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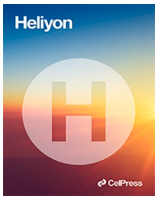

Research article

Development and validation of the project manager skills scale (PMSS): An empirical approach

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ABSTRACT

This paper presents the development and validation of the Project Manager Skills Scale (PMSS), a novel instrument designed to quantify and evaluate the critical skills of project managers. The PMSS is anchored in a comprehensive literature review and expert feedback and identifies five key dimensions of project manager skills: Technical Skills, Managerial Competences, Communication Skills, Management Style-Leadership, and Technological and Methodological Competences. The discovery of an additional fifth dimension in this study underscores the multidimensional nature of project manager skills and deviates from the initial four-cluster expectation outlined in the project management literature. The research framework employed in this study incorporated exploratory and confirmatory factor analysis. Empirical data were gathered from 257 project managers. The criteria for respondent selection were familiarity with the concept of project management and current or past engagement in a project. The findings reveal the relative importance of each dimension and highlight the multifaceted nature of project management. The study emphasizes the need for a balanced skill set that encompasses technical expertise, managerial competences, communication skills, leadership qualities, and technological and methodological competences to achieve successful project outcomes. Despite its significant contributions, this study acknowledges its limitations in terms of geographical scope and sample diversity and suggests future research directions for the development of a universally applicable understanding of project manager skills.

1. Introduction

Project success is a multifaceted and subjective concept, with varying perceptions that are influenced by a multitude of factors such as individual perspectives, professional experiences, and the specific contexts in which projects operate [1]. Some project managers may define success as the completion of projects within stipulated time and budget constraints, thereby ensuring customer satisfaction [2–4]. Others may prioritize effective communication, successful cooperation, and stakeholder involvement as their primary success criteria. The realm of project management is increasingly complex and diversified, necessitating a deeper understanding of the factors that contribute to project success. The topic of critical success factors in project management has been extensively explored in

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academic research. The past few decades have produced a number of investigations into the correlation between project managers' competencies and project success. As a result, competencies lists have become extensive "shopping lists", according to Alvarenga et al. [5]. Carvone [6] emphasized the importance of effective communication within projects, acknowledging that his research merely scratched the surface of potential communication-related issues and suggesting that future research should delve into this area in greater depth. Similarly, Wen-Hsing and Cross proposed a model of technical performance for project teams, highlighting the need for future research to identify additional people-oriented influencing factors [7]. Tereso et al. [8] focused on project management within private organizations and proposed the development of a decision-making model that incorporates the characteristics of those responsible for implementation. Reviewing the literature reveals a number of studies that underscore the importance of human-centered factors (including project managers and project teams) as critical determinants of project success.

Extensive research has been conducted on this broad concept, yet fewer studies have concentrated on the critical role played by the competencies of project managers. In an environment marked by myriad variables influencing project outcomes, the competencies of the project manager often emerge as a pivotal determinant of success. These competencies encompass a broad spectrum of skills, from technical acumen to managerial aptitude, communication prowess to leadership style, and technological and methodological expertise. This paper includes a large number of competencies, summarized and condensed from a large number of researches, i.e. scientific works, of other authors who dealt with this topic, more precisely the field that includes project management and human resources management, since the paper analyzes the key performances that affect the success of the project, which relate to and depend on the project manager. If we take into account that people, and especially the project manager, are the priority and imperative resource of every project, it is important to determine which abilities and skills have an impact on the success of the project, as well as to what extent this impact is reflected, and this is precisely where the greatest importance of this work could be seen. Despite this, the existing literature lacks a comprehensive measurement scale that captures the full array of these competencies and their influence on project success. Recognizing this gap in the literature, the primary goal of this research is to bridge this gap with the development and validation of a novel Project Manager Skills Scale (PMSS) measurement scale. Five dimensions are shown in the paper, namely the 'communication skills' (analyzing the importance of a project manager's communication abilities for project success), the 'technical knowledge' (evaluating the significance of the project manager's technical acumen for successful project completion), the 'management skills' (summarizing management skills of the project manager necessary for successful implementation), the 'management style-leadership' (review of the management styles and key characteristics of the project manager, which will help in the most effective way to achieve the project goals, in accordance with the set plans) and the 'technological and methodological competences' (analyzing the significance of the project manager's abilities for possessing knowledge of different methodological approaches, tools and techniques). This scale is intended to provide a more robust and nuanced understanding of the relationship between project manager skills and project success, offering valuable insights for academia and industry. By doing so, it seeks to enrich the theoretical underpinning of project management research and provide practical implications for project manager selection, training, and development. Our paper's core objective is to outline pivotal performances of project managers, substantiated by secondary data and corroborated through primary research. This is imperative since, despite project management's ubiquity, episodes of subpar project execution abound. The research framework for this study is firmly grounded in existing literature and validated by academic research. However, it also breaks new ground by focusing specifically on project manager skills and competencies, an area somewhat overlooked in previous studies.

This paper is organized into six sections. The first section provides a brief literature review, introducing the concept of project success factors and highlighting previous findings on the essential skills of project managers for successful project execution. The second section details the methodology adopted for this empirical study, which is executed through a quantitative analysis. The third section presents the results of these analyses. This is followed by the fourth section, which discusses these findings. The fifth section outlines the theoretical and practical contributions to project management, and the final section concludes with implications for future research.

