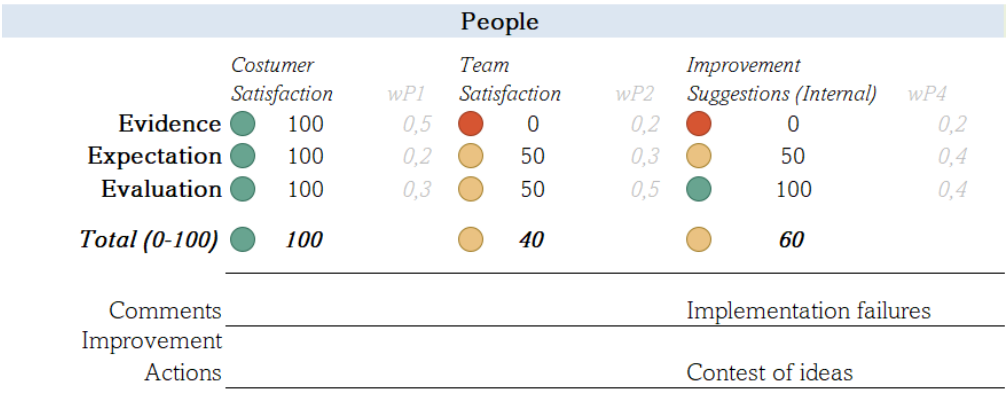


Fig. 5. Agile metrics – template for people (corrective actions omitted for the sake of simplicity)

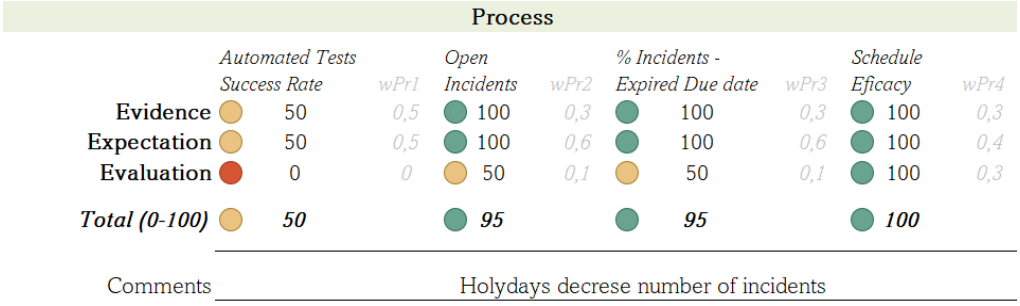
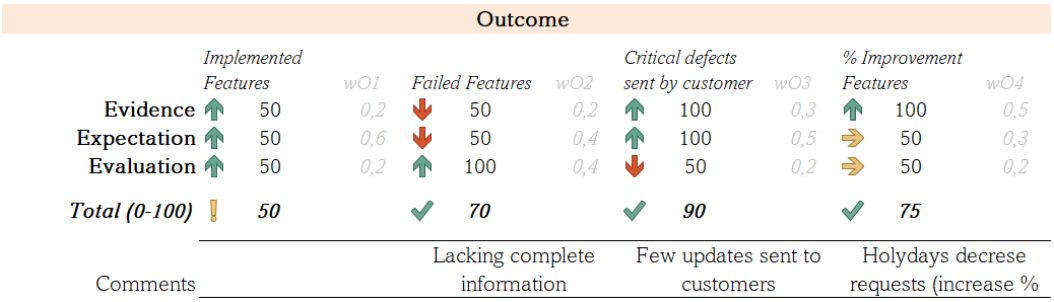


Fig. 6. Agile metrics – template for process



Outcome								
	Implemented Features	*wO1*	*Failed Features*	*wO2*	*Critical defects sent by customer*	*wO3*	*% Improvement Features*	*wO4*
Evidence	50	*0,2*	50	*0,2*	100	*0,3*	100	*0,5*
Expectation	50	*0,6*	50	*0,4*	100	*0,5*	50	*0,3*
Evaluation	50	*0,2*	100	*0,4*	50	*0,2*	50	*0,2*
Total (0-100)	***50***		***70***		***90***		***75***	
Comments			Lacking complete information		Few updates sent to customers		Holydays decrese requests (increase %	

Fig. 7. Agile metrics – template for outcome

The initial problems appeared when we needed to select indicators for agile quality. The research team established the rule that each type of metric should have at least one indicator. Then, the team proposed weights for the dimensions of evidence, expectation, and evaluation for each one.

Figs. 5-7 include tables created to assess our agile metrics. We selected three for people (the team provided the columns: customer satisfaction, team satisfaction improvement, suggestions (internal)), four indicators for the process (Fig. 6), and another four concerning outcome (Fig. 7). The aggregated result of each adaptive metric (line Total ranging from 0 to 100) in each figure is a weighted average. For example, for "customer satisfaction" in Fig. 5 (column 1), evidence is weighted 0.5, expectation 0.2, and evaluation 0.3. We decided not to use a continuous scale to simplify evaluation. Therefore, each dimension can have a measure of 100 (clear improvement), 50 (no improvement), and 0 (regression). The project participants can comment on the results and propose actions that remain in the table if they are active. Proposing new metrics is out of the scope of our study; our proposal is a new way to evaluate them in a three-dimensional space.

On analyzing the "process" metric in Fig. 6, indicators relating to "Open Incidents" and "% Incidents - expired due date"; initially, there was a decrease in both indicators for the last week ("100" for evidence), and it was clearly below their established target ("100" for expectations). Still, the team highlighted that customer holidays usually have fewer incidents, so their number and percentage allocations are not justifiably comparable with other periods. They considered this as "normal" but not excellent, the latter of which would be interpreted if we only looked at the quantitative value compared to a pre-determined target. Outcome-related metrics (Fig. 7) are also insightful. For example, on initial inspection, "failed features" presented worrying results, but the reason attributed to this was external to the team (problems in information completeness).

Another example is "critical defects sent by customers" that improved compared to the target (expectation) and past values (evidence), but the team attributed this to a reduction in system updates. Finally, the "% of improvement features" increased compared to previous periods ("100" in evidence) while still not on target ("50" in expectations). The percentage increased because the total number of features decreased, making the number of improvements more significant in that situation.

This cycle was a starting point, but understanding the changes in different settings was necessary. The company auditors were enthusiastic about this proposal because it could provide evidence of improvement and individuals' commitment to improvement. The next cycle allowed tool testing over several months with a deeper evaluation of the internal and external effects on the organization.

5.3.1 Results in CAR#2

The artifacts created in CAR#1 were used from the beginning of our intervention in the RTD institute (CAR#2). The company selected two ASD projects. The team decided to adopt the same indicators and weighting formula of CAR#1 to simplify

the cycle initiation in practice, and were eager to ascertain whether the selected indicators were also applicable to them. One of the projects was the implementation of mobile platforms in a food company (A), and the other (B), also mobile, in a paper manufacturing company (apps for manufacturing). The projects are summarized in Table 4.

Table 4. ASD projects

	Project A	Project B
Industry	Food	Paper
Goal	Mobile applications for document management and quality control in food production lines: mobile audit tool for IFS and BRC standard (BRC, 2015; IFS, 2012)	Mobile applications for production, maintenance, and quality data
Team	3 (6 months)	4 (12 months)
Agile practices	Scrum	Scrum

Fig. 8 presents an excerpt of the results obtained for "Project A" during four sprints.

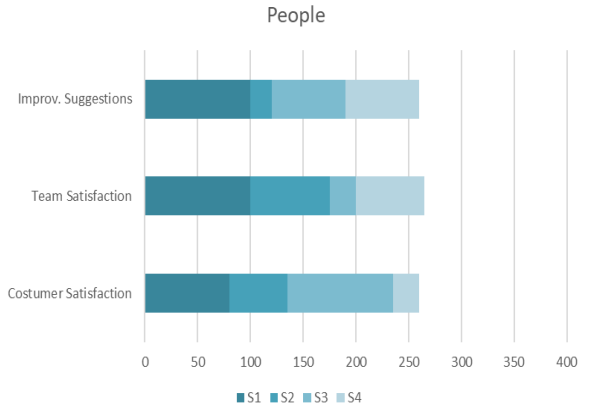
			People			Process				Outcome			
			Costumer Satisfaction	*Team Satisfaction*	*Improvement Suggestions (Internal)*	*Automated Tests Success Rate*	*Open Incidents*	*% Incidents - Expired Due date*	*Schedule Eficacy*	*Implemented Features*	*Failed Features*	*Critical defects sent by customer*	*% Improvement Features*
S1	*Evidence*												
	Expectation		50	100	100	50	50	50	0	100	100	50	100
	Evaluation		100	100	100		0	50	50	100	100	100	50
	Total (0-100)		***80***	***100***	***100***	***50***	***40***	***50***	***20***	***100***	***100***	***65***	***80***
S2	*Evidence*		50	50	0	50	100	50	50	100	0	0	0
	Expectation		0	50	0	50	50	50	50	100	50	0	50
	Evaluation		100	100	50		50	100	50	100	0	50	0
	Total (0-100)		***55***	***75***	***20***	***50***	***65***	***55***	***50***	***100***	***20***	***10***	***15***
S3	*Evidence*		50	0	50	100	50	100	50	0	50	100	100
	Expectation		100	0	100	100	50	100	50	50	50	50	50
	Evaluation		100	50	50		0	100	50	100	50	100	50
	Total (0-100)		***75***		***70***	***100***	***45***	***100***	***50***	***50***	***50***	***75***	***75***
S4	*Evidence*		0	50	50	0	50	0	50	100	100	50	50
	Expectation		50	100	50	50	100	50	100	50	50	50	100
	Evaluation		50	50	100		50	100	100	100	50	50	100
	Total (0-100)			***65***	***70***		***80***	***40***	***85***	***70***	***60***	***50***	***75***

Fig. 8. 3View Applied to four sprints – project A (excerpt)

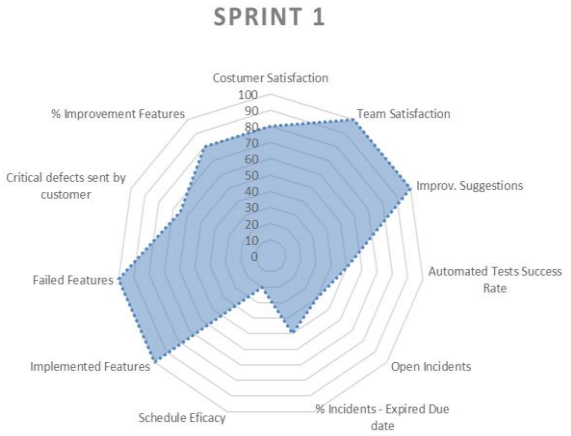
The first column in Fig. 8 presents the four sprints with the following goals: S1 - Audit Management, S2 - Audit Checklist, S3 - Actions System, and S4 - Audit Analytics. The four elements delivered in Project A are part of the mobile audit system for the food industry. The evidence grades for S1 were not considered in this case due to the lack of previous values. The other grades follow the procedure described in the earlier sections. Fig. 9 presents a sample of useful analytic reports based on the adaptive metrics approach.

CAR#2 focused on using adaptive metrics to make social and organizational changes. One of the researchers participated regularly in the project meetings to evaluate the debate and understand how the metrics evolved in each sprint. The team considered the tools simple to use, and the results were generally positive. According to a food auditor in Project A, the tables provide a guide to interpreting raw data for improvement, and (...) the metadata is a possible way to assess the employee's commitment to quality principles. Also, the developers considered the framework accessible in their projects

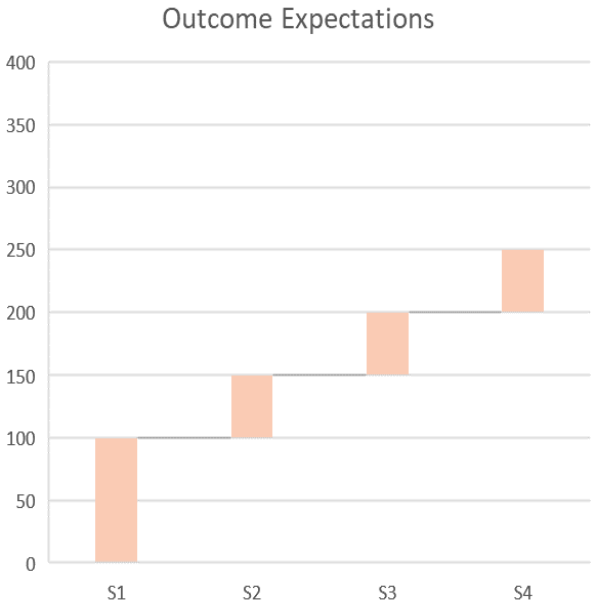
– it does not increase bureaucracy and is flexible to change. The major shortcoming, as expected, was the necessity to have metadata generated during the artifacts' evaluation. However, the research team, the scrum master, and the customer considered this an advantage to improve project documentation. During this cycle, we also asked the customers in both projects to fill in the tables presented in Fig. 8, allowing for contrasting perspectives (only accessing a part of the indicators) with the team. A deeper discussion of these findings is presented in Section 6.



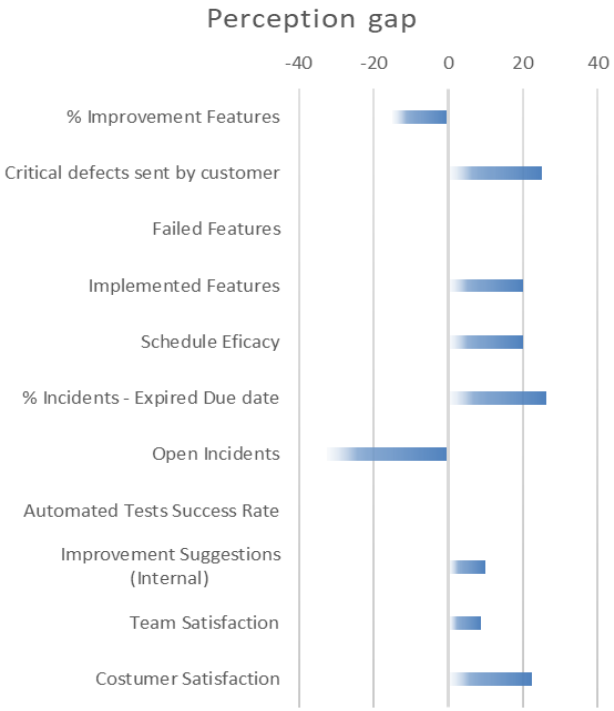
Agile quality – People dimension evolution in four sprints (S1-S4, maximum 400)



Radar chart of the results in S1 (totals)



Evolution of outcome expectations in four sprints – burnup chart for a maximum of 400 (100 for each sprint)



Average difference between grades of evaluation and total in four sprints (the team evaluated higher in most cases)

Fig. 9. 3View analytics (sample)

5.4. Evaluating the two CAR cycles

This section is structured according to the principles presented by Davison et al. (2004):

- Principle of the Researcher–Client Agreement

Researchers and practitioners agreed that CAR was an appropriate approach to studying socially constructed metrics in practice. The participating organizations explicitly committed to the project and adopted our proposed solutions within their teams. Their objective was to improve quality assessment using meaningful metrics that they could apply to their project. Interviews, observation, and document collection were used.

- Principle of the Cyclical Process Model

This research followed the five stages of CAR (Susman & Evered, 1978). We created our frame of reference with a literature review and semi-structured interviews that were discussed at top-tiered information systems conferences (Barata & Coyle, 2016; Coyle & Barata, 2016). Next, we made a diagnosis of the situation in each company. The researchers and the quality manager developed an action plan and evaluated it according to CAR principles. The framework outlined in CAR#1 served as the starting point for CAR#2.

- Principle of Theory

Our theoretical frame of reference included studies in agile metrics and models for quality improvement. The academic contribution of this work is an agile framework for using metrics that introduce flexibility in their selection and weightings (Li et al., 2017). Moreover, we follow a human-centric approach to metric adaptation, fostering continuous interaction and debate to accommodate variable factors.

- Principle of Change through Action

First, we created an innovative way of using and calculating metrics, including self-evaluation within a metric structure. We created artifacts and promoted routines to guide the development team and other stakeholders. The organizational situation was evaluated before, during, and after the intervention, ensuring the research team documented and evaluated change. Changes occurred internally with the use of the 3View artifacts and externally when we asked the customer to complete the tables at the end of each sprint. The customer found the proposal interesting to give feedback to the team and allow them to evaluate the possible interpretation gaps. In particular, customer satisfaction, schedule efficacy, and critical defects were the customer-included comments regarding the interpretation of metrics.

- Principle of Learning through Reflection

This principle was applied in different CAR stages. Joint reflection ensured that our results would be relevant, helped to improve the client's situation, and ensured project success. Progress reports were provided to the participating organizations. We learned about the benefits and the challenges of our framework, emerging from critical analysis and adaptive agile metrics that required justification. New questions were also addressed in future work, more restricted to each organization's strategy. For example, "Should we create rules to enforce corrective actions below value X? Should we enforce explanations if the evaluation differs from the other two dimensions (e.g., evaluation 0 when the other dimensions receive 100)?"

6. Discussion

We can conclude that traditional singular perspectives on quality are neither sufficient nor practical for ASD. We found that it is necessary to obtain synergies from *evidence* that emerges from ASD practices, *expectations* expressed in the form of goals, and *evaluation* resulting from a critical reflection. Combining different perspectives can promote sensemaking (Weick et al., 2005) and a debate about improvement actions supported by more meaningful metrics. Our work extends recent research focusing on the methods and tools of quality evaluation in ASD (Fatima et al., 2024; Pfeiffer & Aaen, 2024), studying the co-creation of metrics that include a subjective component in their structure and measurement process.

The first cycle, aiming at unraveling socially constructed metrics for agile, has encountered some challenges. First, regarding selecting measures for people, process, and outcome, the team looked across the literature and within the organization. For simplicity, we reduced the number of indicators to four for each metric type and selected indicators relevant to the project priorities. However, the set of indicators can be adapted according to each company and project's characteristics, which are aligned with the needs of ASD. Allocating weight to each dimension of the indicator and its grading was not straightforward. In this case, the project managers selected the weights. Still, it is possible to use a more inclusive approach, like a workshop, to define the indicators and weights according to the guidelines presented in Tables 1 and 2. Moreover, the first CAR cycle allowed us to identify a possible solution for one of the main challenges put forward by Ram et al. (2018), namely, when "a company is uncertain about that metric's potential in providing actionable inputs". 3View actionable inputs emerge from the deeper evaluation of the three metric components, two based on evidence, and the other obtained by subjective evaluation.

Allocating values to each indicator later opened up discussions that were considered invaluable to the teams. We concluded that the weighted value of the indicator (60) in Fig. 5 is the least important compared to the debate that included the search for solutions and open communication among team members and management. This conclusion is aligned with the importance of commitment (Alami et al., 2022; Machuca-Villegas et al., 2021). The participants also felt more empowered, taking part in the decisions based on project evidence (Karhapaa et al., 2024), and were flexible enough to adapt to the context. Additionally, the practitioners in CAR#2 stated that one of the most important aspects of 3View is to offer an opportunity to share different viewpoints and conflicting perspectives on the development performance.