2. Literature review

Project management is pervasive in nearly all organizations, yet instances of poor project performance persist. It is crucial, therefore, to identify the key factors that influence the success of a project. Therefore, the quest to identify as many influencing factors as possible has been a longstanding pursuit in research. This body of literature provides the theoretical basis for the survey questionnaire that drives our primary research. One of the nuanced areas in project management literature is the distinction and overlap between "skills" and "competences." Aiman et al. [9] shed light on this by stating that a competence is a set of personal and job knowledge, skills, abilities, or attitudes for a specific task, job, or profession within a job performance scope. This perspective is echoed by Spencer & Spencer [10] who noted that competences could be defined as abilities and skills acquired through training and varied experiences from job and life. Hence, in certain sections of this paper, particularly in the survey, we have used "managerial competences" interchangeably with "project managers' skills". This choice was deliberate, as our target respondents were professionals well-versed in the realm of project management.

An overarching theme in the literature is the significant role "communication" plays in determining project success, a view upheld by numerous authors [6,11–15]. Delving deeper, some papers dissect the nuances of communication and its affiliated elements. For instance, Montequin et al. identified two influential clusters: failure causes and success factors [16]. They posited that fluent communication among all stakeholders is essential, alongside clear vision and goals, commitment of the project manager, and precise specification of the project's requirements.

The quality of communication becomes especially important in instances of high degrees of electronic linkage [17]. Brill et al. categorized all factors into eight groups, where verbal and graphic communication skills were listed under "Communication Expertise"

[18]. Fisher [19] researched people management and its role in project management, concluding that informal conversation and active listening significantly contribute to project success.

Clarke [20] emphasized the understanding level of all project participants' communication, the establishment of both formal and informal communication channels, and appropriate communication with different audiences Newton [21] singled out constant communication regarding changes in the project plan throughout the project's lifecycle, and the provision of task-specific instructions to team members, as key factors for successful project implementation.

In recent decades, project management has furnished a plethora of methodologies, models, classifications, and approaches [22]. These provide managers with various techniques and tools to leverage during project execution. As modern project management methodologies, such as agile methods, begin supplanting traditional ones, the ability to manage agile projects is gaining prominence [23,24]. This transition has a significant bearing on the skills and competences required for successful project management.

For example, Belassi and Tukel prioritized effective planning and the effective use of technology [25], while Loufrani-Fedida and Missonier highlighted key performances, including establishing a technological solution for the customer, controlling individual competences availability, implementing and managing schedules, and establishing and assessing the technical risks of the projects [26].

Table 1
Clusters of the key abilities and skills WHICH relate to and depend on the project manager having an impact on the success of the project.

Clusters	Representative Source
Communicational Skills - frequent and clear communication, - quality of communication, - expressed verbal communication skills, - strong graphic communication skills - spend more time in informal conversations, - active listening - the level of understanding of the communication of all participants in the project - establishment of formal communication channels - appropriate communication with different audiences - establishment of informal communication channels, explains and continuously communicates any changes to the project plan, as it changes throughout the project's life cycle, - provide specific instructions to team members, related to each task	[16–21]
Technical Skills - effective planning, - effective use of technology, - risk management, - abilities (technical skills), - problem solving, - ability to use project management methodologies (process analyses, system design and so on), - focusing on critical elements of technical management (key factors of project success, deadlines, financial reports), - adaptation of traditional and agile tools, techniques and methods for each project, - thorough planning and prioritization, - managing project elements, including schedule, costs, resources, risks, - establishing a technological solution for the customer, - control of the availability of individual competencies, - selection and control of subcontractors, - implementation and management of schedules and their implementation, - establishing and assessing the technical risks of the project, - setting deadlines, - understanding the specific request	[15,18,25–30,32,33]
Managerial Competences - managers capable of managing agile processes, - teamwork, - conflict management, - effective planning - effective coordination, - effective use of managerial skills, - effective control and monitoring, - ability to know the available resources (funds, equipment, people and the like), - manager's ability in agile processes, - project portfolio management	[11,17,18,23,25,27,29,32,39]
Management Style – Leadership - self-awareness, - motivation of the team, - human resource management, - development of human resources, - sensitivity, - empowerment of the team - the influence of the project manager on the team members - critical thinking	[11,15,21,28,35–39]

Risk management, a rich area of study, is often underlined as a cornerstone for project success by several authors [27–30]. Notably, the data and measurements habitually accumulated by managers for monitoring can be deployed to manage and mitigate risk throughout the project lifecycle [31].

Technical skills, another paramount influence, are a recurrent theme across numerous studies. A variety of authors emphasize the necessity of technical skills, and related factors such as a focus on critical elements of technical management, meticulous planning, and prioritization, and adept management of project components including schedule, costs, resources [30,32]. Complementary aspects like effective planning, setting deadlines, understanding specific requests, and problem-solving also warrant attention [30,33]. In this context, the advent of novel application sequences for tools tied to lean and quality practices promises to resolve enduring problems swiftly and result in substantial gains [34].

Table 2
Questions used in questionnaire.

Question with its code	Reference
Communicational Skills	
K1 I believe that frequent and clear communication by the project manager, both internally and externally, is important for the project's success.	[16]
K2 I believe that the quality of the project manager's communication is important for the project's success.	[17]
K3 I believe that the project manager's effective verbal communication skills are essential for the project's success.	[18]
K4 I believe that the project manager's strong visual communication skills are essential for the project's success.	[18]
K5 I believe that active listening by the project manager is important for the project's success.	[19]
K6 I believe that the project manager's informal communication with team members is important for the project's success.	[19]
K7 I believe that the project manager's level of understanding of communication, along with all participants in the project, is important for the project's success.	[20]
K8 I believe that the project manager's establishment of formal communication channels is important for the project's success.	[20]
K9 I believe that the project manager's establishment of informal communication channels is important for the project's success.	[20]
K10 I believe that the project manager's appropriate communication with different stakeholders is important for the project's success.	[20]
K11 I believe that the project manager's ability to provide specific instructions to the team members is important for the project's success.	[21]
K12 I believe that the project manager's ability to explain and continuously communicate possible changes to the project plan to the team members is important for the project's success.	[21]
Technical skills	
T1 I believe that the project manager's effective use of technology is important for the project's success.	[25]
T2 believe that the project manager's establishment of a technological solution for the customer is important for the project's success.	[26]
T3 I believe that the project manager's control of the availability of individual competences and the selection and control of subcontractors is important for the project's success.	[26]
T4 I believe that the project manager's ability to implement and manage schedules and their realization is important for the project's success.	[26]
T5 I believe that the project manager's ability to establish and assess the technical risks of the project is important for the project's success.	[26]
T6 I believe that the project manager's ability to combine various project management methodologies is important for the project's success.	[18]
T7 I believe that the project manager's ability to develop comprehensive project plans, incorporating milestones and tasks, is crucial for the project's success.	[25,30]
T8: I believe that the project manager's adherence to deadlines, ensuring timely deliverables, is paramount for the project's success.	[30]
T9 I believe that the project manager's ability to assess risks, deadlines, budgets, and costs is important for the project's success.	[15]
T10 I believe that the project manager's ability to manage risks is important for the project's success.	[27–30]
T11 I believe that the project manager's understanding of the specific requirements of the project is important for the project's success.	[33,39]
T12 I believe that the project manager's ability to solve problems is important for the project's success.	[33]
T13 I believe that the project manager's ability to focus on the critical elements of technical management is important for the project's success.	[15]
T14 I believe that the project manager's ability to adapt traditional and agile tools, techniques, and methods is important for the project's success.	[15]
T15 I believe that thorough planning and prioritization by the project manager is important for the project's success.	[15]
T16 I believe that the project manager's ability to manage the elements of the project is important for the project's success.	[15]
Managerial competences	
U1 I believe that the project manager's ability to manage conflicts is important for the project's success.	[11]
U2 I believe that the project manager's ability to know the available resources (funds, equipment, people and the like) is an important factor in the project's success.	[18]
U3 I believe that the project manager's ability to manage the project portfolio is important for the project's success.	[29]
U4 I believe that effective planning by the project manager is important for the project's success.	[25]
U5 I believe that the effective use of management skills by the project manager is important for the project's success.	[25]
U6 I believe that effective control and monitoring by the project manager is important for the project's success.	[25]
U7 believe that the project manager's ability to coordinate is important for the project's success.	[25]
U8 I believe that the project manager's ability to manage agile processes is important for the project's success.	[23]
U9 I believe that the project manager's team management skills are important for the project's success.	[11,17,32]
Management Style – Leadership	
L1 I believe that the project manager's management of human resources is important for the project's success.	[28,36]
L2 I believe that the project manager's empowerment of employees is important for the project's success.	[36]
L3 I believe that the project manager's management of employee development is important for the project's success.	[36,37]
L4 I believe that the project manager's motivation of employees is important for the project's success.	[21,36,39]
L5 I believe that the project manager's influence on team members is important for the project's success.	[36]
L6 I believe that the project manager's self-awareness is important for the project's success.	[11]
L7 I believe that the project manager's sensitivity is important for the project's success.	[35]
L8 I believe that the project manager's critical thinking is important for the project's success.	[15]

Successful project execution necessitates that a project manager embody a suite of robust management competencies. These may encompass conflict management, risk management, project portfolio management, as well as proficiency in planning, coordination, control, monitoring, and the comprehensive application of management skills [11,25,29]. Given the project manager's role in leading a team, teamwork skills are crucial [11,17,32]. Guiding a project and its affiliated team towards success obliges project managers to perform their duties both efficiently and effectively. The leadership facet of project management is multifaceted, including elements like self-awareness, sensitivity to work, motivation, team development and empowerment, and the influence exerted by the project manager on team members [11,21,28,35–38]. It also extends to human resource management at large. The aforementioned factors can be categorized into four distinct clusters, as depicted in the ensuing table (see Table 1).

3. Development of PMSS

3.1. Research instrument

This research is both descriptive and explanatory in nature, employing a quantitative approach executed via a survey method.

The perspectives of respondents on the research constructs were gathered using a questionnaire disseminated electronically, leveraging online tools for data collection. This approach was based on the literature review presented in the prior section.

The online survey tool, www.surveymonkey.com, facilitated the research process. The distribution of the questionnaire was conducted electronically, harnessing the communication channels and contact database of the global PMI network, specifically, the local offices in Bosnia and Herzegovina, the Republic of Srpska, and Montenegro. Upon soliciting respondents for participation, instructions inclusive of a link to access the questionnaire were provided. The survey maintained the anonymity of the respondents, and to ensure a single response per participant, multiple submissions were disabled on the www.surveymonkey.com platform. Consequently, access to the questionnaire was granted only once per device.

The questionnaire employed for this research was bifurcated into two sections. The initial section solicited background information from the respondents, capturing socio-demographic characteristics (gender, age, education, employment status, income), and posed questions pertaining to the organization of the respondent's employment. These variables were gauged on a nominal or ordinal scale. The subsequent section instructed respondents to express their personal views on project success factors, specifically those contingent upon the project manager's capabilities (communication skills, technical knowledge, management skills, and leadership style). This grouping isolated four distinct factors (clusters), as presented in Table 2, where the manifest variables were defined. A unipolar, five-point Likert scale was employed to measure responses relating to the subjective assessment of the importance of the manifest variables within each factor, as well as the current state of these variables' representation. The extreme left point (i.e., 1) signified complete disagreement with the statement, while the far-right point (i.e., 5) indicated complete agreement.