We address additional key challenges for ASD metrics in the second CAR cycle, namely, the availability of data sources and process changes (Ram et al., 2018), but also to make templates useful for practice (Durbin & Niederman, 2021). It includes (1) how agile teams define the relative importance of each dimension of the metric; (2) the potential advantages of our adaptive metrics when compared with "traditional" metrics; (3) the potential conflicts that can emerge in the debate and construction of metrics, and how to solve them; (4) the potential difficulties of metrics that require metadata – because there is a combination of evidence, expectations and critical evaluation of stakeholders; and finally, (5) the benefits of socially-constructed metrics for improving communication between different stakeholders, for example, in daily meetings, retrospectives or quality audits.

The main advantages of adopting the framework in CAR#2 were (1) to guide the regular meetings during project development, (2) to provide concrete guidance to interpret quantitative measures, (3) to produce metadata to the selected metrics (e.g., justification of evaluations), (4) assist in the interaction with customers, offering a detailed description of each sprint, (5) identify preventive actions to discuss with the client, and (6) improve ASD reporting, minimizing the effort. The latter is particularly relevant when studies confirm reporting as one of the critical challenges in ASD (Schüll et al., 2023). Curiously, one of the advantages of 3View framework is also its main difficulty, namely, metrics metadata. Adaptive metrics, as we propose, are inherently subjective and specific to the project context. Although it is possible to identify trends (e.g., positive evolution of evidence, expectations, or evaluations) and global assessment (e.g., if most metrics have satisfactory results), the rationale behind each evaluation is not clear from the data alone. Each number (e.g., 50 or 100)

has a particular meaning (e.g., comparing the expected goal for that metric and the actual result). The interpretation must contrast the metric metadata and the results.

The customers of projects A and B (CAR#2) found the approach interesting and complementary to specific approaches to quality (e.g., regulations and standards adoption). For example, the test documentation is critical. Still, the 3View framework lets the customer know the test compliance and the actions produced in each case. Therefore, it is possible to trace project decisions at each point (which may be necessary for auditing purposes), the evidence for measuring quality (Karhapaa et al., 2024), and the continuous improvement effort. The RTD institute that participated in CAR#2 considered that not all the indicators should be shared with the customer. So, they selected the indicators with more potential to "extract" customer perception of the sprint and contrast with the developer's perspective, promoting debate. The justification is that they would feel more comfortable identifying specific weaknesses (e.g., team satisfaction or failed features) and keeping them private to the team while sharing their vision of the project with the customer. For example, the team faced a problem in sprint S2 when the most experienced developer was off duty, creating difficulties for some development tasks. This problem was shared with the customer, and the necessary adjustments were made in sprint 3, prioritizing improvements and unexpected requests.

The 3View framework can be used as a guide to interpret raw data, fostering interaction, customer collaboration, and change management. The 3View reference model proposes three types of metrics but does not prescribe specific indicators for each one. Similarly, project stakeholders should agree on weighting the three dimensions (evidence, expectations, and evaluation). Although not solving the complex interplay of metrics and actions (Bouwers et al., 2012), 3View can reduce the bias of metrics that do not adhere to the dynamics of ASD and the undesirable effect of "obtaining what is measured".

7. Conclusions

This paper proposes the 3View framework to create adaptive metrics in ASD. In our proposal, various stakeholders' perceptions, perspectives, and priorities influence the meaning of quality, which can change from one release (or project) to the next. There are several metrics available in the form of quality goals or quantitative indicators emerging from ASD practices; however, (1) few metrics are related to people, (2) they do not comprehensively provide contextualized information within agile projects, and (3) do not result from a reflection made by project teams, which is essential in the context of both being 'agile' and continuously striving for quality.

Three main types of adaptive metrics are crucial in ASD: people-related, process-related, and outcome-related. We suggest that a small set of indicators should be used; however, in compliance with adaptive project management, companies should allow these to evolve over time. Moreover, agile metrics must include three interrelated dimensions: evidence from practice, stakeholder expectations, and stakeholder evaluation. Our dashboards include accessible indicators and allocation rules for improvement and critical analysis. This combination, however, needs to be cautiously evaluated for inaccuracies or bias, particularly for teams during the "storming" and "norming" stages, as indicated in our findings.

7.1. Implications

Our theoretical contribution is aligned with the tenets of action research. It includes new artifacts, lessons learned, and changes observed in the client-system infrastructure that justify a flexible approach to using metrics in agile. The literature is fertile with ASD metrics that are useful in different software development phases. These metrics focus on various aspects, including people, process, and outcome. However, the dynamic context of ASD may lead to different interpretations of metrics. For example, comparison with past results may reveal excellent results when past project performance was poor, and comparison with project goals may also provide a false sense of success if the goals were not well established. People's interpretation of each metric, or what can be called its social construction (Berger & Luckmann,

1991) allows to make a reflection about the current context of the ASD project, promotes a sense of fairness in metrics analysis, and puts metrics in the center of ASD project meetings.

The popular notion that "you get what you measure" is true in software development projects, because metrics steer people and must be compared with the past results and project goals (Bouwers et al., 2012). We could not agree more, but it is also well known that "culture eats strategy for breakfast", as stated by Peter Drucker. Teams can be tempted to change the system as a way to improve the metric value (Bouwers et al., 2012). Based on our findings, we would add that metrics in ASD must be interpreted, socially constructed, and used to communicate a shared vision of project performance. We argue that the traditional view of imposed metrics "is in contrast to most accounts of agile which involve voluntary, bottom up adoption on small co-located teams developing systems deemed to be suitable for agile development" (Conboy et al., 2011).

Several implications for practice can be summarized. First, accessible artifacts are proposed to guide practitioners in using meaningful metrics, namely, how to weight them and the steps to do it within the ASD project lifecycle. Second, the proposed framework can integrate any quantitative or qualitative metric in different facets of project management, being metrics-agnostic. Third, discrepancies in the three pillars of 3View (comparability with past projects, project expectations, and adaptability to dynamic conditions) are not a problem, but an opportunity to gain a clearer understanding of each metric's meaning and its value in informing improvement actions.

7.2. Limitations

Several limitations must be stated. First, the selection of databases and keywords for the literature review. Our work has evolved over several years, and we can evaluate the changes over time, but the ASD literature is constantly evolving. Second, action research allows the transferability of the findings, but only two complete CAR cycles were conducted. Third, social interventions are complex, and there are risks of the Hawthorne effect, suggesting that the observed participants' behavior and feedback could be affected by the attention they receive (French, 1950). To minimize threats to the validity of our study, we followed existing guidelines for literature reviews (Webster & Watson, 2002), elaborated an interview protocol (McLellan et al., 2003), and compared the interviews with other sources in the literature. Two authors of the paper proceeded in parallel during the entire research project, contrasting different data sources and constantly challenging the results at each stage of the research process.

The practitioners consider this model an improvement in team interaction. However, some limitations are inherent in our use of adaptive metrics. First, it is necessary to see the values of the three dimensions to understand the result. Second, it is a contextualized evaluation and cannot be used to compare different companies, although it may be used to compare various in-house projects. Third, it includes a subjective part of the evaluation that makes the value representative of the team's reality.

7.3. Future Work

Several opportunities for future research are identified. First, the approach could be tested in different development contexts and software development methodologies. Second, it was interesting to identify profiles of users based on historical data, for example, evaluating optimistic/pessimistic views on the project and understanding the motivations and interpretations for the subjective evaluation components. Third, it is possible to contrast the impact of adaptive metrics (or each of its dimensions) on project success. Fourth, although we present a way of calculating metrics, we do not propose specific indicators for each dimension. Suggesting a list of indicators for each case and recommendations for weighting in different project typologies is also possible. More studies are necessary to understand which indicators affect motivation, compliance with project schedules, team interaction, and client communication. Fifth, the metrics metadata can be used to create a knowledge base for training and decision support systems for ASD. For example, they identify the actions with the most effect in each metric improvement. Sixth, the customer of project B (CAR#2) suggested using the

3View framework for employee reward and recognition. According to them, it has the potential to merge direct measures with the feedback from the development team, potentially improving the accuracy of rewards and a better understanding of the reward selection, according to evidence (comparison with the past), expectation (compare to the goals for each employee) and evaluation (balancing contextual factors and reflection about practices).

Quality procedures are challenging to incorporate into the daily practice of ASD. Still, we hope this work may inspire future contributions to improve the situation and build a socially constructed vision of quality, perhaps less inspective and prescriptive but certainly more agile.

Acknowledgments

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Biographical notes

João Barata is an Assistant Professor at the Department of Informatics Engineering, Faculty of Science and Technology of the University of Coimbra, Portugal. He is also a researcher at CISUC/LASI - Centre for Informatics and Systems of the University of Coimbra and was invited to join the Polytechnic Institute of Coimbra, in 2016, as Assistant Professor of Information Systems (IS). Prior to this, João was the IS unit manager of a technological center. João has an experience of 22 years as an IS consultant and has worked with over 300 public and private organizations in Europe, America, and Africa. João holds a Ph.D. in Information Systems, participated in 23 co-funded research and innovation projects, and published over 90 papers, including leading IS conferences (ICIS, ECIS, AMCIS, PACIS) and journals such as Technovation, Business & Information Systems Engineering, Applied Soft Computing, Journal of Industrial Information Integration, and Electronic Markets. His main research interests are information systems, digital transformation, digital twins, supply chain management, and Industry 4.0/5.0.

ORCID: 0000-0002-7456-594X

Sharon Coyle is Director of Executive Education and an Assistant Professor in Digital Business at the University of Galway. She previously worked as a Senior Lecturer with the School of Information Systems and Technology Management (ISTM) at the University of New South Wales (UNSW), Sydney, and as a Lecturer at the University of Sydney Business School. She is an award-winning educator and holds a Ph.D, a Masters of Business Studies, and a Bachelor of Commerce from the University of Galway. Sharon has published and presented her research in leading international IS journals, conferences and industry forums. Prior to joining academia, Sharon gained extensive industry experience in her work as a Management Consultant for Accenture, working on a variety of high-profile projects for government bodies and financial services institutes.

ORCID: 0000-0003-1875-4719

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RESEARCH ARTICLE

Towards conceptual clarity in digital platform research: a systematic literature review

Ilyass Zeamari
Université Catholique de Louvain, Bd du Jardin Botanique 43, 1000 Bruxelles, Belgium,
Ilyass.zeamari@uclouvain.be

Wim Laurier
Université Catholique de Louvain, Bd du Jardin Botanique 43, 1000 Bruxelles, Belgium,
Wim.laurier@uclouvain.be

Abstract

The emergence of digital platforms has attracted considerable attention in economics and information systems, shaping scholarly discourse over the past few years. Digital platforms have been the subject of extensive research by scholars, who have examined them from various perspectives, including technical, economic, and socio-technical perspectives. However, despite the frequent use of the term 'digital platform' in the literature, its definition covers a wide range of meanings. Scholars often use the term to mean distinct concepts, which creates semantic confusion within the scientific community. To clarify the different elements and perspectives that shape the definition of a digital platform, a systematic literature review was conducted. A total of 74 definitions from 58 scholarly resources were collected and analyzed through qualitative content analysis. This analytical process aimed to isolate and identify the fundamental elements used in defining digital platforms, as well as the multiple theoretical perspectives through which the term is conceptualized. Furthermore, this study traces the evolution of the term's definition alongside the rapid development of digital platforms in recent years.

Keywords

digital platform; definition; conceptualization; systematic literature review; typology.

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1. Introduction

The growing adoption of digital platforms across diverse areas of activity has attracted substantial attention from scholars in economics and information systems due to their transformative impact on economic, social, and political landscapes (De Reuver et al., 2018; Schreieck et al., 2024; Wulf & Westner, 2022). Recent studies emphasize that digital platforms have become central infrastructures of value creation and coordination in the digital economy (Assalaarachchi et al., 2025; Egbert & Ulbricht, 2024; Tian et al., 2024). They are regarded as drivers of innovation, enabling firms to reconfigure their business models and establish new logics of value co-creation and distribution (Hein et al., 2020; Mammadli et al., 2026). According to Kenney and Zysman (2015), the salience of digital platforms indicates that we are currently witnessing a fundamental restructuring of our economy, with platform companies acquiring a level of power comparable to that of Ford, General Motors, and General Electric in earlier eras. More recent analyses corroborate this view, highlighting the growing societal embeddedness and regulatory relevance of digital platforms (Heylen, 2024; Tian et al., 2024). With this expansion of digital platforms, it has become imperative for researchers to clearly understand and define the conceptual boundaries of the term 'digital platform'. Misinterpretation or misuse of this term could lead to paradoxical research results, prevent the comparability of studies, and hinder effective communication between researchers (De Reuver et al., 2018; Derave et al., 2024).

The need for a common understanding of the term 'digital platform' is not just a semantic necessity; it is fundamental to both theoretical and practical progress. The lack of a clear definition of the term 'digital platform' poses several challenges, particularly in academic research and legal regulation (De Reuver et al., 2018; Heylen, 2024; Tian et al., 2024; Zysman & Kenney, 2016). First, without clear definitions, researchers may study different phenomena under the same label. This can prevent researchers from building upon previous research, comparing findings across studies, or conducting meta-analyses (Kaplan, 2017; Koch et al., 2022; Tarannum et al., 2025). Second, the absence of a clear definition complicates the establishment of regulatory frameworks for digital platforms. Policymakers struggle to determine which entities qualify as platforms and how to categorize them without constraining innovation (Afina et al., 2024; Heylen, 2024). This challenge is illustrated by recent findings showing that heterogeneous digital compliance disclosures hinder effective evaluation and enforcement (Aberkane et al., 2025).

To build a common understanding of what constitutes a digital platform, this article presents a systematic literature review that collects and analyzes existing definitions of digital platforms. It then uses qualitative methods to analyze these definitions. A systematic literature review is a tool for synthesizing scientific evidence to answer a specific research question in a transparent and replicable way while seeking to include all published evidence on the subject and assess the quality of that evidence (Lame, 2019; Okoli, 2015). Systematic literature reviews are an appropriate approach for defining concepts and understanding the evolving aspects of terminology in a specific field of research (Lame, 2019; Snyder, 2019). Asadullah et al. (2018) used a systematic literature review to reveal the multidimensional and heterogeneous nature of digital platforms, as well as the persistent ambiguity surrounding their conceptualization in the information systems and management literature. More recently, Tian et al. (2024) highlighted the ongoing fragmentation of platform definitions and called for an integrative synthesis that connects diverse perspectives. Building on these insights, the present study systematically identifies, categorizes, and analyzes existing definitions to advance the conceptual clarity of digital platforms.

This article makes several important contributions to the literature on digital platforms. First, it provides a comprehensive review of the different definitions associated with the term digital platform, revealing a variety of perspectives and concepts that clarify the boundaries of the term and help determine which entities can be considered as platforms. Second, it highlights an important omission in many existing definitions, namely the limited attention given to the technological dimension, which makes it difficult to distinguish digital platforms from non-digital ones. Third, the article emphasizes the need to specify research perspectives, such as economic, technical, socio-technical, and organizational approaches, in

order to make studies more comparable and support cumulative knowledge building. Fourth, the study shows that the definition of a digital platform is not static but evolves with advances in technology and changes in platform applications. Building on these insights, the article proposes a theoretical framework in the form of a matrix that combines the economic, technical, socio-technical, and organizational perspectives to provide a comprehensive view of digital platforms. Finally, it presents a definition template based on the key concepts identified in each perspective to standardize the conceptual foundation of digital platform research, promote greater consistency across studies, and improve communication among researchers, practitioners, and policymakers.

This article proceeds as follows. First, the problem statement is discussed in greater detail. Second, the method and approach to a systematic review of the field are thoroughly explained. Third, the definitions of digital platforms are analyzed in-depth to highlight the key concepts, elements, and perspectives used by scholars to refer to digital platforms. Finally, suggestions are made as to where future research might focus.

2. Background

Current literature reflects an ongoing debate about how to conceptualize the term 'digital platform' (Asadullah et al., 2018; De Reuver et al., 2018; Heylen, 2024). Academics often use the term 'digital platform' to describe different ideas without clearly defining what they are referring to (Bonina et al., 2021; De Reuver et al., 2018; Zysman & Kenney, 2016). Despite the emergence of many studies on digital platforms across a range of academic disciplines in recent decades, the academic community often defines the term loosely (Egbert & Ulbricht, 2024; Tian et al., 2024). This ambiguity has resulted in a fragmented understanding, where scholars and practitioners alike use different approaches to defining digital platforms, driven by the dynamic evolution of information and communication technologies (Cusumano et al., 2019; Jovanovic et al., 2022; Egbert & Ulbricht, 2024). Many studies either omit a clear definition or rely on examples and illustrations to explain the term, further contributing to the lack of conceptual clarity (Van Eijk et al., 2015). Scholars have also used a variety of distinct yet overlapping terms, such as software platforms, online platforms, two-sided platforms, and multi-sided platforms to describe similar phenomena.

Some academics and industry experts argue that the term 'digital platform' encompasses a wide range of digital business models and technological systems, each with unique characteristics and implications (Mini & Widjaja, 2019). Others argue that the term 'digital platform' is a multifaceted term that can describe a variety of phenomena (Bonina et al., 2021; Zysman & Kenney, 2016). The confusion surrounding the conceptualization of digital platforms has prompted calls for a clearer definition (De Reuver et al., 2018). Zysman and Kenney (2016) noted that the absence of a clear and universally accepted definition complicates efforts to determine what constitutes a digital platform. Similarly, De Reuver et al. (2018) and Van Eijk et al. (2015) highlighted the necessity of providing an explicit outline of the perspectives from which the term 'digital platform' is defined.

A lack of shared conceptualization has significant consequences for research on digital platforms. As Conboy (2009) demonstrated in his reconstruction of the concept of agility, conceptual inconsistency hampers the cumulative development of theory and leads scholars to use the same term to describe different underlying phenomena. The same applies to digital platforms. When multiple, loosely defined conceptualizations coexist, knowledge creation becomes fragmented, which weakens the field's capacity to produce insights that are both theoretically robust and practically relevant (De Reuver et al., 2018). This fragmentation affects not only academic discourse but also regulatory and managerial practices. Policymakers face difficulties in determining which entities qualify as platforms and how they should be governed (Heylen, 2024; Afina et al., 2024). Firms also encounter challenges in identifying their strategic positions and governance mechanisms within platform ecosystems (Cusumano et al., 2019; Gawer, 2022).

Although various systematic literature reviews and taxonomies have enhanced our understanding of digital platforms, they often focus on specific aspects. For example, Mallon (2021) performed a systematic literature review (SLR) on the business

models of digital platforms, highlighting unique characteristics that set them apart from traditional business models. In a similar vein, Hermes et al. (2020) conducted a systematic literature review focusing on the market dominance of digital platforms. Their findings highlight the urgent need for policymakers to develop new regulatory approaches to mitigate the potential exploitation of such dominant positions. To improve the conceptual understanding of digital platforms, other researchers have developed various taxonomies and typologies (Blaschke et al., 2019; Bock and Wiener, 2017; Derave et al., 2024; Staub et al., 2021). These frameworks focus mainly on the dimensions that distinguish digital platforms from one another.