Each cluster epitomizes a set of project manager's skills. The 'communication skills' cluster comprises twelve questions assessing the importance of a project manager's communication abilities for project success. The items from K1 to K12 are focused on various dimensions of communication, ranging from the frequency (K1) and quality (K2) to more specific areas like verbal (K3) and visual (K4) communication skills. While K1 and K2 highlight the overarching importance of communication, subsequent items delve deeper into various modalities and channels of communication, emphasizing the multifaceted nature of communicational skills in project management. The 'technical knowledge' cluster comprises sixteen questions aimed at assessing the significance of a project manager's technical acumen for the successful completion of a project. Items from T1 to T16 shed light on various technical proficiencies a project manager should possess. The authors acknowledge that certain items, especially T7 and T8, seems to overlap. However, it must be highlighted that T7 focuses on the project manager's ability to develop a comprehensive project plan, incorporating detailed milestones and tasks. This emphasizes the broader competency of strategic project planning. T8, on the other hand stresses the project manager's commitment to adhering to the set deadlines, ensuring that deliverables are timely and punctual. The 'management skills' and 'management style-leadership' clusters incorporate nine and eight questions respectively, appraising the importance of the project manager's management prowess and leadership style for project success. U1 to U9 emphasize the project manager's capacity to handle conflicts (U1), be aware of resources (U2), or manage a portfolio (U3). While items like U4 and U5 might seem to intersect, U4 emphasizes planning, whereas U5 speaks to the broader utilization of management skills. L1 to L8 underscore the human-centric leadership qualities of a project manager. Each item taps into different aspects of leadership, from managing human resources (L1) to being self-aware (L6) and showcasing critical thinking (L8).

3.1.1. Sample and data collection

An online survey was the chosen method of data collection for this study. The survey was conducted over a period of three months, spanning from February to April 2022. Each survey session was designed to be completed within a time frame of approximately 15–20 min. The target group comprised individuals who had either participated in a project previously or are current project participants. This means that individuals who understand project management issues, whether or not their organization primarily engages in project execution, were considered. This also included organizations that implement projects periodically, in addition to their primary, regular activities.

The geographical distribution of respondents spanned Bosnia and Herzegovina, Serbia, and Montenegro. During this process, a total of 281 questionnaires were completed. However, some had missing values and were consequently excluded from further analysis. Thus, a total of 257 valid responses were collected.

3.1.2. Sample demographics

The sample for this study was diverse in terms of demographics, experience, and organizational representation, providing a comprehensive perspective on project management from various angles. The gender distribution was nearly equal, with 129 females (50.2 %) and 128 males (49.8 %). The age of respondents ranged from 23 to 70 years old. All respondents were highly educated, the majority holding PhDs (49.8 %). This is presented in Table 3, which also shows that 7 % have a high school education, 30.4 % have completed their faculty studies, and 12.8 % hold a master's degree.

On the organizational front, 121 respondents (47.1 %) reported that their organizations have a dedicated unit for project, program, and portfolio management. However, 136 respondents (52.9 %) indicated their organizations lack such a unit. Only 21 respondents held a certificate for project management (8.2 %), while the majority (91.8 %) did not. A notable observation is the low percentage of respondents with project management certifications, which could indicate a potential gap in formal project management training in the surveyed geographical region.

In terms of roles within project teams, 91 respondents (35.4 %) functioned as project team members, 94 (36.6 %) as project managers, and the remaining 72 (28 %) held other roles.

There was a wide range of experience in the field of Project Management among the respondents. The distribution of this experience is as follows: 13.6 % with less than a year, 20.2 % with 1–2 years, 10.9 % with 3–5 years, 20.6 % with 6–10 years, 17.5 % with 11–15 years, 10.9 % with 16–20 years, 3.1 % with 21–30 years, and 3.1 % with over 30 years.

The organizations employing these respondents, and to which all further questions are related, varied in size: 39.7 % had 1-50 employees, 35.8 % had 51-200 employees, 12.8 % had 201-500 employees, 5.8 % had 501-1000 employees, and 5.8 % had over 1000 employees. The sample structure for the moderating variable is given in Table 4.

4. Results

4.1. Exploratory factorial analysis

An Exploratory Factor Analysis (EFA) was conducted on a dataset comprising responses from 257 participants, with the aim of measuring latent variables associated with key project success indicators. The EFA utilized a principal component analysis approach with Varimax rotation.

The Kaiser-Meyer-Olkin measure, a statistic that indicates the degree of common variance among variables, yielded a value of 0.918, suggesting a high adequacy for factor analysis. Bartlett's test of sphericity, which tests the hypothesis that variables are unrelated, gave a result of 6543.931 ($df = 990$, $p < 0.000$), indicating a high level of significance and the appropriateness of the factor analysis.

This analysis resulted in the extraction of five factors, together accounting for at least 59.657 % of the total variance. A review of the reliability coefficients (Cronbach's α) for all relevant variables within the rotated factor matrix revealed a range from 0.837 to 0.942 (as detailed in Table 5), exceeding the widely accepted threshold of 0.7. This result suggests a high level of internal consistency among the items within each factor.

Upon examining the factor loading scores for each item, these five components were interpreted as distinct clusters: Technical Skills (TS), Managerial Competences (MC), Communication Skills (CS), Management Style-Leadership (MSL), and Technological and Methodological Competences (TMC).

An interesting observation emerged from the analysis. While the initial expectation was to identify four clusters (as outlined in Table 2), the analysis resulted in five. The Technical Skills cluster was bifurcated into two separate clusters, namely Technical Skills (TS) and Technological and Methodological Competences (TMC).

4.2. Confirmatory factorial analysis

Following the EFA, a Confirmatory Factor Analysis (CFA) was conducted to estimate the latent factors measurement model, providing an opportunity to validate the underlying constructs and ascertain their reliability. The initial model fit indices demonstrated promising results, as evidenced by a Comparative Fit Index (CFI) of 0.961 and a Tucker-Lewis Index (TLI) of 0.959, both exceeding the accepted threshold of 0.95. In addition, the Root Mean Square Error of Approximation (RMSEA) and the Standardized Root Mean Square Residual (SRMR) were 0.047 and 0.062, respectively, both of which fall below the acceptable cut-off of 0.08. These

Table 3
Sociodemographic characteristics of respondents (N = 257).