Despite these efforts to refine the conceptualization of digital platforms, there remains no shared understanding of what constitutes a platform or which attributes define it. Existing studies emphasize different aspects such as technology, intermediation, governance, and ecosystems, yet three key gaps persist. First, the literature provides a limited synthesis of the elements that compose existing definitions and how they interrelate. Second, little is known about how definitions have evolved over time in response to technological and institutional change. Third, few analyses relate existing definitions to prevailing typologies of digital platforms. At the same time, scholars increasingly highlight the continued evolution of the digital platform concept. A growing body of work views platforms as complex, socio-technical infrastructures that both enable and govern interactions across multiple actors (Egbert & Ulbricht, 2024; Hamadi, 2026; Tian et al., 2024). Recent work on digital system lifecycles highlights growing ethical and accountability requirements, further emphasizing the importance of clearly defined platform boundaries (Alamäki et al., 2025). This ongoing evolution reinforces the need for periodic conceptual consolidation to ensure that scholarly definitions keep pace with technological and organizational change.

To address these gaps, this study systematically analyzes existing definitions of digital platforms and their evolution over time. It synthesizes the concepts and elements used to define platforms and proposes a unified framework aligned with prevailing typologies. Rather than imposing a single universal definition, the study offers a set of alternative formulations that provide the conceptual precision required for theoretical and empirical research. The proposed template ensures completeness by integrating key definitional elements identified across multiple perspectives, while also offering flexibility by allowing researchers to adapt these elements to specific theoretical lenses or disciplinary contexts. In doing so, this approach contributes to closing existing gaps in the literature by providing both scholars and policymakers with a clearer understanding of digital platforms and their diverse manifestations. Ultimately, it supports the development of a more coherent body of knowledge to guide future research and policy in this rapidly evolving field.

3. Research methods

The primary objective of this study is to systematically research and analyze the fundamental components of digital platform definitions, as documented in academic journals and book chapters. To achieve this overarching goal, this study seeks to answer the following research questions:

(1) What are the different definitions of ‘digital platform’, and how many definitions have been identified?

(2) What are the different concepts and perspectives used to define digital platforms?

(3) What are the common elements used to define digital platforms?

(4) How did the definition of ‘digital platform’ evolve over the past years?

3.1. Data collection method

To collect the definitions of the term ‘digital platform’, we conducted a systematic review analysis, adhering to the PRISMA protocol, focusing on English language, peer-reviewed journal articles, and book chapters. Such published works represent a scientifically validated source of knowledge (Reim et al., 2015; Podsakoff et al., 2005). To collect our data, we used the

Scopus database. The Scopus database is a reliable source of knowledge for conducting systematic literature reviews as it encompasses a wide range of academic literature in various fields (Omorede et al., 2015).

To select our keywords, we began by conducting an initial literature review to understand the range of terminologies used in discussions of digital platforms. Drawing on the literature reviews by Asadullah et al. (2018) and De Reuver et al. (2018), we identified several key terms closely associated with digital platforms. This approach enabled the identification of terms that are not only widely used but also reflect the diverse conceptualizations and models of digital platforms across disciplines. These selected terms were then applied to identify relevant articles and book chapters for our literature review. Our search focused specifically on the keywords of each article, as these keywords are often carefully chosen by authors to represent the core themes of their research and are indexed accordingly. By limiting the search to keywords, we adopted a more targeted strategy that increased the likelihood of finding relevant definitions while minimizing the risk of gathering an unmanageable volume of data. The following search query was used to identify relevant publications, with no restrictions on publication date:

> 'digital platform' OR 'two-sided platform' OR 'multi-sided platform' OR 'intermediary platform' OR 'platform marketplace' OR 'platform business model'

These keywords were intentionally broad enough to capture a wide range of articles that might include a definition of digital platforms. The search query returned 1,703 peer-reviewed journal articles and 228 book chapters. During the screening stage, we reviewed the titles and abstracts of all identified publications, excluding those in which digital platforms were not the primary focus of analysis. This step reduced the number of articles and book chapters to 186. At the eligibility stage, we conducted a full-text review to ensure that each publication provided a clear definition of the term 'digital platform.' Studies were excluded if (1) they only mentioned digital platforms in passing, or (2) they focused on non-digital platforms (e.g., industrial or physical platforms). Following this process, 51 articles met our inclusion criteria. Additionally, forward and backward citation searches identified seven additional relevant journal articles, resulting in a final total of 58 included studies. The above process is summarized in Fig. 1.

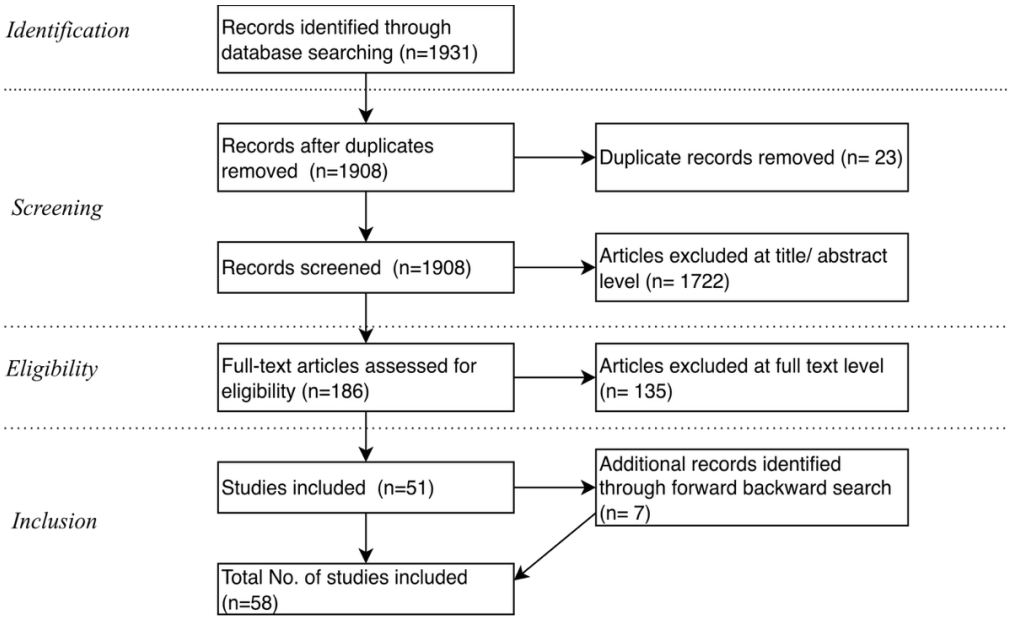


Fig. 1. Stages of the literature review.

From the articles and book chapters, 74 unique definitions of the term 'digital platform' were collected. The collected definitions were then stored in a separate document for analysis. Table 1 provides a summary of the frequency of definitions published by year, whereas Appendix A offers a detailed compilation of the collected definitions.

Table 1. Number of definitions published by year of publication.

Year	Number of definitions published
2010	1
2016	1
2017	2
2018	6
2019	4
2020	6
2021	10
2022	31
2023 (Jan–Aug)	13
Total:	74

3.2. Data analysis methods

The analysis of definitions related to digital platforms was conducted using NVivo, a qualitative data analysis software that facilitates the systematic examination of textual data. This study employed a content analysis approach, which is particularly effective for exploring written definitions and allows researchers to derive meaningful conclusions while describing and quantifying specific phenomena (Downe-Wamboldt, 1992; Lindkvist, 1981). Content analysis allows the examination and interpretation of content within the data to identify underlying themes, patterns, and meanings. It is also useful for classifying texts into categories that represent similar meanings (Drisko & Maschi, 2016).

The analysis began by identifying classes of objects (concepts) as presented in the definitions. A class of objects refers to the part of a definition that indicates the category or group to which a term belongs (Szczesniak, 1963). In this initial phase, we carefully reviewed all the collected definitions to extract key concepts. These identified concepts were then compared with established perspectives on digital platforms in the literature. This comparison contextualized the extracted concepts and ensured alignment with existing research. The frequency of each concept in the collected definitions is reported in Table 3.

In the second stage of the analysis, we used NVivo to examine word frequencies within the definitions, aiming to identify recurring elements that characterize digital platforms. This quantitative step offered valuable insights into the most frequently appearing terms across the dataset. We then grouped these terms based on their semantic similarity. For example, terms such as 'orchestrate', 'intermediate', 'facilitate', and 'coordinate' were grouped together. This process allowed us to create coding categories. For example, terms such as 'software', 'technology', 'technical', and 'algorithm' led to the creation of a coding category called 'technology.' These coding categories helped define the key elements of digital platform definitions. The frequency of each coding category is recorded in Table 4, providing a quantitative foundation for our qualitative analysis, and highlighting the prominence of each code within the dataset.

In the third stage of our analysis, we organized the collected definitions into four distinct categories, each representing a specific perspective: economic, technical, socio-technical, and organizational. Within each category, we conducted a

detailed examination to understand how the codes identified in stage 2 were reflected in the definitions from each perspective. Table 5 provides a summary of this coding process, showing the number of articles classified under each perspective and highlighting the key elements identified in those articles.

In the fourth stage of the analysis, we examined the evolution of definitions of digital platforms over time, linking these changes to advances in technology and information systems. Figure 4 illustrates this evolution by showing how the conceptual understanding of digital platforms has shifted. To further validate our findings, we compared the definitions with existing typologies of digital platforms.

The coding process for definitions across all stages was conducted iteratively and involved two researchers. Each researcher independently coded a subset of definitions to enhance reliability, followed by team discussions to resolve any discrepancies. This collaborative approach not only improved coding consistency but also deepened our understanding of the nuances within the definitions. Figure 2 summarizes the entire coding process.

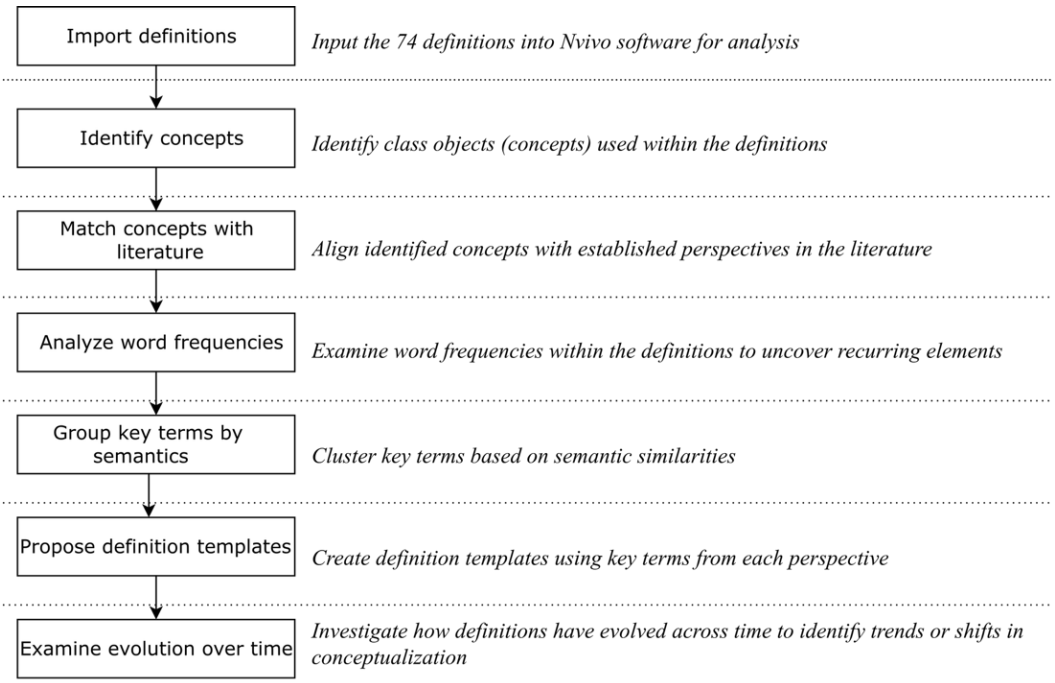


Fig. 2. Data analysis process.

4. Results and discussion

Although our sample of articles is limited, analyzing the distribution of subject areas among studies defining digital platforms provides valuable preliminary insights. As shown in Table 2, the conceptualization of digital platforms is most prevalent in Business, Management, and Accounting, underscoring a strong emphasis on economic interpretations. The significant representation of Computer Science and Engineering highlights the technical dimension of platform conceptualizations. Furthermore, contributions from Social Sciences and Psychology suggest a socio-technical perspective, aligning with definitions that frame platforms as intermediaries and socio-technical infrastructures shaping user interactions. A more detailed analysis of these perspectives will be provided in the next section.

Table 2. Distribution of articles by subject area.

Subject Area	Number of Papers
Business, Management and Accounting	39
Computer Science	17
Social Sciences	15
Decision Sciences	14
Economics, Econometrics and Finance	8
Engineering	7
Psychology	4
Energy	3
Environmental Science	3
Mathematics	2
Agricultural and Biological Sciences	1
Arts and Humanities	1
Medicine	1
Multidisciplinary	1
Nursing	1

4.1. Concepts and perspectives used to define digital platforms

During the analysis of the 74 definitions of digital platforms, an inventory of the key concepts used to define a digital platform was created in the first round of content analysis. The inventory identified 15 key concepts used in the 74 definitions. It was interesting to note that many definitions use these concepts when defining digital platforms. Academics have identified the use of three main perspectives to define digital platforms: (1) economics with a market-based perspective, (2) technology management with a technical perspective, and (3) information systems with a socio-technical perspective (De Reuver et al., 2018; Mallon, 2021; Hein et al., 2020).

Further analysis of the articles and concepts used in the definitions enabled us to identify an implicit perspective in the literature—the organizational perspective. This perspective is shaped by ongoing academic debates surrounding the nature of digital platforms. While some scholars regard platforms as distinct organizational entities, others highlight their transformative influence on traditional organizational structures (Gawer, 2022; Saadatmand et al., 2019).

Moreover, the analysis of the key concepts used in the definitions reveals a correlation between the perspectives and the concepts used in the definitions. For instance, concepts such as 'software system' and 'technology architecture' indicate a technical perspective. Similarly, concepts such as 'third-party economic system' and 'two-sided markets' are indicative of an economic perspective. Concepts such as 'socio-technical infrastructures' and 'socio-technical intermediary' point to a socio-technical perspective. Finally, terms such as 'organizational forms' and 'supra-organizational forms' highlight the organizational perspective in defining digital platforms. Table 3 lists the concepts used to define or refer to digital platforms across the 74 definitions, along with the number of definitions in which each concept appears.

Table 3. Concepts used to define digital platforms.

Concepts used to define digital platforms	# of definitions using the concept
Software-based system	6
Infrastructures	6
Digital (resources, systems, core)	5
Software and hardware	3
Socio-technical (infrastructures, intermediary, assemblage)	3
(Supra)organizational forms	3

Concepts used to define digital platforms	# of definitions using the concept
Business/online firm	3
Multi-sided platform	2
Two-sided markets	2
Marketplace	2
Technological platform	1
Information system	1
Technology architecture	1
Business model	1
Third-party economic system	1

4.1.1. Economic, Business, and Market-Based Perspective

This perspective focuses on the economic, business, and market-oriented aspects of digital platforms. It examines how digital platforms enable interactions and transactions among businesses (B2B), among consumers (C2C), between consumers and businesses (C2B), and between businesses and consumers (B2C). It also emphasizes their role as intermediaries that facilitate transactions and enable value creation. Based on our analysis of the definitions from this perspective, a digital platform can be defined as "a set of digital resources, including services and content, that enable value-creating interactions between external producers and consumers" (Komljenovic, 2021, p.381).

4.1.2. Purely Technical and Technological Perspective

This perspective focuses on the technical and technological aspects of digital platforms. It considers the software systems, architectures, and information and communication technology (ICT) components that form the core of digital platforms. By focusing on technical functionalities and extensible codebases, this perspective provides a better understanding of the technical foundations that govern platform operations. From this perspective, a digital platform can be defined as *"the extensible codebase of a software-based system that provides core functionality shared by the modules that interoperate with it and the interfaces through which they interoperate"* (Tiwana et al., 2010, p.676).

4.1.3. Socio-technical perspective

The socio-technical perspective views digital platforms as complex assemblages of technical elements (software and hardware) embedded in social components. This perspective recognizes that digital platforms are shaped by both technology and user interactions. It seeks to explore the complex interplay between technology and social systems, highlighting the wider ecosystem in which these platforms operate. From this perspective, digital platforms can be defined as *"hybrid structures (organizations, systems, and technologies) that focus on value creation by providing and facilitating direct interaction and exchange between two or more groups of external users within a single digital ecosystem of algorithmic relationships"* (Geliskhanov 2018, p.22).

4.1.4. Organizational perspective

The organizational perspective conceptualizes digital platforms as organizational forms that coordinate activities among independent users (see subsection 4.2). It emphasizes the role of digital interfaces in orchestrating interactions among diverse stakeholders and enabling novel forms of organization and control. From this perspective, digital platforms are defined as "supraorganizational entities that use digital technology to facilitate interactions between diverse actors, leading to novel forms of organization and accompanying forms of control" (Ens et al., 2023, p.890).

4.2. Common elements used to define digital platforms

In the next stage of the analysis, content analysis was employed to identify recurring elements used to define digital platforms across the collected definitions. The software NVivo was used to analyze word frequencies across all definitions. Subsequently, key terms were categorized into codes based on their semantic similarity and meaning. Table 4 provides an overview of the coding process, presenting the codes, their scope, and the frequency with which they occur across the 74 definitions. The content analysis revealed a strong emphasis on technology in definitions of digital platforms, as well as their role in facilitating intermediation and interactions among multiple user groups. The code 'organizational form' also emerged as a key element in several definitions, with some authors conceptualizing digital platforms as organizational forms characterized by specific governance mechanisms and technological architectures. Finally, value creation and exchange were identified in a subset of definitions, underscoring the role of digital platforms in generating stakeholder value and enabling value exchange.

Table 4. Content analysis of the definitions of digital platforms

Code	Number of definitions	Code scope
Technology	60	The definition refers to the technical components and infrastructure that support digital platforms.
Intermediation function	43	The definition refers to the intermediation role of digital platforms in connecting multiple user groups.
Multi-party interaction	28	The definition mentions interactivity among multiple users.
Organizational form	9	The definition characterizes digital platforms as organizational structures with specific governance mechanisms, or as mediators among organizations.
Value creation	6	The definition highlights the role of digital platforms in creating value for users, businesses, and other stakeholders.
Value exchange	3	The definition mentions the exchange of value between different parties facilitated by digital platforms.

4.2.1. Technology

Most authors recognize technology as a central element in defining digital platforms. It is commonly identified as the foundational component that enables platform operations, including interactions, transactions, and the creation and exchange of value among different user groups. Technology is also portrayed as the underlying infrastructure upon which digital platforms are built, allowing them to deliver services to users. Accordingly, the concept of technology is employed in several distinct ways in the literature to define digital platforms, as outlined below.

- **Enable interactions:** Many definitions emphasize the role of technology in enabling interactions and transactions among different user groups, including businesses, consumers, and peers. Technology functions as a facilitator that allows interactions to occur efficiently within the digital platform ecosystem. For example, digital platforms *"allow interaction between end-users, or demand and supply sides, based on varying degrees of extensible software systems that share functionality with add-on software"* (Müller et al., 2018, p.140).
- **Shape organizational forms**: Technology contributes to the organizational form of digital platforms by providing the architectural and infrastructural foundations required to orchestrate activities among independent users and complementors. In this sense, digital platforms *"are supraorganizational entities that use digital technology to*

facilitate interactions between diverse actors, leading to novel forms of organisation and accompanying forms of control" (Ens et al., 2023, p.890).

- **Promote Value Creation**: Several definitions highlight the role of technology in enabling value creation for users, businesses, and other stakeholders. Digital platforms rely on technology to create and deliver services, content, and resources that support value-creating interactions. As noted by Zoppelletto et al. (2020, p.562), digital platforms comprise *"digital resources that enable value-creating interactions between external actors."*

Taken together, technology is used to define digital platforms by describing the foundational infrastructure on which they are built and the ways in which technology facilitates connections and interactions among different user groups and organizations to enable value creation.

4.2.2. Intermediation function

Several authors highlight the role of digital platforms as intermediaries among multiple user groups as a core element of their definition. Intermediation manifests in different forms and is discussed across a variety of contexts in the literature. The following forms of intermediation were identified across the analyzed definitions:

- **Transaction intermediation:** Digital platforms frequently act as intermediaries that facilitate transactions among different parties, such as businesses, consumers, and peers, by providing a digital space in which goods and services can be bought, sold, or exchanged. For example, *"digital platforms are online firms that intermediate transactions between businesses, consumers, and peers and extract rent from this"* (Naudé, 2023, p.94).
- **Value exchange intermediation:** Digital platforms function as intermediaries in processes of value exchange by enabling interactions among different user groups. They provide an environment in which such interactions support value co-creation through the exchange of resources and services. As noted by Drewel et al. (2021, p.412), *"digital platforms are intermediaries and enable interactions and the exchange of values between at least two different, interdependent user groups."*
- **Collaboration intermediation**: Digital platforms facilitate collaboration among different user groups by lowering barriers to interaction and coordination. This form of intermediation supports cooperative activities aimed at mutual benefit. As Staub et al. (2022, p.907) observe, *"digital platforms facilitate interactions and collaboration between two or more mutually interdependent groups of participants thanks to their ability to leverage production, transaction, and innovation."*

4.2.3. Multi-party interaction

Several authors mention interactivity among multiple platform users when defining or referring to digital platforms. This interactivity is described in different ways across the definitions, encompassing interactions between users with complementary needs as well as interactions between distinct sides of the marketplace. Within the digital platform ecosystem, such interactions are frequently associated with value-creation processes. The following forms of interaction were identified in the analyzed definitions:

- **Interaction between users with complementary needs**: Several definitions describe interactivity as occurring among users with complementary needs, often referred to as complementors. This perspective highlights the role of digital platforms in bringing together users or entities that provide products or services that enhance or complement those offered by other actors. As Wen (2023, p.2) notes, digital platforms are *"online tools that enable users with complementary needs to interact with each other."*
- **Interactions within a marketplace**: In some definitions, interactivity is identified as a defining characteristic of digital platforms, particularly in the context of marketplaces. Interactions between the different sides of a marketplace facilitate the creation and exchange of value. For example, Eferin et al. (2019, p.132) describe digital platforms as *"multi-sided marketplaces with business models that enable producers and users to create value together by interacting with each other."*

- **Interactions for value creation**: Several authors explicitly associate interactivity with value creation. Digital platforms are portrayed as dynamic environments in which diverse users engage in exchanges, transactions, and collaborative activities. Such interactions within the platform ecosystem foster value creation for multiple stakeholders. As articulated by Zoppelletto et al. (2020, p.562), digital platforms comprise *"digital resources that enable value-creating interactions between external actors."*

4.2.4. Organizational form

Some authors use the term *'organization'* when defining or referring to digital platforms. In this context, certain definitions emphasize the role of digital platforms in connecting bilateral or multilateral organizations, while others conceptualize digital platforms themselves as organizational forms that use technology to coordinate the activities of multiple actors. Such organizational arrangements typically comprise a technological component and interdependent user groups linked through formal and informal relationships, operating within a single digital ecosystem.

- **Digital platforms connecting organizations**: Some definitions employ the term *'organizations'* rather than *'users'* or *'actor'* to describe the intermediating role of digital platforms. In this view, platforms connect coordinated entities or groups of individuals characterized by defined roles, responsibilities, and objectives. For example, Li et al. (2023, p.4) describe digital platforms as a "*third-party economic system that can connect bilateral (or multilateral) organizations to make transactions and gain benefits from them.*"
- **Digital platforms as organizations**: Other authors conceptualize digital platforms as organizations in their own right, emphasizing that platforms operate within a specific organizational framework that structures the conditions under which interactions occur. Accordingly, digital platforms *"are an organizational form made up of a technological architecture and governance mechanisms for managing autonomous complementors."* (Saadatmand et al., 2019, p.1).

4.2.5. Value creation

Although value creation is not consistently identified as a core element in definitions of digital platforms, it is occasionally referenced in this context. Several definitions associate the concept of a digital platform with processes of value creation, whereby value emerges from dynamic interactions between external producers and consumers within a digital ecosystem. Moreover, some authors argue that the essence of digital platforms lies in fostering value creation among distinct groups of external users operating within a unified digital ecosystem governed by algorithmic relationships. For example, digital platforms have been described as "multi-sided marketplaces with business models that enable producers and users to create value together by interacting with each other" (Eferin et al., 2019, p.132) and as "digital resources that enable value-creating interactions between external actors" (Zoppelletto et al., 2020, p.562).

4.2.6. Value exchange

Value exchange is occasionally referenced in definitions of digital platforms. Although this element does not appear to be a necessary condition for defining digital platforms, it contributes significantly to understanding their role. In particular, it highlights the dual function of digital platforms: they not only generate value for a range of stakeholders but also facilitate the efficient exchange of that value. For example, digital platforms have been described as intermediaries that *"enable interactions and the exchange of values between at least two different, interdependent user groups"* (Drewel et al., 2021, p.412) and as *"a technology-enabled business model allowing producers and consumers to exchange value"* (Mancha et al., 2018, p.1).

4.3. Perspective-based analysis of definitions

This section presents an in-depth analysis of the term *'digital platform'* from multiple analytical perspectives. The definitions are examined in detail to elucidate how the previously identified codes are reflected in these definitions when considered from each perspective.

4.3.1. Key elements in defining digital platforms from a technical and technological perspective.

Of the 74 definitions analyzed, 16 explicitly adopt a technical perspective in defining or referring to digital platforms. Within this subset, the code *'technology'* was present in all definitions, whereas the other previously identified codes were absent. This finding suggests that, from a purely technical perspective, these other codes are not regarded as essential elements in the definition of a digital platform.

4.3.2. Key elements in defining digital platforms from economic, business, and market-based perspectives.

The analysis of the 74 definitions identified through the systematic review reveals a clear pattern: 32 definitions adopt an economic perspective when conceptualizing digital platforms. This prevalence indicates the prominence of economic considerations in how digital platforms are defined in the literature. In contrast to the technical perspective, this subset of definitions incorporates all previously identified codes. The *intermediation function* code appears in 25 of the 32 definitions, followed by *technology* (22), *multi-party interaction* (16), *value creation* (4), *value exchange* (3), and *organizational form* (1). From an economic perspective, these frequencies suggest that the core elements in defining digital platforms are their capacity to enable intermediation and interaction among users, underpinned by technological infrastructure.

4.3.3. Key elements in defining digital platforms from the socio-technical perspective.

A total of 21 definitions adopt a socio-technical perspective in defining digital platforms. This perspective integrates both technological and social dimensions. Content analysis of these definitions reveals the presence of the *technology* code in 19 of the 21 definitions, followed by *intermediation function* (14), *multi-party interaction* (10), *organizational form* (3), and *value creation* (2). Overall, the socio-technical perspective provides a holistic understanding of digital platforms by emphasizing the interplay between technical architectures and dynamic socio-economic relationships.

4.3.4. Key elements in defining digital platforms from an organizational perspective

In contrast to the preceding perspectives, the organizational perspective, which emerged in 2019, is relatively recent and less prominent in the literature. Only five definitions adopt this perspective when defining or referring to digital platforms. Within this subset, the *organizational form* code appears in all five definitions, followed by *technology* (4), *intermediation function* (4), and *multi party interaction* (2). This emerging perspective places greater emphasis on digital platforms as organizational entities characterized by distinct modes of control and governance.

Table 5 maps the various definitions of digital platforms according to four key perspectives: technical, economic, socio-technical, and organizational. Each perspective is analyzed through six key elements: technology, intermediation and connection function, multi-party interaction, organizational form, value creation, and value exchange. Across all perspectives, technology is consistently recognized as an essential element supporting platform functionalities. The technical perspective focuses exclusively on digital infrastructure, emphasizing software systems and modular architectures. In contrast, the socio-technical perspective integrates technological components with social processes, highlighting how technology supports social activities and community building. The economic perspective emphasizes how technology enables economic transactions and large-scale data distribution, linking it directly to market dynamics and value creation. The organizational perspective examines technology in relation to governance mechanisms and the structuring of organizational activities. To provide a concise visual synthesis, Figure 3 illustrates the extent to which each

definitional perspective emphasizes the six elements by reporting their frequency of occurrence across definitions, thereby highlighting areas of convergence and divergence among perspectives.

Table 5. Elements and definition perspectives matrix

Elements/Perspectives	Technical	Economic	Socio-technical	Organizational
Technology	5,6,15,24,31,36,44,48,49,50,54,57,58,59,63,72	1,4,13,19,20,23,25,26,27,29,32,37,38,43,45,50,52,55,61,65,67,70	7,8,9,17,22,28,30,33,34,39,42,46,51,56,60,66,68,73,74	10,11,12,47
Intermediation/ connection function		1,2,13,14,16,18,19,23,26,29,32,37,38,40,43,45,50,52,53,55,61,64,67,69,70	8,17,21,22,28,30,34,39,41,42,46,51,68,73	11,12,47,62
Multi-party interaction		3,4,14,16,18,19,26,35,38,43,45,61,64,69,70, 71	8,17,21,30,34,39,56,66,68,73	10,12
Organizational form		2	7,30,39	10,11,12,47,62
Value creation		18,19,26,71	33,39	
Value exchange		14,20,53		

Note: Numbers refer to the corresponding definition IDs in Appendix A.

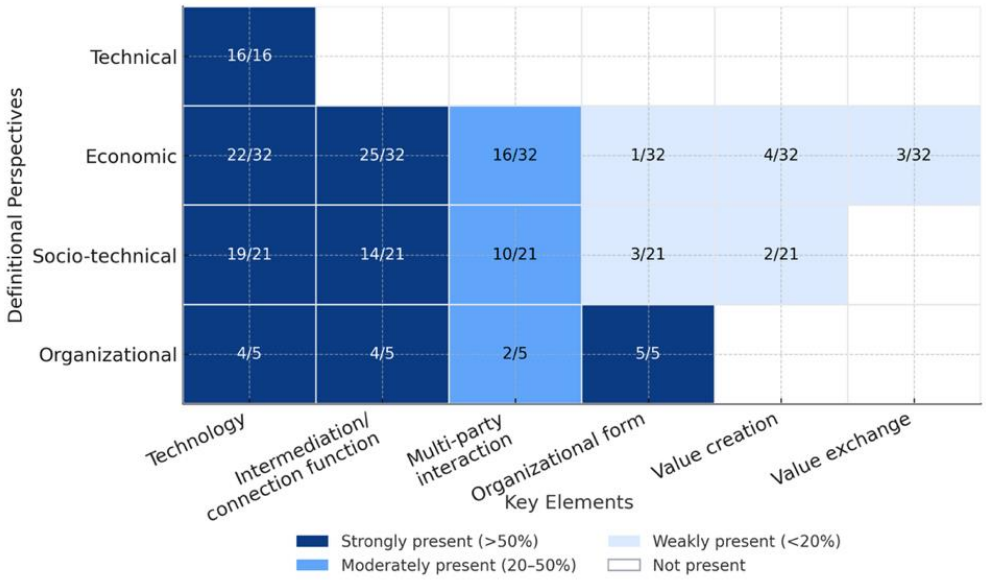


Fig. 3. Mapping of definitional perspectives and key elements of digital platforms.

As illustrated in Figure 3, intermediation and multi-party interaction are central elements in definitions of digital platforms and appear across all perspectives except the technical one. From an economic perspective, these elements are particularly prominent, reflecting the emphasis placed on the economic benefits and efficiencies generated through platform intermediation and the interactions it enables among economic actors. The socio-technical perspective broadens this view by incorporating intermediation and interaction in relation to a wider range of activities, including economic, political, and social processes. From an organizational perspective, these elements are used to examine how platforms coordinate activities among multiple parties and to assess the implications of such interactions for organizational structures and dynamics.

The key element organizational form is less prevalent across the definitions. It is consistently present within the organizational perspective and appears occasionally in the economic and socio-technical perspectives, while remaining absent from the technical perspective. When addressed, this element is commonly associated with the capacity of digital platforms to establish new organizational structures, orchestrate relationships among organizations, and enable organizations to leverage specific technological functionalities. The element value creation is mentioned sporadically within the economic and socio-technical perspectives and is absent from the others. By contrast, value exchange is exclusively referenced within the economic perspective.

Overall, the elements and definitional perspectives matrix provides a structured framework for interpreting the multifaceted nature of digital platforms. The insights derived from this matrix suggest that digital platforms are inherently multidimensional, shaped by diverse business models, heterogeneous user behaviors, and significant societal implications. This complexity underscores the importance of adopting an interdisciplinary approach to platform research. A comprehensive understanding of digital platforms therefore requires the integration of perspectives from multiple disciplines, including economics, sociology, technology studies, and business management.

4.4. Evolution of the definition of digital platforms in the last decade

The analysis of the definitions reveals a clear evolution in the concepts and elements used to characterize digital platforms, reflecting their increasing complexity and multifaceted nature. This evolution is illustrated in Figure 4, which traces the temporal progression of dominant concepts and definitional elements associated with digital platforms over time. As shown in the figure, shifts in emphasis correspond to broader technological, economic, organizational, and societal developments. This evolution can be attributed to several interrelated factors.

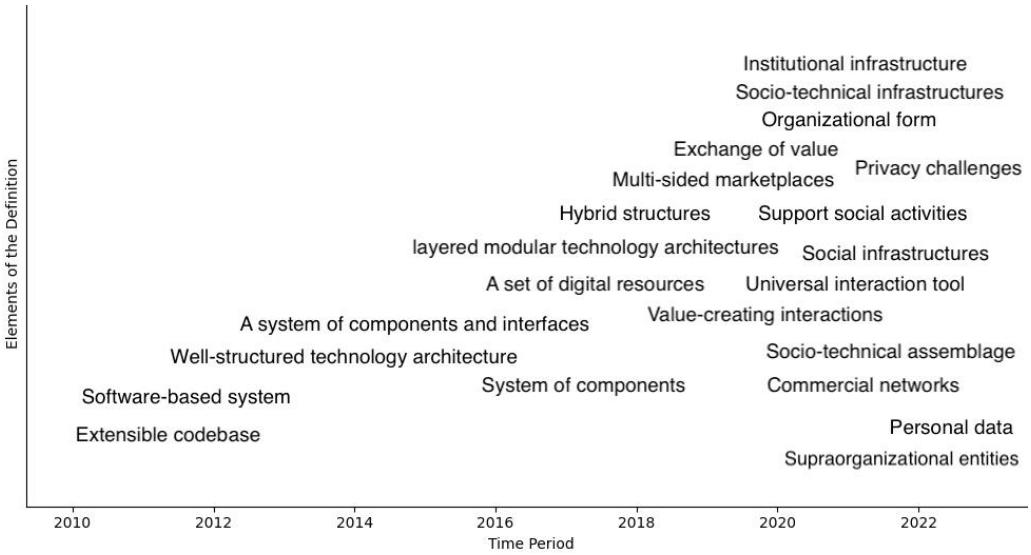


Fig. 4. Evolution in the definition of the term 'digital platform'

Technological advancements: In the early period from 2010 to 2017, definitions predominantly emphasized the technical foundations of digital platforms, such as extensible codebases and adaptable technological architectures. During this phase, platforms were primarily conceptualized as technical artifacts, with limited attention given to user experience or business model implications. The focus was instead placed on the technological capabilities required to support diverse applications and functionalities.

Economic impact: Around 2018, definitions began to incorporate economic dimensions, marking a significant shift in how digital platforms were conceptualized. Rather than being viewed solely as technological tools, platforms increasingly came to be understood as hybrid structures that facilitate value creating interactions within digital ecosystems. This shift reflects a growing recognition of the economic role of digital platforms as enablers of market activity and value generation.

Organizational shifts: By 2019, definitions further evolved to frame digital platforms as distinct organizational forms. Platforms were no longer perceived merely as technical infrastructures or economic intermediaries, but as organizational entities characterized by specific governance mechanisms, architectural arrangements, and modes of control. This shift was likely driven by the recognition that platforms actively shape, rather than simply host, the conditions under which interactions and transactions occur.

Socio-technical perspective: In 2021 and 2022, socio-technical perspectives became more prominent, emphasizing that digital platforms cannot be fully understood through purely technical or economic perspectives. Instead, they were increasingly conceptualized as socio-technical systems in which technological components, social interactions, and economic activities are tightly interwoven.

Societal impact: By 2023, the definitions recognized the societal impact of digital platforms, highlighting their role in forming communities, posing new privacy challenges, and processing large amounts of personal data. This reflects the growing concerns about the implications of digital platforms and the need for responsible data handling and privacy practices.

The evolution of the term 'digital platform' reflects the broader shifts in our understanding of these platforms, moving from a narrow, technology-centric view to a more holistic perspective that recognizes their multifaceted roles in society. Referring to Gartner's hype cycle (Dedehayir & Steinert, 2016), digital platforms such as social media, e-commerce platforms, cloud services, and digital collaboration tools have moved well beyond the initial hype. They are progressing through the 'slope of enlightenment' toward the 'plateau of productivity'. These platforms continue to evolve, addressing privacy, security, and regulatory challenges while delivering value to businesses and consumers around the world. The pace of innovation and adoption remains dynamic, driven by ongoing advancements in technology and changing societal needs.

4.5. Definitions of digital platforms and current typologies

Digital platforms can be categorized based on different dimensions. Some scholars classify platforms according to their business models, distinguishing among integrator platforms, product platforms, and multi-sided platforms (Boudreau & Lakhani, 2009). Other studies focus on interaction modes as a basis for classification (Boudreau & Lakhani, 2009). From this perspective, two main interaction modes have been identified: collaborative platforms and competitive platforms. Platforms can also be differentiated based on their governance modes, which are commonly classified as either open or closed (Boudreau & Lakhani, 2009; Broekhuizen et al., 2021; Parker & Van Alstyne, 2010).