Type of Variable	Frequency	Percent (%)
Gender		
Male	128	49.8
Female	129	50.2
Education		
Higher school	18	7.0
Faculty	78	30.4
Master's degree	33	12.8
phD	128	49.8

Table 4
The sample structure.

Type of Variable	Frequency	Percent (%)
Organization's active status in a field of Project Management		
1–5	39	15.2
6–10	32	12.5
11–20	54	21.0
21–30	44	17.1
31–40	16	6.2
41–50	19	7.4
More than 50	53	20.6
Organization's structure		
organic (flexibility and employee participation)	89	34.6
mechanistic (bureaucracy with a high level of formalization)	34	13.2
something between the two previous types	131	51.0
Missing	3	1.2
Number of organization's involvement in the projects		
1	18	7.0
2–10	158	61.5
11–20	46	17.9
21–30	10	3.9
More than 30	25	9.7

findings indicate a satisfactory model fit, justifying the final measurement scale which includes five latent factors comprising 45 items in total.

In our study, we prioritized ensuring both construct reliability and validity by employing different methods. Specifically, we conducted an HTMT analysis for construct validity and introduced both Cronbach's α and McDonald's ω for assessing construct reliability. This decision was made based on the specific nature of our data, the context of our research, and the complexities that arose during our statistical analysis. Scale reliability was assessed through Composite reliability (CR), Average variance extracted (AVE) indices, Cronbach's α and McDonald's ω (Table 6). The convergent validity of each dimension was examined by calculating the score of the average variance extracted (AVE) [40]. A substantial convergent validity is achieved when all item-to-factor loadings are significant and the AVE score is higher than 0.50 and (CR) is higher than 0.60 within each dimension [40]. Results showed that all dimensions had AVE higher than 0.50 and CR higher than 0.60 (Table 6) which indicates good convergent validity. Values of Cronbach's α and McDonald's ω are above 0.7 threshold [41], thus proving scale reliability (Table 6).

To check the constructs' discriminant validity authors used Fornell-Larcker criterion and heterotrait-monotrait ratio (HTMT). In Fornell-Larcker criterion factor correlations were compared with the square root of the average variance extracted (AVE) for each factor [40]. The results show that the square root of the AVE for each factor is greater than the correlations with other factors, supporting discriminant validity (Table 7). Regarding HTMT, discriminant validity violation is met if the HTMT ratio is close to one [42]. Authors used more rigorous cut of value of 0.85 [44,45]. Table 7 shows that all values are below 0.85 (values mentioned in italics in brackets), indicating that there were no violations of $HTMT_{0.85}$. Overall, the results for the measurement model indicate scale reliability and validity.

4.3. Incremental statistics on socio-demographic implications

To determine the discriminative capacity of the scale in the context of the respondents' demographic characteristics, we examined variables such as gender, age, education, team position, industry type, international certification, project management experience, organizational size, structure, culture, number of current projects, the organization's experience in project management, and the presence of a project management office in relation to the PMSS.

1) Independent *t*-test

Regarding the Communicational Skills (CS) dimension, an independent *t*-test uncovered significant differences between male and female respondents. Males assigned a higher value to the CS factor ($t = -2.233$, $p = 0.026$), suggesting that they perceive communicational skills as more crucial in project management.

2) One-way ANOVA and Post Hoc LSD Test

Further discrepancies were investigated using a One-way ANOVA and Post Hoc LSD Test in relation to age, education, team position, industry type, project management experience, organizational size, structure, culture, current projects number, and project management experience. No significant differences were found concerning age, education, team position, industry type, organizational tenure in project management, structure, culture, and the number of current projects. These results suggest that these factors may not significantly impact the perception of project management skills.

However, significant differences were identified in the responses to the Technical Skills (TS) dimension based on the industry type.

Table 5
Descriptive statistics for each latent variable and its items.

Factors and Items	Factor loadings	Eigen value	Cronbach's α	Variance explained (%)
F1 Technical Skills (ts)		18.108	0.937	15.562
T4 I believe that the project manager's ability to implement and manage schedules and their realization is an important factor in the project's success.	.526			
T5 I believe that the project manager's ability to establish and assess the technical risks of the project is important for the project's success.	.396			
T7 I believe that the project manager's ability to plan, set deadlines, and manage schedules is important for the project's success.	.638			
T8 I believe that the project manager's ability to set deadlines is important for the project's success.	.620			
T9 I believe that the project manager's ability to assess risks, deadlines, budgets, and costs is important for the project's success.	.616			
T10 I believe that the project manager's ability to manage risks is important for the project's success.	.565			
T11 I believe that the project manager's understanding of the specific requirements of the project is important for the project's success.	.439			
T12 I believe that the project manager's ability to solve problems is important for the project's success.	.687			
T13 I believe that the project manager's ability to focus on the critical elements of technical management is important for the project's success.	.586			
T15 I believe that thorough planning and prioritization by the project manager is important for the project's success.	.653			
T16 I believe that the project manager's ability to manage the elements of the project is important for the project's success.	.648			
L1 I believe that the project manager's management of human resources is important for the project's success.	.578			
F2 managerial competences (mc)		**2.942**	**0.942**	**14.761**
U1 I believe that the project manager's ability to manage conflicts is important for the project's success.	.655			
U2 I believe that the project manager's ability to know the available resources (funds, equipment, people and the like) is an important factor in the project's success.	.696			
U3 I believe that the project manager's ability to manage the project portfolio is important for the project's success.	.644			
U4 I believe that effective planning by the project manager is important for the project's success.	.751			
U5 I believe that the effective use of management skills by the project manager is important for the project's success.	.740			
U6 I believe that effective control and monitoring by the project manager is important for the project's success.	.661			
U7 believe that the project manager's ability to coordinate is important for the project's success.	.750			
U8 I believe that the project manager's ability to manage agile processes is important for the project's success.	.649			
U9 I believe that the project manager's team management skills are important for the project's success.	.561			
F3 communicational skills (cs)		**2.332**	**0.909**	**14.073**
K1 I believe that frequent and clear communication by the project manager, both internally and externally, is important for the project's success.	.647			
K2 I believe that the quality of the project manager's communication is important for the project's success.	.656			
K3 I believe that the project manager's effective verbal communication skills are essential for the project's success.	.683			
K4 I believe that the project manager's strong visual communication skills are essential for the project's success.	.594			
K5 I believe that active listening by the project manager is important for the project's success.	.669			
K6 I believe that the project manager's informal communication with team members is essential for the project's success.	.625			
K7 I believe that the project manager's level of understanding of communication, along with all participants in the project, is important for the project's success.	.645			
K8 I believe that the project manager's establishment of formal communication channels is important for the project's success.	.459			
K9 I believe that the project manager's establishment of informal communication channels is important for the project's success.	.562			
K10 I believe that the project manager's appropriate communication with different stakeholders is important for the project's success.	.644			
K11 I believe that the project manager's ability to provide specific instructions to the team members is important for the project's success.	.586			