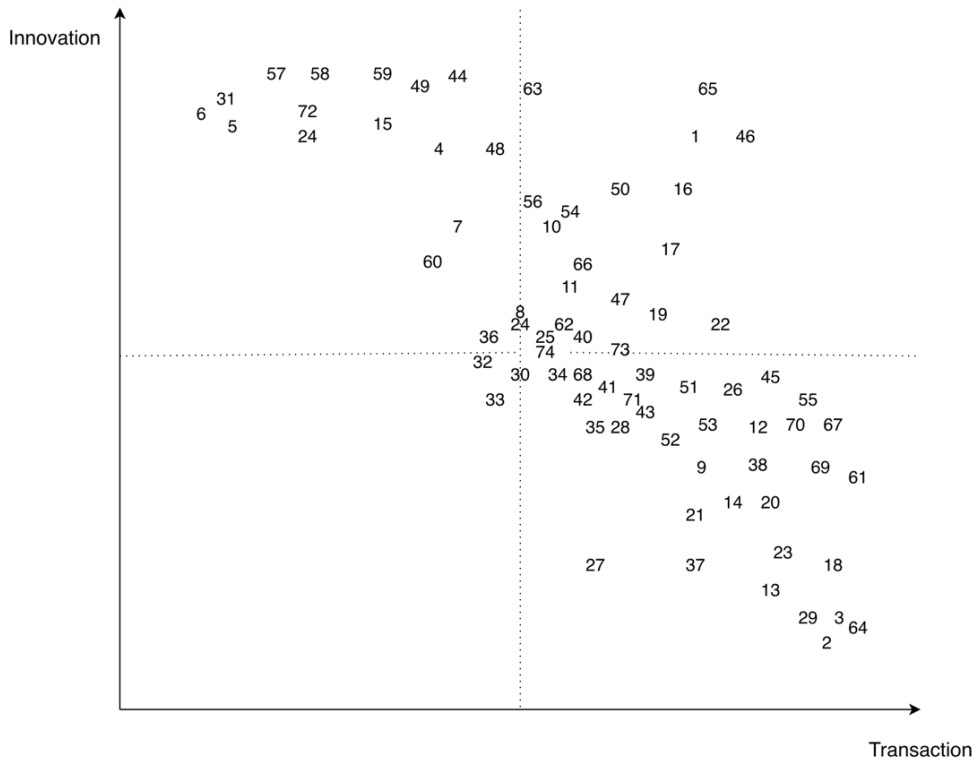
Two major types of digital platforms are dominant in the literature: transaction and innovation platforms (Cusumano et al., 2019). Transaction platforms are described as intermediaries or online marketplaces that enable people and organizations to share information or buy, sell, or access a variety of goods and services. Innovation platforms are different from transaction platforms, as they mainly provide a technological base from which new products can be developed (Cusumano et al., 2019). Given that many academics employ this straightforward classification system (transaction vs. innovation), our comparison of definitions is confined to these two platform categories.

The analysis of the 74 definitions reveals a noteworthy emphasis on the role of digital platforms as transaction intermediaries (Figure 5). These platforms are often described as facilitators of economic exchanges between businesses, consumers, and organizations. This focus on transactional characteristics indicates a keen interest among scholars in understanding the economic and business implications of digital platforms.

While some authors focus on the transactional functionalities of digital platforms, others emphasize the innovative aspects of digital platforms in their definitions. They view digital platforms as catalysts of novel ideas and transformative solutions. However, it is crucial to note that these two approaches to viewing digital platforms are not mutually exclusive but rather complementary. The essence of digital platforms lies in their dual role: they are often both transactional intermediaries and innovation incubators.

A comparison of the definitions with the current typologies of digital platforms revealed that most scholars do not specify the type of digital platform they refer to when defining them. The lack of clarity regarding the type of platform being considered has critical implications for the unit of analysis being studied, as the business model, the targeted user base, and the network effects can vary dramatically depending on the type of platform. For example, social media platforms such as Facebook have different business models, user bases, and network effects than e-commerce platforms such as Amazon.

The varied definitions show that digital platforms do more than facilitate transactions and innovation. They play a major role in building communities, offering new ways of creating and sharing value between stakeholders, and aggregating information that could benefit a large number of users. The growing scope of digital platforms and their increasing impact on society call for the development of typologies that better encompass the variety of services that digital platforms can offer.



Note: Numbers refer to definition IDs in Appendix A; positioning is indicative and reflects key elements emphasized in each definition.

Fig. 5. Conceptual positioning of definitions: Transaction vs. Innovation focus.

5. Conclusion

This article presented an analysis of 74 definitions of the term 'digital platform' from 58 academic publications. The goal was to identify the different perspectives, key concepts, and defining elements used across these definitions. The analysis highlights the existence of four main perspectives through which digital platforms can be defined: (1) economics with a market-based perspective, (2) technology management with a technical perspective, (3) information systems with a socio-technical perspective, and (4) organizational perspective. Academics use several concepts to refer to digital platforms, including concepts such as 'software-based systems' 'digital (resources, systems, core)', 'socio-technical (infrastructures, intermediary, assemblage)', 'organizational forms', and 'two-sided markets'.

Building on the insights gained from these definitions, our analysis of 74 definitions reveals that the key elements shared between all the definitions are: (1) the use of technology, (2) the intermediary function and (3) multi-party interaction. Common elements found in most, but not all, definitions are (1) reference to organization forms, (2) value creation, and (3) value exchange.

The study of the evolution of the definition of digital platforms over time indicates that the conceptualization of a digital platform has evolved alongside technological advancements and the maturation of digital ecosystems. Our analysis shows that researchers have gradually refined their understanding of digital platforms by incorporating new key elements into their definitions over time. Initially, researchers considered digital platforms primarily as technical infrastructures. Later, they began to recognize the economic impact of digital platforms, acknowledging their role in facilitating the creation and exchange of value. Over time, the conceptualization of digital platforms has broadened even further, recognizing that digital platforms are not only technical and economic entities but also enablers of social interactions and new forms of organization.

Our analysis shows that the term digital platform remains used inconsistently across the literature, largely because many definitions fail to clarify the context or theoretical perspective that guides them (e.g., Constantinides et al., 2018; De Reuver et al., 2018). Many definitions remain vague, failing to distinguish clearly between digital and non-digital platforms or to specify the core elements that define what a platform is. In addition, few authors make explicit the perspective from which they define digital platforms, which contributes to ongoing conceptual confusion.

Our findings confirm earlier theoretical views that emphasize the technological, economic, and socio-technical nature of platforms but extend them by identifying the core concepts and defining elements within each perspective. This broader understanding challenges narrow infrastructural or market-based conceptualizations by showing that platforms operate as governance and coordination mechanisms linking diverse actors, technologies, and value systems. Building on this, the study identifies four main perspectives: technical, economic, socio-technical, and organizational, and delineates the key elements emphasized in each, offering a clearer and more structured basis for understanding platforms. The resulting integrative framework consolidates dispersed definitional elements and makes their interconnections explicit, thereby bridging previously fragmented conceptualizations and establishing a robust foundation for future research to examine how definitional choices influence both theoretical framing and empirical analysis in digital platform studies.

For policymakers, this study provides a clearer conceptual foundation to identify the characteristics that define different types of digital platforms and to distinguish between entities that qualify as platforms and those that do not. By clarifying how different perspectives emphasize different aspects of governance, intermediation, and multi-party interaction, our study helps regulators better understand how platforms operate and exert influence. This understanding can support the development of more targeted and effective regulations addressing platform accountability, market fairness, and data governance (Heylen, 2024). Beyond policymaking, this study also holds practical value for platform owners, managers, and designers, as it clarifies the defining characteristics that shape platform governance, ecosystem coordination, and innovation strategies. It further helps practitioners align key dimensions of platform design and management—for example,

linking technological choices with business models and integrating social aspects that support business development and operations.

Based on these observations, we recommend that researchers clearly define the term 'digital platform' in their articles and specify the perspective from which they are examining these platforms. Additionally, it is advisable to indicate the specific type of platform being studied. To facilitate this process, this article proposes both a general definition of 'digital platform' and specific definitions tailored to various perspectives. The overarching definition integrates key elements identified across all definitions, whereas the perspective-specific definitions are derived from elements unique to each subset of definitions.

From a broad perspective, a digital platform is defined as a technology infrastructure (hardware and software) that mediates interactions and transactions among diverse participants within a well-structured organizational entity.

From a technical perspective, a digital platform can be defined as an extensible digital core (hardware and software) that provides core functionality shared by inter-operating modules and interfaces.

From an economic perspective, a digital platform is defined as a layered technological architecture that constitutes a dynamic third-party economic system. It mediates interactions and transactions among different stakeholders while promoting the creation and exchange of value.

From a socio-technical perspective, a digital platform is defined as a socio-technical infrastructure that integrates organizations, systems, and technologies. It leverages digital technology to enable communication, interaction, innovation, and engagement in economic and social activities.

From an organizational perspective, a digital platform is defined as an organizational entity that leverages digital technology to mediate interactions among a diverse range of stakeholders. Such entities are characterized by novel forms of control and governance.

These definition templates aim to help academics, researchers, and practitioners include all essential elements when defining digital platforms. Furthermore, these templates allow scholars and researchers to clarify the perspective from which they define or refer to digital platforms. These templates harmonize definitions, thereby improving communication among researchers and facilitating the comparison of studies.

In line with conventional research practices, it is important to interpret the results of this study within its limitations. This work is limited because it focuses only on definitions published in the Scopus database. This limitation not only underscores the need for further research but also presents specific research opportunities. Future research could broaden its horizons by incorporating definitions derived from a wider range of academic databases or grey literature. Subsequent studies could deepen the comparison between existing definitions and current typologies and taxonomies. Moreover, a promising direction would be to conduct a Delphi study to identify which key elements experts consider most important within each perspective. Such an approach could clarify whether the less frequently cited elements are absent from definitions due to unawareness or omission, or because they are viewed as less relevant. Another interesting area of exploration could be the study of how the lack of a universally accepted definition of the term 'digital platform' influences the development of regulations. This could reveal the interplay between definitional clarity and regulatory frameworks, thereby contributing to the discourse on digital platform governance.

Finally, as the digital landscape continues to evolve, it will be crucial for scholars to revisit and refine the definitions of digital platforms to account for emerging trends, technologies, and organizational innovations. This ongoing refinement will be essential for maintaining the relevance and clarity of the concept in a rapidly evolving digital environment.

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Appendix A. List of digital platform definitions.

1. "hybrid multi-sided platforms that use digital technology as an intermediary bridge between the demand side and the supply side, which enables new business models even in traditional industries" (Li et al., 2023, p.2).
2. "third-party economic system that can connect bilateral (or multilateral) organizations to make transactions and gain benefits from them" (Li et al., 2023, p.4).
3. "is typically a two-sided market created by sellers, buyers, and platform firms, consisting of buyers, sellers, trading partners, customers, and government or regulatory agencies' (Lee et al., 2023, p.58).
4. 'refer to commercial networks which facilitate companies and customers to rapidly grow and activate digital services on a large scale" (Nassani et al., 2022, p.3).
5. "systems based on extensible software providing primary functionality to be shared by all applications operating with interfaces and between themselves" (Dos Santos et al., 2022, p.255).
6. "are layered modular information and communication technology (ICT) enabled architectures with stable core components and flexible complementary modules" (Senyo et al., 2021, p.1).
7. "socio-technical assemblage encompassing the technical elements of software and hardware, and associated organizational processes, standards, and dynamics" (Qiu et al., 2022, p.4).
8. "are digital systems that facilitate communications, interactions, and innovations to support economic transactions and social activities" (Chen et al., 2021, p.1307).
9. "are social infrastructures of the digital age that promote social inclusion, by offering the ability to form meaningful communities, while also presenting new privacy challenges, since they typically collect and process large amounts of personal data as a constitutive characteristic of their business models." (Arzoglou et al., 2023, p.1).
10. "are an organizational form made up of a technological architecture and governance mechanisms for managing autonomous complementors" (Saadatmand et al. 2019, p.1).
11. "organizational forms that orchestrate activities between independent users through the use of digital interfaces" (Harracá et al., 2023, p.2).
12. "are supraorganizational entities that use digital technology to facilitate interactions between diverse actors, leading to novel forms of organisation and accompanying forms of control" (Ens et al., 2023, p.890).
13. "are online firms that intermediate transactions between businesses, consumers, and peers and extract rent from this" (Naudé, 2023, p.94).
14. "are intermediaries and enable interactions and the exchange of values between at least two different, interdependent user groups" (Drewel et al., 2021, p.412).
15. "consist of constant components in the core and variable components in the periphery" (Drewel et al., 2021, p.412).
16. "facilitate interactions and collaboration between two or more mutually interdependent groups of participants thanks to their ability to leverage production, transaction, and innovation" (Staub et al., 2022, p. 907).
17. "Digital platforms are online tools that enable users with complementary needs to interact with each other" (Wen, 2023, p.2).
18. "multi-sided marketplaces with business models that enable producers and users to create value together by interacting with each other" (Eferin et al., 2019, p.132).
19. "digital resources that enable value-creating interactions between external actors" (Zoppelletto et al., 2020, p.562).
20. "a technology-enabled business model allowing producers and consumers to exchange value" (Mancha et al., 2018, p.1).
21. "infrastructures that mediate interactions between complementors and users" (Adam et al., 2023, p. 440).
22. "software-based systems, products, and services that facilitate transactions between parties. However, digital platforms enable more than simply economic transactions" (Ballerini et al., 2023, p.2).
23. "a software system to enable a digital ecosystem service that facilitates the exchange of assets (e.g., products and services) between their providers and consumers" (Bartels & Schmitt, 2022, p.2).

24. "is a common, shared set of services and architecture used to host complementary or additive offerings, including digital artifacts" (Braune & Dana, 2022, p.239).
25. "are technological platforms that allow firms to edit, homogenize, and distribute data on a huge scale" (Chatterjee et al., 2022, p.1).
26. "a set of digital resources including services and content that enable value-creating interactions between external producers and consumers" (Constantinides et al., 2018, p.381).
27. "a service offering by a digital platform company to the users that may be bound to an agreement" (Derave et al., 2022, p.3).
28. "a common foundation or technological base that enables transactions, information dissemination, and access among members of distinct customer groups" (Fuchikawa, 2020, p.103).
29. "digital marketplaces that connect and facilitate transactions between two or more groups of actors, or sides" (Garud et al., 2022, p.450).
30. "hybrid structures (organizations, systems, and technologies) that focus on value creation by providing and facilitating direct interaction and exchange between two or more groups of external users within a single digital ecosystem of algorithmic relationships" (Geliskhanov, 2018, p.22).
31. "the extensible codebase of a software-based system that provides core functionality shared by the modules that interoperate with it and the interfaces through which they interoperate" (Tiwana et al., 2010, p.676).
32. "are software and applications on the web that act as mediators between the service providers and service recipients" (Hanafizadeh et al., 2020, p.365).
33. "are computerized, technology-enabled touch-points that are conducive to cocreation" (Hollebeek et al., 2021, p.25).
34. "socio-technical infrastructures and business arrangements that facilitate and coordinate interactions between different sides of a marketplace" (Hracs & Webster 2021, p.41).
35. 'is a universal interaction tool that simplifies the management process and aims to increase economic efficiency' (Inozemtsev et al., 2022, p.21).
36. "a kind of legal asset—a set of software and hardware elements that provide services." (Inozemtsev et al. 2022, p.21).
37. "a business model that allows consumers and suppliers to connect online to exchange products, services, and information." (Inozemtsev et al., 2022, p. 83).
38. "an information society service accessible via the Internet or similar digital means that allows customers to enter into contracts with suppliers of goods, services or digital content" (Inozemtsev et al., 2022, p.148).
39. "cyber-physical structures (organizations, systems, technologies) focused on creating value. by providing and facilitating direct interaction and exchange between two or more groups of external users within a single digital ecosystem" (Inozemtsev et al., 2022, p. 82).
40. "are ecosystems; that is, business models that combine several groups of products, services, and information to meet customer needs" (Inozemtsev et al., 2022, p. 82).
41. "a service that performs an intermediary function when accessing information, services or goods. These services organize and prioritize content for presentation to end users" (Inozemtsev et al., 2022, p.81).
42. "a set of intermediary services provided wholly or in large part using the Internet" (Inozemtsev et al., p.81).
43. "a set of online services for connecting stakeholders, as a result of which they can interact without significant transaction costs" (Inozemtsev et al., 2022, p. 82).
44. "is a complex system of technologies, computer programs, and computer equipment and devices that provide a set of service capabilities on the basis of which many different products can be developed and deployed" (Inozemtsev et al., 2022, p. 82).
45. "an enterprise operating in two (or many) third-party markets that use the Internet to enable interaction between two or more different groups of users who are connected by indirect network effects" (Inozemtsev et al., 2022, p.148).

46. "is a complex information system that provides the functions of interconnection between market participants, open for use by customers and partners, application developers, service providers, and agents" (Inozemtsev et al., 2022, p.303).
47. "can be considered as a technical framework connecting organizations to the platform, which enables organizations to collect, integrate and calculate information in the platform" (Jiang et al., 2023, p.2).
48. "are combinations of hardware and software intended to aid in collecting, archiving, sharing, and using data for local or larger-scale assessment, planning, and decision-making" (Johnson et al., 2021, p.452).
49. "are layered modular technology architectures in business networks" (Kazan et al., 2018, p.186).
50. "is a software system that forms the technical core of a digital ecosystem, is directly used by providers and consumers via APIs or UIs—such as a digital marketplace—and facilitates the matching of a provider and a consumer in relation to an asset within a digital ecosystem service" (Koch et al., 2022, p.9).
51. "is a socio-technical intermediary creating multi-sided markets and coordinating network effects" (Komljenovic, 2021, p.1032).
52. "have a modular architecture and provide an interface that facilitates multilateral transactions and exchanges among users and providers of complementary products and services, i.e., 'complementors'"(Li et al., 2019, p.1448).
53. "are matchmakers facilitating the exchange of value between two or more platform sides" (Mancha et al., 2021, p.129).
54. "shared space to host services and an architecture that provides complementary offerings along with digital artifacts" (Modgil et al., 2022, p.2).
55. "are businesses that connect different groups of user, notably clients and workers, and charge a fee for an algorithmically managed service based on Terms of Service agreements" (Molina et al., 2023, p.17).
56. "allow interaction between end-users, or demand and supply sides, based on varying degrees of extensible software systems that share functionality with add-on software" (Müller et al., 2018, p.140).
57. "extensible codebases where third parties add complementarities in the form of new modules and services" (Müller et al., 2018, p.140).
58. "a shared, common set of services and architecture that serves to host complementary offerings, including digital artifacts' (Nambisan, 2017, p.1032).
59. 'a system of components and interfaces that forms a common structure shared by a set of products" (Parmentier & Gandia, 2017, p.3).
60. "nested hierarchies of systems that are shaped by, and in interaction with, their environment" (Poniatowski et al., 2022, p.257).
61. "connect two interdependent groups of web users (parties offering goods, services, and digital content; and parties interested in accessing this supply) and enable their transactions" (Quarta, 2020, p.1).
62. "an institutional infrastructure enables, constrains, and coordinates the ecosystem actors and is used by the ecosystem orchestrator to govern the ecosystem actors" (Schreieck et al., 2022, p.9).
63. "a technology architecture that allows the development of its computing functionalities and allows the integration of information, computing and connectivity technology platforms available to an organization" (Sedera et al., 2016, p.367).
64. "connect potential buyers and sellers, allows them to negotiate, and facilitates the final transactions" (Shree et al., 2021, p.354).
65. "are technological infrastructures that allow member firms to develop, configure, and deliver advanced services efficiently and on an unprecedented scale" (Suuronen et al., 2022, p.415).
66. "multi-sided digital frameworks that shape the terms on which participants interact with one another" (Szalkowski & Mikalef 2023, p.1).
67. "a service that connects different groups of entities and mediates transactions through digitalized mechanisms to take advantage of network externality" (Takagi, 2020, p.452).

68. "is a connected digital system that provides a common set of design and governance rules to facilitate interactions between multiple users" (Teece et al., 2022, p.7).
69. "act as intermediaries between different kinds of 'customers,' matching supply and demand of a given resource, and engaging in new forms of interaction with different customer groups" (Trabucchi et al., 2021, p.35).
70. "are multi-sided platforms that enable interactions between two or more groups of surrounding customers and complementors online" (Wang et al., 2022, p.2).
71. "places of consumer crowdsourcing and crowdsending, which lie at the core of platformized value creation and which the brand can foster or restrict to shape platform interactions" (Wichmann et al., 2022, p.110).
72. "an extensible digital core that is equipped with complements for third parties" (Xie et al., 2022, p.1).
73. "is a programmable digital infrastructure that facilitates interaction between users through the aggregation of information and shapes the 'platform ecology' in the information society" (Xu & Wang 2022, p.1).
74. "information aggregation infrastructures coupled with technology, society, and economics" (Xu &Wang 2022, p.2).

Biographical notes

Ilyass Zeamari is a PhD candidate in Information Systems at the Université catholique de Louvain (UCLouvain) and a member of the Center for Research in Economics (CEREC). He holds a Master's degree in Business Economics from the Université Libre de Bruxelles. His research addresses the conceptual foundations of digital platforms, with a focus on value creation mechanisms in multi-sided markets, platform strategy, and innovation-driven business models. His work has been published in peer-reviewed book chapters and conference proceedings, including volumes in LNBIP and leading Information Systems conferences.

ORCID: 0000-0002-4493-2614

Wim Laurier, PhD, is Professor of Business Information Management at UCLouvain Saint-Louis Brussels and Visiting Professor at KU Leuven. He earned his PhD in Applied Economic Sciences from Ghent University and specializes in information systems, computational thinking, and enterprise architecture. Laurier integrates technology and management through innovative, multilingual curricula and Python-based learning. His research explores blockchain governance, decentralized platforms, and open value networks, supported by collaborations in Japan, Canada, and Europe. He has supervised numerous theses, published in leading journals, and served on international program committees. Laurier champions inclusive digital education and open resources to foster sustainable transformation.

ORCID: 0000-0002-9448-248X

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RESEARCH ARTICLE

One man's meat is another man's poison: Assessing the role of variations in project managers' leadership and structures on the relationship between neoliberal governmentality and project performance

Muhammad Yousaf Malik
University of Agriculture Faisalabad, Institute of Business Management Sciences, 38000, Faisalabad, Pakistan,
yousaf.malik@uaf.edu.pk

Linzhuo Wang
BI Norwegian Business School, Department of Leadership and Organizational Behavior Nydalsveien 37, 0484, Oslo, Norway,
linzhuo.wang@bi.no

Fangwei Zhu
Dalian University of Technology, School of Economics and Management, No.2 Linggong Road, Ganjingzi District, Dalian, China,
zhufwdlut@foxmail.com

Muhammad Salman Latif
North China University of Water Resources and Electric Power, Zhengzhou, Henan, China,
salmanlatif98@gmail.com

Abstract
Variations among human aspects of governance and management, and the structure of project-based organizations (PBO) may synergize or contrast with each other, eventually impacting project performance (PP). To investigate these variations, the study develops a conceptual model using neoliberal governmentality (NG), transformational (TFL), and transactional leadership styles (TSL) of project managers, centralization of governance structures (CEN) with PP. The data for the study was collected from PBOs in the construction sector. Partial Least Squares-Structural Equation Modeling (PLS-SEM) was applied to assess the results. Later, the conceptual model was validated using an Artificial Neural Network (ANN) Approach. The results revealed that TFL positively mediates the relationship between NG and PP in PBOs characterized by decentralized governance structures (Low CEN). TSL shows competitive partial mediation with NG and hence appears to be the least important predictor of PP in the studied context. Using contingency theory, the study extends the Sociological Perspective of Governance (SPG) to develop a cohesive model for understanding the variations of humans and structures for PP. Project owners, governors, and practitioners should hire synergetic project managers and provide them with training and communication opportunities during project. NG requires decentralized decision-making to empower a TFL for better PP.

Keywords
neoliberal governmentality; project manager leadership; transactional versus transformational styles; project performance; centralization of governance structure; sociological perspective of governance.

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1. Introduction

Projects drive organizational value (Ika & Pinto, 2022; Thomas, 2026) and effective project governance ensures their alignment with organizational strategic objectives and realization of intended benefits (Ul Musawir et al., 2020). However, project governance is still a budding phenomenon due to its varying role such as external versus internal (Ahola et al., 2014), multilevel of operations such as organizational, portfolio, and project level (Derakhshan et al., 2019), and its multifacetedness such as humanistic or structural aspects (Simard et al., 2018). More recent studies address these issues; for example, the sociological perspective of governance (SPG) positions human and structural agency together by elucidating project governance external to a specific project and operating at a higher level than the management (Müller, 2022). SPG describes project governance as an aggregation of governmentality and governance structures. From this perspective, governmentality is a human agency to its structural counterpart governance at the steering level, whereas leadership and management are their corresponding agencies at the project execution level. Governance in rational terms means structures for organizing in societies, such as firms or projects, while governmentality is how those in governance roles (i.e., governors) interact with those they govern. Management is a task-oriented activity for achieving planned results and is structural means for execution of getting things done by others while Leadership is a people-oriented activity (Müller, 2022; Müller et al., 2023).

Apart from a conceptual perspective, which attempts to clarify several uncertainties in project governance literature, SPG provides an opportunity to holistically study the variations of human aspects and structural arrangements of governance that impact project outcomes (Malik et al., 2025a; 2025b). Isolated studies on governmentality (Clegg et al., 2002; Müller et al., 2017), governance structure (Joslin & Müller, 2016; Narayanan & Narasimhan, 2014), and project managers' leadership styles (Müller & Turner, 2006; Nixon et al., 2012) are associated with project outcomes, like project success or project performance (PP). PP refers to behavioral results of an organization's expectation of a project (Zhu et al., 2021). Nevertheless, conception of variations in the forms of governmentality with the project level affecting PP has received meagre attention, especially when its forms such as authoritative, liberal and neoliberal are widely recognized (Clegg & Ninan, 2023; Dean, 2010; Müller, 2022). Prior studies observe governmentality, governors' style to the governed, to let project managers' leadership flourish in decision-making, eventually influencing PP (Turner, 2020a), who act as a buffer for translating the governmentality at the project level, while their styles may contrast or synergize with employed governmentality influencing the governance effectiveness (Malik et al., 2024). Recent studies also endorse use of governmentality as a conceptual tool to understand human-related issues like leadership styles, personalities, culture, politics, and tribalism in PBOs (Ul Musawir et al., 2024). However, despite the historic understanding of differences in human's perception of work (McGregor, 1960) and locus of control (Rotter, 1954), variations between neoliberal governmentality and project manager leadership style influencing PP remain unaddressed. To explore this generalized theoretical gap, this research selected construction sector of Pakistan as an empirical context to explore and validate proposed relationships.

The construction industry is selected due to several evidences of governance-related factors impacting PP, such as conflicts among participant (Li et al., 2018; Sinesilassie et al., 2017; Wu et al., 2019), leadership skills (Rehan et al.,2025; Enshassi et al., 2012), and project failure in developing countries due to governance issues (Damoah et al., 2018). This study focusses a specific form of governmentality, i.e., neoliberal governmentality (NG). NG differentiates itself from authoritative and liberal forms by having indirect interactions between the governors and the governed (Müller et al., 2017), and it is implemented by creating values and ideologies that develop the self-control of members (Franck & Jungwirth, 2003). There exists a positive relationship between NG and PP (Müller, 2022). However, a mismatch between governmentality and project manager leadership styles leads to information asymmetries and manipulation (Malik et al., 2024), raising agency cost which reduce PP (Eisenhardt, 1989; Jensen & Meckling, 1976). PP was specified as outcome variable for this study rather than project success, which has a broader scope (Atli & Krystallis, 2025; Ika & Pinto, 2022).

Based on the theoretical foundation outlined, the study poses its first research question below.

RQ1: Do varying project managers' leadership styles influence the relationship between NG and PP?

Additionally, recent research suggests that governance's human and structural aspects must be studied together (Müller et al., 2016; Simard et al., 2018). Existing literature elucidates the effectiveness of optimal internal arrangements of projects (Aubry & Lavoie-Tremblay, 2018) and the joint impact of governmentality-governance structures on project success (Müller et al., 2017). In projects, the reflexive processes between humans and structures contribute to organizational choices and decisions (Bakker et al., 2016). Organizational Project Management (OPM) discourse observes project managers as responsible and accountable actors, who exist at close proximity to the project governance (Drouin et al., 2017; Müller et al., 2019; Müller et al., 2023). Thus, project managers are influenced not only by the governmentality but also by the governance structures in place. So, to understand variations in structural aspects of governance alongside human aspects effecting PP, the study selects Centralization of governance structure (CEN) and proposes the following research question.

RQ2: Do variations in CEN influence the relationship between NG and differentiated project leadership styles for PP?

Collectively, RQ1 and RQ2 answer the main research question, i.e., *do varying project managers' leadership styles and CEN in PBOs influence the relationship of NG impacting PP?* The main research question accounts for the intertwined nature of structure and human in PBOs (Archer, 2010; Müller, 2022; Turner, 2020a). This study utilizes contingency theory, due to its prevalent use in project studies to understand optimal design arrangements of PBOs (Ul Musawir et al., 2020). The study used convenient sampling to collect data from 218 PBOs performing construction projects in Pakistan. The questionnaire for data collection included measurement scales that had already been used and tested in the project and management literature. The article uses Partial Least Squares-Structural Equation Modeling (PLS-SEM) and PLS-process for assessing the measurement model, structural model, and testing hypotheses (Hair et al., 2023). Furthermore, the study uses Analytical Neural Networks (ANN) for factor ranking, model validation, and sensitivity analysis (Al-Sharafi et al., 2023; Liébana-Cabanillas et al., 2017). This study adopts critical realism as an ontological and epistemological stance, acknowledging that results may not be generalizable universally, but are context-specific and grounded in the observed dataset (Bhaskar, 2010). Theoretically, the study contributes to present a novel conceptual model to understand the mediating role of TSL and TFL, and moderating role of CEN in the relationship between NG and PP, by extending SPG (Müller, 2022). Furthermore, the study acknowledges the superiority of human's self-reflexitivity over structures (Archer, 2010; Turner, 2020a, 2020b) by utilizing NG as an antecedent variable. Practically, the study explains governors of PBOs employing NG to use lower levels of CEN and empower project manager with TFL for higher PP.

The article is structured into four further standard sections: literature review, hypotheses development and research model, methodology, data analysis and results, and discussion and conclusions.

2. Literature review, hypotheses development, and research model

This section reviews prior studies relating to NG, PP, project leadership, and CEN. This literature informs the formulation of hypotheses in response to the research questions and subsequently aids in developing the study's research model.

2.1. Neoliberal governmentality

Clegg and colleagues studied construction megaprojects where networks joined through contractual ties and established cultural norms to develop an alliance culture to foster values for members to respond (Clegg et al., 2002), i.e., NG (Dean, 2010). Later, governmentality was proposed to manage projects through dialogues, cultures, and optimistic news (Clegg & Ninan, 2023) and to manage external stakeholders using social media to create positive community engagement towards the project (Ninan et al., 2019). Another influential perspective of understanding governmentality is the SPG

(Müller, 2022; Müller et al., 2023). SPG is theoretically grounded in Archer's Realist Social Theory (ARST), which underscores human self-reflexivity while explaining the inseparable concepts of human and structure (Archer, 2010). Prior studies acknowledge three distinct ways, rationalities, and mentalities of governors, i.e., authoritative, liberal, and neoliberal (Dean, 2010). Several studies have also shown the impact of forms of governmentality on project outcomes (Müller, 2017, 2022; Müller et al., 2015; Müller et al., 2017).

Forms of governmentality are recommended to understand the internal and immediate stakeholders (Clegg & Ninan, 2023), which this study aims to achieve. NG highlights the mentalities of governors who consider the collective interests of people and their consent, leading them to voluntarily abide by the contextual frameworks that shape but may or may not determine the people's behavior (Clegg et al., 2002). This approach indicates social rationality, whereby hierarchical positions do not directly govern individuals but are influenced by social reality and subtle forces within the 'formed society'.

Thus, neoliberal approaches focus more on optimizing the societal context against differences for the benefit of the governed system rather than normalizing any individual's behavior (Lemke, 2001). NG build team members' alignment with the values and ideologies of the project to nurture self-control within basic governance structures (Franck & Jungwirth, 2003). Most projects and activity-based organizations are expected to follow this philosophy (Müller et al., 2019).

2.2. Project performance

Project success has gradually changed meanings (Ika & Pinto, 2022). Barne's iron triangle, i.e., time, budget, and quality received criticism, as it does not account for customer and stakeholder satisfaction (Berssaneti & Carvalho, 2015; Creasy & Anantatmula, 2013; Williams et al., 2015). Project success was understood as hard and soft criteria (Pinto & Slevin, 2006). Objective success factors are the hard criteria (Davis, 2014), whereas human factors are soft criteria (Imam & Zaheer, 2021). Hard and soft success factors have been quantitatively proven to account for 50% of project success (Müller & Jugdev, 2012). PP is a similar construct, concerned with the behavioral reflection of the PBOs' expectations of a project (Zhu et al., 2021). Key indicators of PP, i.e., cost, quality, and progress are augmented with key determinants such as project team relationships (Gang et al., 2016), project values (Liu et al., 2019) and stakeholder satisfaction (Xiong & Li, 2018). More recent studies, particularly in construction sector, suggest customer relations, cost, quality, schedule, collaboration and communication, environmental and stakeholder satisfaction, safety and finance to be additional performance areas (Ingle & Mahesh, 2020).

Governmentality in the public sector is associated with manager's behavior and performance (Dent, 2014; Llewellyn et al., 2015; Rhodes et al., 2009); organizational learning and performance (Gherardi & Nicolini, 2002); decision-making for performance (Kroes, 2011) and individuals' social and personal lives (Miller & Rose, 2008). Governmentality is correlated to enhanced PP (Clegg et al., 2002; Müller et al., 2017). Prior studies show positive relationship between NG and project outcomes (Müller, 2022; Müller et al., 2017). So, the study hypothesizes,

H1: NG is positively associated with PP.

2.3. Neoliberal governmentality and project managers' leadership style

Governmentality and project managers' leadership styles can influence each other; however, governmentality sets the platform for leadership to perform (Dean, 2010; Turner, 2020a, 2020b). OPM discourse presents an onion model highlighting project activities in organizations where governmentality is at a higher hierarchical level than the project leadership (Müller, 2022; Müller et al., 2019; Simard et al., 2018). NG is an indirect approach (Müller et al., 2017) exercised by the formation of ideologies and values through which the members adhere to standards by self-control (Franck & Jungwirth, 2003). Governors emphasize collective interest in a given context to achieve voluntary abidance from the members (Clegg et al., 2002). Conversely, transformational managers develop a collective vision and empower their followers by encouraging them to use imagination (Barber & Warn, 2005). They modify morales, ideals and foster values

to achieve these collective goals from their followers (Pieterse et al., 2010). Recent studies show that NG is well suited with transformational leaders in comparison to transactional leaders for the effectiveness of governance at the project level (Malik et al., 2024). On the other side, transactional leaders require goal clarity from the upper management to get the task done by their followers, using contingent reward and punishment (Winkler, 2010). Hence, NG, may not provide the direct instructions (Müller et al., 2017), required by TSL. Thus, the study hypothesizes,

H2: NG is positively associated with TFL.

H3: NG is negatively associated with TSL.

2.4. Project managers' leadership style and project performance

Leadership skills are considered an important pre-requisite for project management (Kearney et al., 2024; Mohammad Al-Naghi & Alaghbari, 2024) and project manager's leadership style is crucial for PP (Clarke, 2010; Nixon et al., 2012; Odusami, Iyagba, & Omirin, 2003). Leadership effects efficiency and effectiveness of projects (Anantatmula, 2010; Potts, 2000) and a key capability of project manager for project success (Clarke, 2010; Moradi, Kähkönen, & Aaltonen, 2020; Müller & Turner, 2010). Effective leadership styles for successful projects are not investigated much by researchers (Khan, Jaafar, Javed, Mubarak, & Saudagar, 2020). Transactional and transformational leadership styles of project managers are two differentiated concepts that are well-researched in project management (Müller & Turner, 2006; Söderlund, 2011; Tyssen et al., 2014).

Transformational leaders are effective when the environment demands creativity and openness (Raziq et al., 2018), whereas transactional leaders are endorsed for engineering projects (Müller & Turner, 2007). Both project managers' transformational and transactional leadership styles positively impact PP (Jiang et al., 2021). Thus, the study hypothesizes its next set of hypotheses.

H4: TSL is positively associated with PP.

H5: TFL is positively associated with PP.

2.5. Mediating role of project managers' leadership style

Project managers look forward to the senior management to acquire organizational support (R. Ahmed et al., 2022; Riaz Ahmed et al., 2016). Therefore, the informal and interpersonal skills of the project manager become more important in maintaining a positive relationship with the senior management (Müller & Turner, 2010). NG is differentiated in its ideology as it develops a value system for self-compliance (Clegg & Ninan, 2023; Clegg et al., 2002) and OPM discourse considers NG at a higher hierarchical level than the project manager's leadership (Drouin et al., 2017; Müller et al., 2019). Thus, the project manager's style becomes central in conceiving and shaping the value system for the project members in NG, as they act as a buffer for the translation of governmentality at the project level (Malik et al., 2024).

Different project managers in terms of management have the same authority and power prescribed by the structure of the PBOs (Müller, 2022), but they may differ in how they conceive and perform their duties as explained in introduction using McGregor's theory X and Y (1960) and Rotter's social learning theory (1954). TSL and TFL also differ in how they accomplish their tasks (Bass, 1985, 1990; Bass & Avolio, 2004; Bass & Riggio, 2006). Therefore, this variance of project managers may influence the relationship of NG and PP differently. Hence, the study proposes the hypotheses:

H6: TSL mediates the relationship between NG and PP.

H7: TFL mediates the relationship between NG and PP.

2.6. Moderating role of centralization of governance structure

Governance structures have been associated with project outcomes in project management studies (Badewi, 2022; Badewi & Shehab, 2016; Joslin & Müller, 2016; Narayanan & Narasimhan, 2014). Recent studies also highlight the moderating nature of governance while studying decision-making in projects for successful performance (Turner, 2020a, 2020b). Governance structures are also observed to moderate the relationship between the governance level and project-level human agents, i.e., governmentality and project leadership (Malik et al., 2024). Furthermore, the structural arrangements are observed to strengthen the relationship between leadership and project success (Ahmed et al., 2023). Hence, following these studies, this paper investigates the moderating effect of governance structure on the relationship between NG and project leadership styles and, eventually, PP.

This study uses CEN to differentiate the centralized versus decentralized governance structures in the PBO. CEN is a key characteristic of organizational structure (Robbins & Judge, 2008). It refers to power and authority dynamics in an organization and is associated with decision-making by the top-level hierarchy (Hage & Aiken, 1969). Highly centralized structures concentrate resources at the top (Child, 1973). NG characterized by a basic structure (Franck & Jungwirth, 2003) appears to be divergent from the concept of CEN. NG is expected to have less structure and flexibility (Lemke, 2001); thus, structures are supposed to be at a lower level of CEN in PBOs with NG. So, to investigate this, the study hypothesizes,

H8: CEN moderates the relationship between NG and PP.