(*continued on next page*)

Table 5 (*continued*)

Factors and Items	Factor loadings	Eigen value	Cronbach's α	Variance explained (%)
F1 Technical Skills (ts)		18.108	0.937	15.562
K12 I believe that the project manager's ability to explain and continuously communicate possible changes to the project plan to the team members is important for the project's success.	.659			
F4 management style – leadership (msl)		**2.080**	**0.875**	**8.389**
L2 I believe that the project manager's empowerment of employees is important for the project's success.	.473			
L3 I believe that the project manager's management of employee development is important for the project's success.	.440			
L4 I believe that the project manager's motivation of employees is important for the project's success.	.577			
L5 I believe that the project manager's influence on team members is important for the project's success.	.668			
L6 I believe that the project manager's self-awareness is important for the project's success.	.636			
L7 I believe that the project manager's sensitivity is important for the project's success.	.658			
L8 I believe that the project manager's critical thinking is important for the project's success.	.563			
f5 technological and methodological competences (tmc)		**1.383**	**0.837**	**6.871**
T1 I believe that the project manager's effective use of technology is important for the project's success.	.719			
T2 believe that the project manager's establishment of a technological solution for the customer is important for the project's success.	.701			
T3 I believe that the project manager's control of the availability of individual competences and the selection and control of subcontractors is important for the project's success.	.371			
T6 believe that the project manager's ability to combine various project management methodologies is important for the project's success.	.716			
T14 I believe that the project manager's ability to adapt traditional and agile tools, techniques, and methods is important for the project's success.	.464			

Table 6
Reliability of the instruments epas

Constructs	AVE	CR	Cronbach's α	McDonald's ω
F1	0.69	0.96	0.93	0.95
F2	0.74	0.96	0.94	0.96
F3	0.61	0.95	0.90	0.94
F4	0.65	0.93	0.87	0.92
F4	0.61	0.89	0.83	0.89

Table 7
Discriminant validity epas

	F1	F2	F3	F4	F5
F1	0.83				
F2	0.548 *(0.796)*	0.86			
F3	0.535 *(0.707)*	0.542 *(0.670)*	0.78		
F4	0.539 *(0.765)*	0.583 *(0.780)*	0.503 *(0.593)*	0.81	
F5	0.468 *(0.755)*	0.419 *(0.542)*	0.42 (0.607)	0.476 *(0.690)*	0.78

Participants working in administrative projects, plan design, event organization, and the IT sector assigned the highest values, while those in product development, scientific research, environmental, and other industries assigned moderate values, and those in construction assigned the lowest values ($F = 2.321$, $p = 0.035$). This finding may reflect the specific technical demands of various industries, as technical skills might be more prioritized in industries such as IT and event planning compared to construction.

According to project management experience, respondents with less than a year, 1–2 years, and 11–15 years of experience assigned the highest value to the Communicational Skills (CS) dimension. Respondents with 3–5 years, 6–10 years, and 16–20 years of experience gave a moderate value, and those with more than 21 years' experience gave the lowest value ($F = 2.256$, $p = 0.031$). This suggests that the perceived importance of communicational skills varies with experience, which may reflect evolving priorities and skillsets as project managers gain experience.

The analysis also revealed that the number of employees within an organization influences perceptions of Technical Skills (TS) and Managerial Competences (MC). Organizations with 501–1000 employees assigned the highest values to the TS dimension, while organizations with 51–200, 1 to 50, and more than 1000 employees gave moderate values, and organizations with 201–500 employees

gave the lowest values (F = 2.561, p = 0.040). Managerial Competences (MC) were most valued by organizations with 501–1000 employees, moderately by organizations with 51–200 employees and more than 1000 employees, and least valued by organizations with 1–50 employees and 201 to 500 employees (F = 2.878, p = 0.024). These findings may reflect the different challenges and demands faced by organizations of various sizes, with larger organizations possibly placing a greater emphasis on technical and managerial.