Prior research suggests that a higher level of CEN is expected to heighten transactional behaviors in leaders (Sarros et al., 2002). Conversely, higher levels of CEN are supposed to suppress the empowerment required by transformational leaders (Kim & Shin, 2019). Higher CEN is also found to limit the autonomy and discretion exercised by members from primary decisions and confine them to defined boundaries (Sarros et al., 2002). NG and TFL are observed to be aligned, whereas NG contrasts with TSL for effectiveness of governance at the project level (Malik et al., 2024). Hence, to investigate this, the study hypothesizes,

H9: CEN moderates the relationship between NG and TSL.

H10: CEN moderates the relationship between NG and TFL.

According to leadership contingency theory, leadership effectiveness is contingent upon the contextual elements of the organization (Fiedler, 1996; Fiedler & Chemers, 1967; Katz & Kahn, 2015; Pawar & Eastman, 1997). Therefore, to assess the impact of human and structural governance on PP through varying project leadership styles, we propose the following hypotheses:

H11: CEN moderates the relationship between NG and PP mediated by TSL.

H12: CEN moderates the relationship between NG and PP mediated by TFL.

The current study chooses NG as an antecedent variable to investigate these human and structural aspects of governance impacting PP. The conceptual model treats NG as antecedent variable due to following reasons. The hierarchical positioning of NG is higher than the project managers (Drouin et al., 2017; Müller, 2022; Müller et al., 2019). Similarly literature suggests governmentality to be a steering-level phenomenon (Müller, 2017, 2022; Müller et al., 2019; Müller, Pemsel, & Shao, 2014; Müller et al., 2014; Müller et al., 2015) and among structural and human agents, it is the latter who take decisions (Turner, 2020a, 2020b, 2023). Humans are self-reflexive and can navigate structures through deliberation (Archer, 2010). In contrast, structures lack this capacity.

Project managers' leadership style acts as a buffer for the translation of governmentality at the project level (Malik et al., 2024) and is observed to influence PP (Clarke, 2010; Müller & Turner, 2006, 2010; Nixon et al., 2012; Raziq et al., 2018). Several studies in project management literature relate project manager's leadership styles to PP (Müller & Jugdev, 2012; Müller & Turner, 2007; Müller & Turner, 2006; Nixon et al., 2012; Turner, Müller, & Dulewicz, 2009). This study perceives that project managers with both leadership styles can be present in PBOs (Jiang et al., 2021) governed under NG. Hence, TFL and TSL act as differentiation between human actors at the project level.

Prior studies have shown the moderating effects of structural aspects of governance in project management research (Badewi & Shehab, 2016; Joslin & Müller, 2016; Narayanan & Narasimhan, 2014). Hence, following these studies, this study investigates the moderating role of governance structures. We use centralized versus decentralized decision-making (Burns & Stalker, 1961; Sine et al., 2006) to understand the dynamics of structural aspects of governance vis-à-vis human aspects of governance and PP. This study tries to understand project managers' leadership variations via transformational and transactional styles (Bass, 1990). It must be noticed that both leadership styles are different ways to get the task done (Bass, 1985, 1990), and the effectiveness of any leadership style depends on the context provided (Fiedler & Chemers, 1967). In this study, the context is characterized by NG and the degree of CEN. The conceptual model of the research is presented in Figure 1.

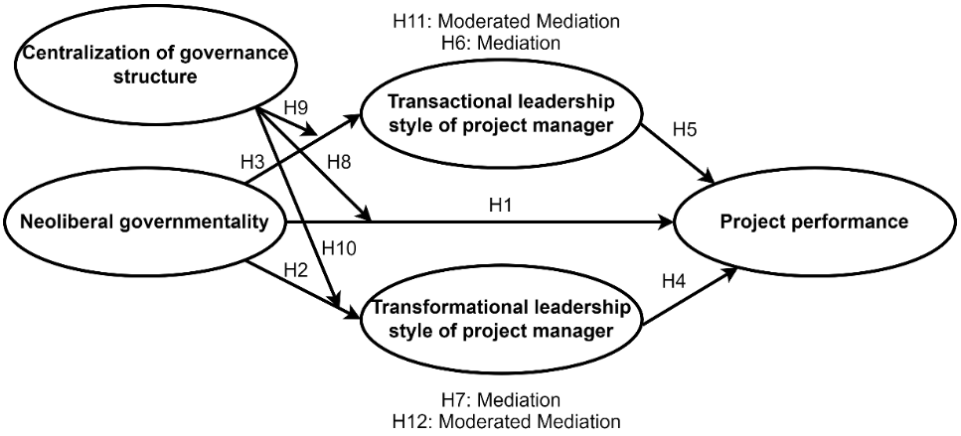

Fig. 1. Conceptual model of the study

3. Methodology

The study follows confirmatory theory to accept or reject the proposed hypotheses (Henseler et al., 2016). The conceptual model (Figure 1) was tested with PLS-SEM using Smart PLS for analysis (Hair et al., 2023; Hair et al., 2016; Hair Jr & Sarstedt, 2019). PLS-SEM is suitable for data samples that are small and skewed, requiring complex modeling such as mediation, moderation, and moderated mediation (Hair Jr & Sarstedt, 2019; Sarstedt et al., 2021; Shmueli et al., 2019). The study follows the guidance provided by Cheah and colleagues for moderating mediation testing using PLS-Process (Cheah et al., 2021). Lastly, the study uses an artificial neural network approach to check the model's robustness, accuracy, and ranking of the key variables (Liébana-Cabanillas et al., 2017).

3.1. Measurement development

This study uses five variables, i.e., NG , PP, TFL, TSL and CEN. All the variables were measured on previously used and tested measurement scales. Items for each scale are presented in Appendix A. The study adapted a five-point Likert scale (from 1-strongly disagree to 5-strongly agree) for all the variables. A three item scale was adopted for NG i.e., independent variable (Müller et al., 2017) and a six item scale for PP i.e., the dependent variable (Rodrigues et al., 2014). TSL and TFL as mediators were measured on four and five items scales respectively (Masa'deh et al., 2016). CEN as moderator was measured on three item scale (Kaufmann et al., 2019). Gender, education, sector, project experience were used as control variables (Zhu et al., 2021).

3.2. Sample and data collection

The study collected primary data by using a structured questionnaire to obtain responses from project-based organizations in Pakistan's construction industry. Construction industry suits this research, as highlighted in the introduction of this article. Convenience sampling was employed to ensure a maximum response rate for the research. Before circulation of the questionnaire, a pilot study was conducted from 36 practitioners and three Professors in project management discipline, who made constructive changes for sequence and flow of the questionnaire. The target population comprised of governors, project directors, project management offices, project managers, assistant project managers, and project team members working in construction sector PBOs. Personal contacts and their industry linkages were utilized to administer the questionnaire to right audience. Personal visits were also done to get the feedback of the respondents. A total of 250 questionnaires were circulated by visiting PBOs using industry contacts. Out of 286 responses (including pilot study responses), 218 dully filled questionnaire were sorted to be used for the final analysis. This number meets the statistical requirement i.e., 10 responses against each item (Hair et al., 2016). A summary is presented in the Table 1.

Table 1. Detailed information of respondents

Content	Category	Coding	Frequency	Percentage (%)
Gender	Male	1	133	61.0
	Female	2	85	38.9
Sector	Public	1	54	24.7
	Private	2	89	40.8
	Public-Private Partnership	3	75	34.4
Education	Undergraduate	1	24	11.1
	Graduate	2	68	31.1
	Masters	3	99	45.4
	PhD	4	27	12.3
Project Skill	Beginner	1	36	16.5
	Intermediate	2	107	49.1
	Expert	3	75	34.4
Experience in Projects (Years)	<5years	1	60	27.5
	5–10 years	2	82	37.6
	11–15years	3	67	30.7
	>15years	4	9	4.2
Employees in Organization	1–500	1	65	29.8
	501–1000	2	92	42.2

Content	Category	Coding	Frequency	Percentage (%)
Unit size of project team	1001–above	3	61	27.9
	100-250	1	60	27.5
	251–500	2	87	39.9
	501–above	3	71	32.5
Budget of project ($mm)	<5	1	63	28.8
	5–10	2	121	55.5
	10–15	3	25	11.4
	>15	4	9	4.2

Note(s): Number of respondents (N=218)

4. Data analysis and results

4.1. Common method bias

Common method bias (CMB) variance is a primary issue in self-reported data (Schwarz et al., 2017) and happens when respondents fill in data for exogenous and endogenous variables (Podsakoff et al., 2003). The study follows the guidelines of earlier studies to minimize CMB variance (Podsakoff & Organ, 1986). Firstly, the respondents were assured of the data confidentiality and anonymity. Secondly, respondents were told that there were no right or wrong answers to the question. Thirdly, respondents were asked to respond according to the last project participated as a reference.

After data collection, the study checked for any CMB concerns using two methods. First, Herman's single factor test indicated that there is no single factor that accumulated above 46.2%, which is less than the suggested cut-off value (Harman, 1976). The second method is full collinearity assessment using Smart PLS software (Shahzad et al., 2020). All the variance inflation factors (VIF) for the inner model were below the minimum threshold presented in Table 2. VIF<3.33 indicates that a study is free from CMB (Kock, 2015).

Table 2. Results of full collinearity assessment

Inner Model Paths	Collinearity Statistics (VIF)
NG → PP	2.564
NG → TFL	1.000
NG → TSL	1.000
TFL → PP	2.442
TSL → PP	1.081

4.2. Measurement validation

Measurement model assessment in PLS-SEM (Hair et al., 2023; Hair et al., 2016; Sarstedt et al., 2021) checks the reliability and validity of the constructs in the model. All the values of Cronbach's alpha (α) and composite reliability (CR) are less than 0.70 (Hair et al., 2016). Next, for convergent validity, the accepted values of average variance extracted (AVE) are greater than 0.50 (Sarstedt et al., 2021). Further, factor loadings for each item of the construct presented standard values (Cohen, 1988, 2013). Detailed information about reliability values and convergent validity of the measurement model is presented in Table 3.

Table 3. Construct reliability and validity

Constructs	OL	α	CR	AVE
NG		0.881	0.927	0.808
NG1:	0.894			
NG2:.	0.883			
NG3:	0.923			
CEN		0.914	0.946	0.853
CEN1:	0.935			
CEN2:	0.916			
CEN3:	0.920			
PP		0.923	0.940	0.723
PP1:	0.730			
PP2:	0.881			
PP3:	0.859			
PP4:	0.891			
PP5:	0.862			
PP6:	0.868			
TFL		0.927	0.945	0.773
TFL1:	0.891			
TFL2:	0.866			
TFL3:	0.898			
TFL4:	0.850			
TFL5:	0.891			
TSL		0.928	0.948	0.820
TSL1:	0.878			
TSL2:	0.914			
TSL3:	0.905			
TSL4:	0.924			

Note(s): OL= Outer loadings, α= Cronbach's Alpha; CR= Composite Reliability; AVE= Average Variance Extracted

4.3. Discriminant validity

The measurement model's discriminant validity (DV) was subsequently assessed using two methods. All the square root values of AVE were significantly higher than the correlation of all used constructs in parallel rows and columns, establishing DV as per Fornell and Larcker criterion (Fornell & Larcker, 1981). These results are depicted in Table 4. A more contemporary method for DV assessment is the Heterotrait-monotrait (HTMT) correlation ratio (Henseler et al., 2016). HTMT values were lesser than the standard cut-off value of 0.85. Hence, this method also established DV for the study depicted in Table 5.

Table 4. Discriminant validity- Fornell and Larcker criterion

	NG	CEN	PP	TFL	TSL
NG	0.899				
CEN	0.661	0.924			
PP	0.612	0.579	0.850		
TFL	0.762	0.610	0.617	0.879	
TSL	-0.233	-0.188	-0.004	-0.085	0.906

Table 5. Discriminant validity- Heterotrait-monotrait ratio (HTMT) matrix

	NG	CEN	PP	TFL	TSL
NG					
CEN	0.735				
PP	0.674	0.625			
TFL	0.840	0.660	0.657		
TSL	0.251	0.189	0.059	0.091	

4.4. Structural model assessment

The structural model is generally assessed before hypothesis testing (Hair et al., 2023; Hair et al., 2016). Predictive and explanatory power for the structural model were assessed using R^2, Q^2, f^2, and path coefficient (β) values of the variables in the study. The R^2 value of the model was observed for TFL=0.581, TSL 0.054, and PP=0.440. R^2 values of 0.26 are considered substantial, 0.13 moderate, and 0.02 weak for an endogenous latent variable (Cohen, 1988, 2013). Hence, the overall model of the study has reasonable explanatory power in terms of R^2 values.

The model's predictive power requires further recommended precautions such as assessment of Q^2 and f^2 values (Sarstedt et al., 2021). Q^2 values presented in Table 6 and f^2 values presented in Table 7 fall in the acceptable range (Cohen, 1988); thus, the model has predictive relevance.

Table 6. Predictive power from the Q-square of the endogenous latent variables

	SSO	SSE	Q^2 (=1-SSE/SSO)
PP	1308.000	898.767	0.313
TFL	1090.000	605.575	0.444
TSL	872.000	835.975	0.041

Table 7. Predictive power from f-square of the endogenous latent variables

Path	f^2
NG → PP	0.104
NG → TFL	1.388
NG → TSL	0.057
TFL → PP	0.081
TSL → PP	0.021

The study used standardized mean square residual (SRMR) for model fitness with an observed value of 0.050, which is less than 0.08 to establish model fitness (Hair et al., 2023; Hair et al., 2016; Hair Jr et al., 2019; Kline, 2005).

4.5. Hypothesis testing

The study used the recent recommendation of taking 10,000 bootstraps rather than 5,000 to analyze hypotheses (Hair et al., 2017). Results for direct effects, mediation and simple moderation are illustrated in Table 8.

Table 8. Summary of results for direct, mediating and moderating effects

Hypotheses	β	SE	T	R^2	Results
Direct Effects					
H1: NG→PP	0.386***	0.099	3.915		Supported
H2: NG→TFL	0.762***	0.042	18.023		Supported
H3: NG→TSL	-0.233**	0.071	3.274	0.440	Supported
H4: TFL→PP	0.332***	0.100	3.303		Supported
H5: TSL→PP	0.114**	0.049	2.305		Supported
Mediating Effects					
H6: NG→TSL→PP	-0.026**	0.014	1.893	0.054	Competitive Partial Mediation
H7: NG →TFL→PP	0.253***	0.076	3.327	0.581	Complementary Partial Mediation
Moderating Effects					
H8: CEN*NG→PP	-0.200**	0.063	3.189	0.504	Supported
H9: CEN*NG→TSL	-0.067	0.082	0.8822	0.060	Unsupported
H10: CEN*NG→TFL	-0.228**	0.076	3.009	0.638	Supported

Note(s): (1) ***p =< 0.001 **p < 0.05 | (2) β = Path Coefficient, SE = Standard Error, T = T-value

The analysis revealed that all the direct effects i.e., H1, H2, H3, H4 and H5 were significant. All the selected control variables in the study showed insignificant p-values for PP, e.g., gender (β= 0.118, t =1.214, p = 0.112); education (β= -0.020, t=0.481, p=0.315); sector (β= 0.031, t = 0.612, p= 0.270); employee in the organization (β= 0.001, t = 0.017, p = 0.493) unit size of project team (β= -0.029, t =0.574, p = 0.283); and experience in projects (β= 0.037, t =0.751, p = 0.226). The results of H6 and H7, i.e., mediation, were assessed and interpreted following the guideline of previous literature (Nitzl et al., 2016). TSL partially mediate the relationship between NG and PP, but in competitive manner. On the other side, TFL mediate the relationship between NG and PP in a complementary manner. The results for moderation for H8 showed that CEN dampens the relationship between NG and PP. On the contrary, H9 was not supported, as the results indicated that there is no significant impact of CEN on the relationship between NG and TSL. This study supports H10 as with increased CEN, the relationship between NG and TFL is dampened. Furthermore, slope analysis of the 'supported' hypotheses i.e., H8 and H10, are presented in Figure 2.

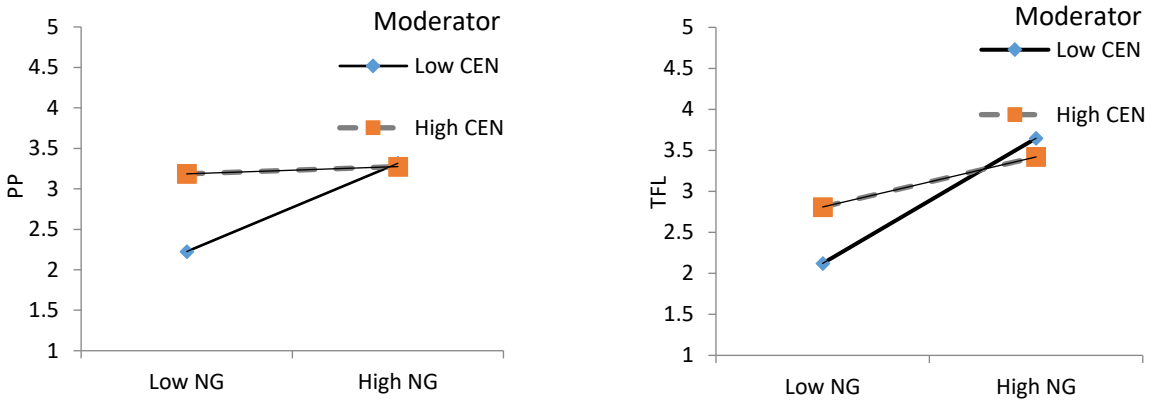

Fig. 2. Slope analysis

This study uses the SmartPLS-4 process tool to analyze and interpret moderated mediation results for hypotheses H11 and H12, following guidelines from literature (Cheah et al., 2021; Hayes, 2015, 2018). The results for moderating mediation and probing moderated indirect effects are presented in Table 9.

Table 9. Moderated mediation results

Hypotheses	β	SE	T	Result
Moderated Mediation Effects				
H11: CEN*NG →TSL →PP	-0.008 *(ω)*	0.011	0.717	Unsupported
H12: CEN*NG →TFL →PP	-0.063** *(ω)*	0.031	2.004	Supported
Probing Moderated Indirect Effects (H12)				
High Level of CEN	0.096**	0.050	1.926	
Mean Level of CEN	0.171***	0.048	3.575	
Low level of CEN	0.246***	0.070	3.514	

Note(s): *ω 1* = Index of moderated mediation for H11= *ω*=[(CEN*NG→ TSL) *(TSL→PP)]
ω 2 = Index of moderated mediation for H12= *ω*=[(CEN*NG→ TFL) *(TFL→PP)]

Interpreting Table 9, the results indicate that there is neither moderating mediation and subsequently no moderated indirect effects for H11 on the path. However, there is a significant and negative CoMe effect for H12. Therefore, probing moderated indirect effects for H12 showed that with the increase in CEN, the indirect effect of NG on PP through TSL is reduced and vice versa.

To understand the indirect effects, the study used Johnson and Neyman's Plot to explain the *CoMe* effect (Preacher et al., 2007). It can be seen in Figure 3 that mediation of the TSL between NG and PP is inversely contingent upon moderation by CEN. We present the finalized model of the study in Figure 4.