5. Discussion

The factor analysis findings provide valuable insights into the underlying structure of the questionnaire items and their relationships with the identified factors. The results reveal distinct dimensions of project management, including Technical Skills (TS), Managerial Competences (MC), Communicational Skills (CS), Management Style - Leadership (MSL), and Technological and Methodological Competences (TMC). Each factor represents a specific aspect of project management that contributes to project success. The high eigenvalue and variance explained percentage of the TS factor (18.108 and 15.562 %, respectively) indicate that this factor plays a significant role in explaining the variability in the data. This suggests that project managers' abilities related to implementing and managing schedules, assessing technical risks, planning, problem-solving, and managing project elements are crucial for project success. The factor loadings of the items within this factor further validate their association with technical skills. Our results suggest that the TS factor plays a significant role in project success, aligning with Loufrani-Fedida and Missonier's assertion on the importance of implementing schedules, assessing technical risks, and related competences [26]. This is further supported by other researchers who emphasize the crucial nature of technical skills [30,32]. Similarly, the MC factor exhibits a high eigenvalue (2.942) and variance explained percentage (14.761 %), indicating its substantial contribution to explaining the variance in the data. The factor loadings of the items within this factor indicate that competences such as conflict management, risk management, project portfolio management, effective planning, management skills, control and monitoring, coordination, agile processes, and team management significantly influence project success. The high Cronbach's alpha coefficient for this factor (0.942) suggests a high level of internal consistency among the items. The MC factor's significance in our findings is consistent with the literature which often underlines risk management, conflict management, and other management competences as pivotal for project success [9,23,27]. This factor's emphasis on teamwork skills also echoes sentiments from various authors on the importance of teamwork [11,17,32].

The CS factor also demonstrates a considerable eigenvalue (2.332) and variance explained percentage (14.073 %), indicating its importance in understanding project success. Effective communication is crucial for project management, and the factor loadings of the items within this factor support this notion. Clear and frequent communication, communication quality, verbal and visual communication skills, active listening, informal communication with team members, and the establishment of formal and informal communication channels are all identified as important factors contributing to project success. Our findings on the CS factor reaffirm the prevailing sentiment in literature about communication's paramount role in determining project success [6,11–15]. Delving deeper into this, the emphasis on informal conversation and active listening echoes Fisher's findings [19].

The MSL factor, although exhibiting a lower eigenvalue (2.080) and variance explained percentage (8.389 %), still plays a significant role in project success. The factor loadings of the items within this factor suggest that employee empowerment, employee development management, employee motivation, influence on team members, self-awareness, sensitivity, and critical analysis are important aspects of project managers' leadership and management style. The TMC factor, with a lower eigenvalue (1.383) and variance explained percentage (6.871 %), represents the importance of technological and methodological competences in project success. The factor loadings of the items within this factor indicate that effective use of technology, establishment of technological solutions, control of competences and subcontractors, technical skills, and adaptability of tools, techniques, and methods are essential for project success. The high-reliability coefficients across all clusters point to the internal consistency of each skill set, reinforcing the importance of these skills for project success.

The MC factor's significance in our findings is consistent with the literature which often underlines risk management, conflict management, and other management competences as pivotal for project success [11,25,29]. This factor's emphasis on teamwork skills also echoes sentiments from various authors on the importance of teamwork [11,17,32]. The results of the CFA further confirm the robustness of the measurement model, demonstrating both convergent and discriminant validity. Interestingly, our EFA revealed a nuanced division within "Technical skills," segregating it into "Technical skills" and "Technological and Methodological competences." This reflects the evolving landscape of project management highlighted by various authors [22–24], suggesting the growing importance of methodologies and technology in project management.

It suggests that distinct components within the broader domain of technical skills contribute to project success. The factor "Technical skills" encompasses items that specifically focus on the project manager's expertise in handling technical aspects directly related to the project's execution. On the other hand, the factor "Technological and methodological competences" includes items highlighting the project manager's ability to leverage technological advancements and employ appropriate methodologies to enhance project outcomes.

The emergence of these two distinct factors suggests that while technical skills are important for project success, project managers also need to possess specific competences related to technology and methodologies. This finding aligns with the evolving nature of project management, where technology plays a significant role in project execution, and methodologies continue to evolve to address different project contexts.

The observed differences in the perceived importance of different project manager skill dimensions based on demographic characteristics and organizational factors offer interesting insights. The finding that male respondents place more value on CS may challenge common stereotypes and indicate the need for further research on gender differences in communication within project

management. This finding may resonate with existing research suggesting that men often prioritize direct and instrumental communication [46]. Fluctuations in the perceived importance of CS depending on years of experience may indicate that the relative importance of certain skills changes over time. This may be due to changes in roles, responsibilities or the evolution of project management practices. Population with less experience gave greater importance to the influence of CS, for the reason that today's project management methodologies are mainly based on communications (e.g. agile methodologies), while people with more experience in project management mainly rely on traditional management methods, with less influence of communication skills. The effect of organizational size on the perceived importance of TS and MC reflects how different organizational structures and cultures may prioritize certain skill sets. Larger organizations may emphasize these skills more due to the complexity and scope of the projects they undertake. While we have contextualized our findings within the backdrop of existing literature, the nuances and specifics are contingent upon the sample and context of our study. Nevertheless, these insights contribute significantly to the discourse on project management skills and competences, building on the foundational works of numerous researchers [11–13,17,21,26,28,32,33,35], and others.

6. Conslusion

6.1. Theoretical contributions

This study significantly contributes to the global project management research field by developing the Project Manager Skills Scale (PMSS), a comprehensive scale designed to measure the multi-dimensional competencies of project managers. The pre-existing research in this area has been predominantly focused on antecedents and outcomes of project success, using various disparate scales to evaluate project manager skills. However, a universally accepted definition and a comprehensive understanding of the constituents of project manager skills have been lacking.