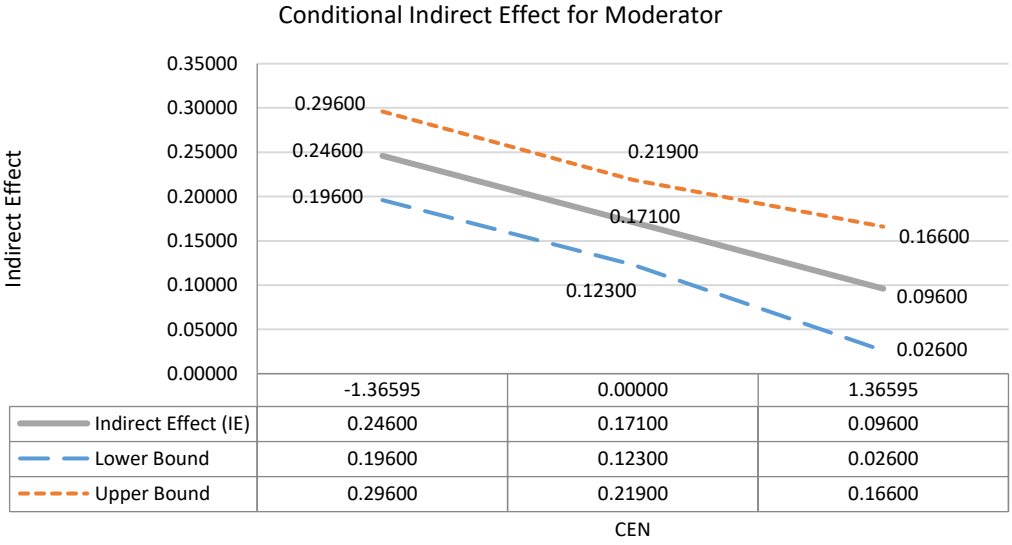

Fig. 3. Moderated mediation plot

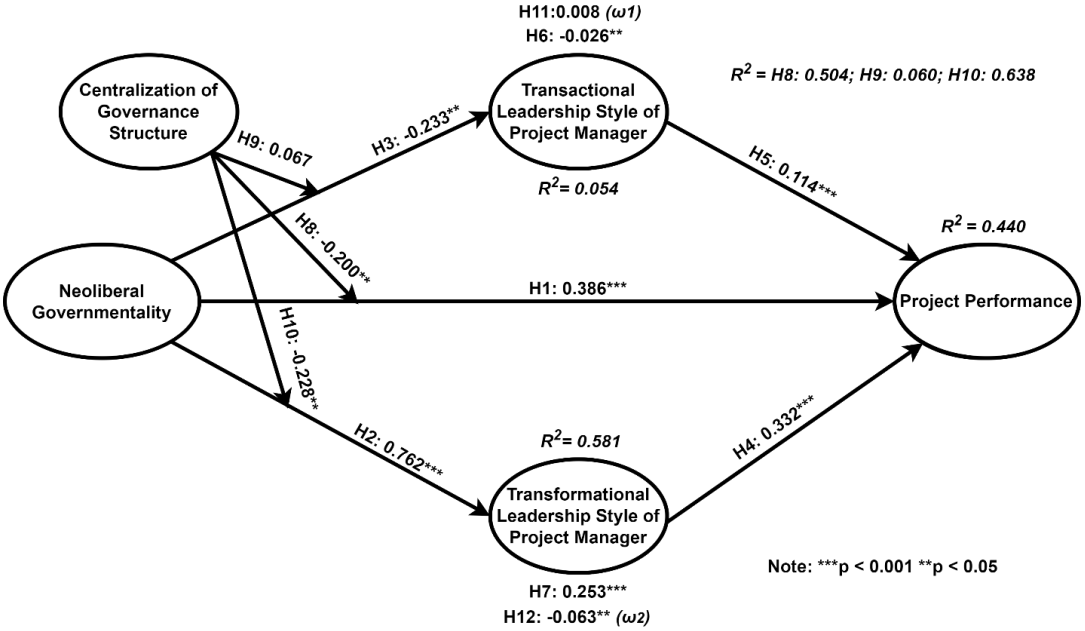

Fig. 4. Finalized model of the study

4.6. Robustness check using artificial neural network approach

This study uses a typically used and well-known artificial intelligence type, the multi-layer perceptron (MLP), to train the neural networks. This study models the neural network, consisting of several hierarchical layers, in SPSS 26.0., following the steps presented in literature (Latif et al., 2024; Liébana-Cabanillas et al., 2017; Shahzad et al., 2022). The Average Root Mean Square Error (RMSE) for PP was 0.460 for training data and 0.456 for testing data, showing a slight difference which confirms that the model generalizes well to the unseen data. The standard deviation assessment for all the RMSE values of the training and testing data set were 0.026 and 0.068, respectively. Therefore, the study considers the model to have acceptable predictive power. These results are shown in Table 10.

Table 10. Neural network validation

	Training data			Testing data		
Neural network	*N*	Sum of square error	RMSE	*N*	Sum of square error	RMSE
1	153	37.027	0.492	65	8.478	0.361
2	162	29.374	0.426	56	12.655	0.475
3	150	31.169	0.456	68	13.981	0.453
4	149	30.186	0.450	69	16.756	0.493
5	157	30.628	0.442	61	14.325	0.485
6	157	29.421	0.433	61	18.648	0.553
7	142	34.481	0.493	76	7.717	0.319
8	146	35.996	0.497	72	17.187	0.489
9	157	31.620	0.449	61	13.662	0.473
10	156	35.900	0.480	62	14.688	0.487
Average			0.460			0.456
SD			0.026			0.068

Note(s): Average Root Mean Square Error (RMSE), *N* refers to the total number of samples, SD refers to the standard deviation

Subsequently, the study performs a sensitivity analysis to assess the influence and ranking of the covariates. The values in Table 11 imply that CEN is the most important predictor of PP after the transformational project manager, with a value of 98.38, followed by NG (68.13). TSL remains the least important predictor for PP in this research, with a value of 51.63. Sensitivity analysis results demonstrate that optimization of the predictor with the highest value results in better outcomes in the observed dataset and improves the model efficiency.

Table 11. Sensitivity analysis

Neural networks	NG	CEN	TFL	TSL
1	0.134	0.231	0.540	0.095
2	0.134	0.309	0.370	0.184
3	0.165	0.422	0.362	0.051
4	0.150	0.368	0.324	0.159
5	0.417	0.174	0.258	0.151
6	0.262	0.290	0.232	0.216
7	0.132	0.422	0.260	0.187
8	0.286	0.253	0.224	0.237
9	0.179	0.259	0.404	0.158
10	0.281	0.364	0.170	0.185
Average Importance	0.214	0.309	0.314	0.162
Relative Importance	0.681	0.984	1	0.516
Normalized Importance	68.13	98.38	100	51.63

5. Discussion and conclusion

5.1. Discussion

The study presents a novel conceptual model to understand the intra-organizational dynamics of humans and the structure for PP in NG using SPG. The study is grounded in, but not restricted to the OPM discourse, that relates all the project activities in hierarchical levels. This model is instrumental in understanding the impact of NG on PP, with varying leadership styles of project managers serving as mediators. NG, governance structures and project managers' leadership styles have been seen as precursors of project outcomes by several studies, but in isolation. However, this study shows the association among these variables to envision their mutual influence on project performance. The study also stresses the role of governance structures as a moderating variable and establishes a link between the human aspects at the governance (NG) and the execution level (a specific project managers' leadership style).

Research shows that NG can impact project performance, however, project managers' leadership that buffers it at the project level is neglected. There is overwhelming evidence that shows effective communication and networking are highly valued in comparison to task-oriented project managers for successful construction projects (Ashok et al., 2024). However, the association of varying styles of leaders in a certain governmentality-governance context remained absent in the literature. The present study acknowledges that there can be different project managers' leadership styles in construction sector (Jiang et al., 2021) and identifies them as mediators for the impact of NG on PP. Furthermore, the study uses ARST (Archer, 2010) to relate the governance structure's moderating effect on human interactions of NG and project managers' leadership styles for PP. We respond to the research questions below to discuss the results of this study further.

RQ1: Do varying project managers' leadership styles influence the relationship between NG and PP? Results revealed that project managers' leadership style do provide mediation between NG and PP. However, the effects of mediation may vary, as different leadership styles of project managers mediate the relationship between NG and PP in distinct ways. Transformational leaders as project managers positively mediate the relationship between NG and PP. These leaders

desire an institutional environment that empowers them and lets them flourish when the neoliberal style of governors is in place (Barber & Warn, 2005; Bass, 1985, 1990; Bass & Riggio, 2006; Pieterse et al., 2010). This study confirms that human dimensions of NG at governance level and TFL at the project level synchronize (Malik et al., 2024) for PP. Despite TSL positive impact on PP, it was considerably lesser compared to TFL impact on PP. Furthermore, TSL showed a competitive mediation between neoliberal governors and PP. A plausible reason for the negative relationship between NG and TSL could be the absence of clear directions from governors in NG. Prior research also explains this characteristic of transactional leaders who are prone to taking clear directions from the top managers to accomplish their tasks using rewards and punishments (Bass, 1985, 1990; Winkler, 2010). Our results are aligned with prior research in construction sector that supports transformational behaviors of project managers for better project outcomes (Ashok et al., 2024).

RQ2: Do varying CEN influence the relationship between NG and differentiated project leadership styles for PP? Results showed interesting insights regarding the moderation effect of CENs on the human aspects of governance at the steering and project level for PP. Results showed that CEN dampened the relationship of NG with PP. This result was expected because of the contrasting characteristics of CEN and NG. CEN means accumulation of power, information, decisions, and resources at the top management hierarchy (Child, 1973; Hage & Aiken, 1969), whereas NG is characterized to have flexible structures (Franck & Jungwirth, 2003) decentralized decision making in comparison to authoritative governmentality (Dean, 2010). Therefore, our research extends the existing knowledge about the structural aspects of governance and highlighted their moderating effect on human aspects for influencing PP. Results of the study indicated that CEN dampened the relationship between NG and TFL. Prior studies have also shown that the CEN of the structure halts the effectiveness of transformational leaders (Kim & Shin, 2019; Sarros et al., 2002; Walter & Bruch, 2010). Furthermore, the results indicated that there was no moderation effect of CEN between the relationship of NG and TSL. Prior studies also indicate that TSL are less likely to be observed in context of NG due to contrasts between the two styles. The same insignificant effect was reciprocated in the indirect effects of moderation on the TSL' mediated relationship of NG and performance. However, TFL as mediators are moderated by lower levels of CEN to enhance the association of NG with PP. This finding aligns with the traditional viewpoint that leadership effectiveness depends on contextual factors within organizational boundaries (F. E. Fiedler & Chemers, 1967).

RQ: Do varying project managers' leadership styles and CEN in PBOs influence the relationship of NG impacting PP? The study answers the main research question by replying to the above initial questions. The relationship between NG and PP is associated through the mediation of TFL, and lower levels of CEN can improve the overall relationship. However, this relationship has competitive partial mediation through TSL, and there is insignificant moderation of CEN in this relationship. Furthermore, the model is validated using a neural network approach. The ranking of variables shows that transformational leadership is mostly associated with PP. CEN is the second most important variable in this model to predict the outcome; it moderates the relationship between two human aspects of NG and project managers' leadership styles. Lastly, TSL are the least important among the studied variables in the model to predict PP. Furthermore, based on the results, the study recommends the TFL suitability for NG's impact on PP. Conversely, TSL in such governance arrangement are undesirable and may prove detrimental to PP. Therefore, the study concludes that one man's meat is another man's poison.

5.2. Theoretical contributions

This study has several theoretical contributions. Firstly, the study extends the SPG (Müller, 2022; Müller et al., 2023) by presenting a conceptual model to understand the human vs structure interactions for PP. The presented model elucidates the variations of the variables at the project level and helps to understand their mutual effect on PP in NG. Secondly, the model illuminates the mediating effect of varying project managers' leadership style on the relationship between NG and PP. The crucial role of project managers in project governance is known (Müller et al., 2019), nonetheless, the variations of their styles in context of NG is novel. Thirdly, the model explains the moderating nature of governance structures by using CEN as a moderator between human aspects at different levels and PP. Prior studies explain the moderating role of

governance structures (Müller & Martinsuo, 2015; Müller et al., 2016). Furthermore, the study acknowledges and adds to the theorization of humans' self-reflexivity compared to the structure (Archer, 2010) by using NG as an antecedent variable and CEN as moderator.

Lastly, previous studies have linked NG (Clegg & Ninan, 2023; Müller et al., 2017; Ninan et al., 2019), governance structures (Badewi & Shehab, 2016; Joslin & Müller, 2016; Narayanan & Narasimhan, 2014) and project managers' leadership styles (Müller & Turner, 2010; Nixon et al., 2012; Raziq et al., 2018) with PP in isolation, however this study checks the combined effect of these variables on PP. This model, thus, contributes to OPM discourse (Drouin et al., 2017; Müller et al., 2019).

5.3. Managerial implications

The study's findings have several practical implications for project owners, governors, and practitioners in construction sector. Project managers' leadership style is interwoven with the governance of a PBO for achieving PP. Hence, hiring project managers must include assessing interpersonal skills apart from their technical expertise. In other words, owners and governors need to understand the importance of behavioral aspects of project managers that could facilitate or hamper the project outcomes. This exercise can save them from unexpected results in terms of PP. Furthermore, appointed project managers must be provided training and communication opportunities to better understand their roles and act in abidance with the NG.

Conversely, neoliberal governors must consider the importance of alignment of structures in place. CEN clamps authority, decision making, and resources at the top. In such a case, the projects may suffer from conflicts, due to sabotaged project managers autonomy for minor decisions. Governors can make required adjustments in the structures to meet the project requirements. The foremost aim of the neoliberal governors is to align their structures with their own style and select appropriate project managers. This can create synergies among the humans and structures, eventually increasing the probability of successful projects.

5.4. Limitations and further research

This study has a few limitations. Firstly, other levels lie in between governors and project managers, for example, portfolio managers (Derakhshan et al., 2019). However, the study followed existing conceptualization that mutually positions governors and project managers in a single frame (Müller, 2022). Also, the neoliberal governors have collective visions that are expected to translate to portfolio managers in a similar fashion to the project managers. Prior studies have also used these two levels to research governance interface (Müller et al., 2016; Pisotska et al., 2022; Winch et al., 2022). Secondly, CEN was the only dimension used for assessing the moderation of governance structures, whereas there are many other dimensions of organizational structures (Burns & Stalker, 1961; Sine et al., 2006). However, researchers have shown that all the constructs of structure might not explain a specific structure, and CEN is a key factor in distinguishing organizational structure (Hage & Aiken, 1969; Robbins & Judge, 2008). Lastly, the dataset was collected from the construction industry in Pakistani PBOs. Therefore, the study restricts the generalizability of results, hence, grounded in critical realism stance (Bhaskar, 2010).

The area of the studied research is critical in order to understand the intricacies of human and structures during their interactions at the project level for PP. Governance and management are entangled concepts in terms of project outcomes. Therefore, assessing disparities in the governmentality, project managers' leadership styles and structures can provide recipes for higher performance and lower performance. Future research can provide different recipes and solutions for achieving high performance due to variations of studied variables or vice versa. Other studies could also replicate the model for other forms of governmentality (authoritative and liberal) to understand the context-specific implications. Subsequent studies may validate these findings in other sectors to explore potential sector-specific dynamics among human and structural aspects of governance for enhanced PP.

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Appendix A. Questionnaire

First section of the questionnaire focused on demographic information. Gender, sector, education, project skill, project experience, employees in organization, unit size of the project and budget of the project were used as control variables following Zhu et al., (2021). Ranges for each asked question are mentioned in detailed information of the respondents in Table 1.

Second section adapted measurement items from existing studies on a five-point Likert scale (from 1-strongly disagree to 5-strongly agree). The items of each variable and relevant reference is provided below.

No.	Code	Item description	Variable and reference
1.	NG1	In my project, the project governance institution communicates values and fosters a culture that allows the project manager/team to control themselves	Neoliberal governmentality (NG) (Müller et al., 2017)
2.	NG2	In my project, the project governance institution expects the project manager and team to decide for themselves based on the collective interest of the stakeholders in the project.	
3.	NG3	In my project, the project governance institution rarely steers the project through directive orders.	
4.	CEN1	I must check with my supervisor before I do almost anything	Centralization (CEN) (Kaufmann et al., 2019)
5.	CEN2	Even small matters have to be referred to someone higher up for a final answer	
6.	CEN3	In general, an employee wanting to make their own decisions in my workplace would be quickly discouraged	
7.	PP1	Compared to the original plan, the project has achieved its progress targets well	Project Performance (PP) (Rodrigues et al., 2014)
8.	PP2	Compared to the original plan, the project has achieved its cost targets well	
9.	PP3	This project has effectively met the technical specifications required by the original plan	
10.	PP4	The project has met the quality standards originally planned	
11.	PP5	The project has been recognized and approved by customers	
12.	PP6	The project has given the company good income and market share	
13.	TFL1	My project manager encourages me to take on challenges	Transformational and transactional teadership style (TFL and TSL) (Masa'deh et al., 2016)
14.	TFL2	My project manager encourages me to think about problems from a new perspective	
15.	TFL3	My project manager displays a sense of power and confidence	
16.	TFL4	My manager helps me to strengthen my abilities	
17.	TFL5	My manager spends time coaching and teaching me	
18.	TSL1	When I am unable to complete my work, my manager reprimands me	
19.	TSL2	My manager precisely records any of my mistakes	
20.	TSL3	My manager gives me what I want to exchange for my hard work	
21.	TSL4	My manager tells me that I can get special rewards when I show good work performance	

Biographical notes

Muhammad Yousaf Malik is a Lecturer in Business Administration at the Institute of Business Management Sciences, University of Agriculture Faisalabad, Pakistan. He holds a Ph.D. in Business Administration with a specialization in Project Management from Dalian University of Technology, China. With over a decade of experience in teaching and research, Dr. Malik is a dedicated academic committed to advancing knowledge and practice in his field. His research interests encompass project governance, leadership, human resource management, and marketing.

https://orcid.org/0000-0001-8310-4646

Linzhuo Wang, PhD, is an Associate Professor of Project Management at BI Norwegian Business School, and concurrently serves as an Adjunct Associate Professor in the Department of Engineering Sciences at Agder University, Norway. Dr. Wang is a member of the Academic Insight Team of the Project Management Institute (PMI), Associate Editor for the *International Journal of Managing Projects in Business* (ijMPB). He was recognized as one of PMI's 2025 Future 50. His research focuses on project resilience, project network governance, and project leadership.

https://orcid.org/0000-0002-4521-1333

Fangwei Zhu, PhD, is a Professor at School of Economics and Management in Dalian University of Technology, China. He is also the President of Zhongnan University of Economics and Law, China. As Executive Director of the China Management Case Sharing Centre, he leads research in organizational project management, network governance, and EPC project management. His expertise is documented in 60+ publications (including 6 books) and six consecutive "Top-100 Chinese Management Cases" awards.

Muhammad Salman Latif holds a PhD in Management Sciences and Engineering from Dalian University of Technology, China. He is currently a Postdoctoral Fellow at the School of Management and Economics, North China University of Water Resources and Electric Power, Zhengzhou, Henan, China. His research focuses on information management, online communities, human–AI interaction, and value co-creation. He was awarded the Academic Star Award (2024) by the School of Economics and Management, Dalian University of Technology, in recognition of his academic contributions. He has published several peer-reviewed articles in leading international journals, including Internet Research, Information Technology & People, and Behaviour & Information Technology. He also serves as a reviewer for multiple high-impact journals in the fields of information systems and management science.

https://orcid.org/0000-0002-4627-9217