This research addresses this gap by employing an empirical approach to investigate the structural dimensions of project manager skills. One of the key findings of this research is the identification of five distinct dimensions of project manager skills: Technical Skills, Managerial Competences, Communication Skills, Management Style-Leadership, and Technological and Methodological Competences. This finding diverges from the traditional four-dimensional theoretical proposal, thus enriching our understanding of project manager skills. This scale's implementation will enhance the precision and consistency of measuring project manager skills, thus contributing to a more robust body of knowledge in project management. By understanding these factor structures and item-factor associations, project management practitioners and researchers can gain insights into the specific dimensions of project management that require attention and improvement. These findings can inform the development of targeted interventions and training programs to enhance project managers' skills in the identified areas. The PMSS, while a novel contribution, is also a culmination of existing research. It offers a more structured and consistent metric for academic studies in project management. As researchers continue to delve into this domain, the PMSS could serve as a consistent reference, aiding in creating a cohesive body of literature. In academic circles, the PMSS might pave the way for deeper inquiries into project management skillsets, offering a base for comparative studies and fostering discussions on its various dimensions. While it's a step forward, its long-term influence will be determined by its adaptability and relevance in evolving research landscapes.

6.2. Practical implications

This study has significant practical implications. At the individual level, the newly developed PMSS serves as a comprehensive tool that enables project managers to conduct a thorough self-assessment of their skills, thereby illuminating areas for potential enhancement. Such self-reflection and subsequent skill development are crucial for increasing project performance, which in turn is not only beneficial for the organization but also fosters personal and professional growth for the project manager.

By leveraging the PMSS, project managers can gain an in-depth understanding of their skill sets, specifically across the five dimensions of communication skills, technical knowledge, management skills, management style-leadership, and technological and methodological competences. This knowledge can then guide them in making targeted improvements, which may consequently help them achieve superior project outcomes, such as timely project completion, increased stakeholder satisfaction, and successful achievement of project goals. The predictive validity of the PMSS in relation to these project outcomes, however, needs to be verified in future research.

Beyond individual project managers, organizations stand to benefit significantly from this research. The PMSS provides a fresh perspective and a precise measurement tool that can be utilized in various organizational processes such as recruitment, selection, and training of project managers. For instance, when recruiting or selecting project managers, the PMSS can guide the identification of candidates with a balanced and comprehensive skill set. Similarly, in the context of professional development, the PMSS can inform the design and delivery of project management training programs. By highlighting the importance of a balanced skill set, training programs could be restructured to provide a more rounded development experience, rather than focusing predominantly on technical skills. This research thereby offers a holistic approach towards understanding and enhancing project management competencies, with potential benefits for both individual project managers and the organizations they serve. On a more pragmatic note, while the PMSS offers a fresh lens to view project management skills, its adoption will rely on its perceived relevance and efficacy in diverse organizational settings. It holds potential utility for organizations seeking a comprehensive assessment tool, yet its widespread applicability will be shaped by how seamlessly it aligns with varied industrial needs.

6.3. Limitations and future recommendations

The geographical focus of this research, anchored in Bosnia and Herzegovina, Serbia, and Montenegro, while providing insights particular to this region, raises questions about the extrapolation of these findings to a global context. This geographic specificity, though intentional, does impose constraints on the broader applicability of the research conclusions. Methodologically, the study has endeavored for comprehensiveness, yet there is recognition of the value in methodological pluralism. The inclusion of qualitative methods, such as focused group discussions and individual interviews, could provide a more nuanced understanding of the multi-faceted domain of project manager skills. The instrument employed in this study, developed with an emphasis on rigor, might still have its limitations in capturing the intricacies of project manager competencies across varied organizational hierarchies or among diverse demographic segments. Future work might productively address the manifestation and prioritization of these skills across different sectors, roles, and cultural environments. Given these observations, it would be fruitful for subsequent research to extend the study's geographical breadth, thereby ensuring a more encompassing representation and understanding of project manager skills. This not only would bolster the external validity but would also account for potential regional variations in the conceptualization and operationalization of these skills. While this research has delineated certain key dimensions of project manager skills, it only marks the initiation. A subsequent and more granular examination of the identified dimensions could reveal specific competencies nested within each, offering actionable insights for targeted training programs. To enrich the perspective further, it would be beneficial to involve a diverse range of stakeholders. Engagement across the organizational hierarchy, from novice project managers to seasoned leadership, would yield a layered understanding of the relevance and manifestation of project management competencies.

We acknowledge the limitations introduced by the potential endogeneity bias. The correlational findings presented should be interpreted with caution and not as causal relationships. Future research should consider designs that can control for or minimize the influence of latent variables, ensuring more robust findings. In the section discussing the sample demographics, a a low percentage of respondents with project management certifications was noted. This observation could be indicative of a latent "ability" factor, which the authors plan to explore further in future research. Acknowledging such potential biases upfront provides transparency in research findings. Finally, in the spirit of academic rigor and in recognition of the evolving nature of research tools, it's anticipated that the employed instrument will undergo iterative refinement. As empirical data accumulates and feedback channels operate, such iterative processes will aim to continually bolster the instrument's reliability and construct validity.

Declarations

Ethics statement

Review and/or approval by an ethics committee was not needed for this study because it falls under the category of non-interventional research, specifically a survey-based study.

We confirm that our study followed ethical guidelines for non-interventional research, including providing clear and transparent information to participants, ensuring anonymity, and obtaining informed consent. All data collected and analyzed were done so in accordance with applicable data protection and privacy regulations.

CRediT authorship contribution statement

Mirjana Jokanović Đajić: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. **Danijela Ciric Lalic:** Conceptualization, Data curation, Formal analysis, Methodology, Supervision, Writing – original draft, Writing – review & editing. **Miroslav D. Vujičić:** Formal analysis, Resources, Validation, Writing – original draft. **Uglješa Stankov:** Formal analysis, Methodology, Resources, Validation, Writing – original draft. **Maja Petrovic:** Writing – original draft, Writing – review & editing. **Željko Đurić:** Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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