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APPLICATION OF FACTOR ANALYSIS IN DETERMINING USER BASIC REQUIREMENT FOR PROJECT MANAGEMENT TOOLS IN THE TELECOMMUNICATIONS INDUSTRY

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Abstract

The telecommunications industry operates in highly complex and technology-intensive environments, requiring project management tools that align with user-centered operational needs. This study aims to identify the user requirement factors for project management tools by applying factor analysis as a data reduction technique to group various user requirement variables into a smaller number of laten variable. The study utilizes primary data collected 78 respondents from professionals in project management activities within the telecommunications industry. The results indicate that the basic user requirement variables can be grouped into seven main factors representing the functional aspects of project management tools, namely operational (17.12%), monitoring (10.35%), task assignment (8.37%), information (7.91%), performance (7.64%), reliability (7.20%), and usability (6.91%). These seven factors collectively explain 65.53% of the cumulative variance, indicating that they are sufficiently representative in describing user requirements for project management tools. The findings provide a more structured understanding of user needs and can serve as a basis for the development and selection of project management tools that align with project operational requirements.

Keywords: *project management tools; user requirements; exploratory factor analysis;*

INTRODUCTION

The rapid adoption of Industry 4.0 technologies, particularly the Internet of Things (IoT) and Artificial Intelligence (AI), has signification to improving efficiency and productivity across multiple industrial sectors. The implementation of these digital technologies depends on the availability of telecommunications networks as platforms for exchange processing, and analysis big data, thereby positioning the telecommunications industry as a strategic enabler of economic and social development (Sirait, 2022). The higher demand for internet access in the world has increased the complexity of telecommunications projects, which involve multiple stakeholders, advanced technologies, and stringent performance requirements. This condition compels companies to strengthen their competitive advantage through effective and efficient project management supported by enterprise resource planning (ERP)–based systems implemented via project management tools (Wanaswa, 2021).

Industry implementation shows that the diversity of project management tools, both commercial and internally developed (in-house), poses a challenge for organizations in identifying solutions that align with the characteristics of projects in the telecommunications industry (Putra et al., 2023). In addition, user requirements for project management tools very widely, including aspects such as ease to use, feature availability, system integration, and collaboration capabilities. Although the number of available project management applications continues to increase, a standardized framework that clearly defines the fundamental user requirements for these tools has not yet been established (Monteiro., 2025).

This condition makes it difficult for organizations to identify the key features needed to effectively support project execution in the telecommunications industry (Milenkovic, 2023). Therefore, this study adopts a systematic approach to identify the fundamental user requirements in selecting project management tools in the telecommunications industry.

LITERATURE REVIEW

Project management functions as an integrative managerial system that coordinates activities across the entire project life cycle, from initiation and planning to execution, monitoring, and closure. It supports key managerial functions such as scheduling, budgeting, resource allocation, risk management, reporting, and team coordination to ensure that project objectives are achieved efficiently. Projects are fundamentally constrained by the three core dimensions of the project management triangle there are cost, time, and scope which must be carefully balanced to deliver optimal quality outcomes while maintaining efficient resource utilization (PMBOOK, 2025). Effective management of these dimensions therefore plays a crucial role in determining overall project performance.

Modern project environments increasingly adopt digital-based systems that enable real-time coordination, centralized data management, and enhanced collaboration among project stakeholders. One prominent approach supporting this transformation is the integration of project management processes with Enterprise Resource Planning (ERP) systems, which facilitate cross-functional integration across areas such as finance, procurement, human resources, and operations (Nirmala et al., 2025). Within this framework, project management tools operate as integrative digital platforms that support the entire project life cycle through functionalities such as task scheduling, resource management, communication, documentation, and performance monitoring. Their implementation enhances data visibility, improves decision-making accuracy, and increases operational efficiency through better integration of project processes and optimized resource utilization (Meiryani & Fernando, 2021; Monteiro, 2025).

Despite these advantages, the implementation of project management tools remains highly context-dependent and varies across organizations. The selection and adoption of such tools are influenced by factors including project complexity, organizational scale, management structure, corporate culture, and user competence. Additional considerations such as business process requirements, development and maintenance costs, vendor dependency, human resource readiness, and compatibility with existing systems further contribute to the heterogeneity of implementation practices (Ahmed, 2016). Moreover, the increasing availability of commercial and internally developed tools introduces additional complexity for organizations attempting to identify solutions that align with operational requirements and user preferences. Previous studies indicate that tool selection is influenced by multiple criteria—including usability, feature completeness, integration capability, cost efficiency, and scalability—reflecting the multidimensional nature of user requirements in adopting project management technologies (PMBOOK, 2023). However, many existing studies primarily focus on evaluating the effectiveness of tool utilization rather than systematically identifying and structuring the underlying variables that represent user requirements (Putra et al., 2023; Ritongga, 2023; Khasana, 2024).

Furthermore, research integrating statistical dimension reduction with structured analytical approaches remains limited, particularly in the context of telecommunications projects. To address this gap, this study applies factor analysis to identify the latent dimensions underlying diverse user requirements for project management tools. By reducing numerous observed variables into a smaller set of meaningful factors, this approach provides a systematic representation of user needs and supports a more empirically grounded basis for selecting project management tools in the telecommunications industry.

METHOD

This study uses a quantitative approach by applying factor analysis as the primary method to identify the structure of user requirements for project management tools. Factor analysis is used to reduce a large number of observed variables into several latent factor groups that represent the key dimensions of user needs. Through this approach, various user requirement variables can be systematically grouped, resulting in a more concise and representative factor structure that explains user needs requirement.

Primary data were collected through a structured questionnaire distributed to professionals involved in project management activities within the telecommunications industry. The sample selection employed a purposive sampling approach, with the criterion that respondents are project management professionals working in the telecommunications sector and have more than three years of experience. The respondents were members of the Project Management Institute Indonesia (PMII) community, which consists of a population of 300 professionals. Based on this population size, the number of research samples was determined using the Slovin formula to ensure that respondents adequately represent population.

$$n = \frac{N}{(1+Ne^2)}$$

$$n = \frac{300}{(1+(300\ x\ (0{,}10)^2)} = 75\ Responden$$

In this study, a total of 78 respondents meeting the specified criteria were successfully collected and included in the analysis. The respondents represent professionals with more than three years of experience in project management within the telecommunications industry.

Table 1. Reponden Caracterictic

Company Type	Company	Staff	Manager	Executive
Operator	Perusahaan B	10	6	4
	Perusahaan C	3	10	1
	Perusahaan D	0	0	0
	Perusahaan A	15	5	0
	Perusahaan E	2	1	1
Vendor	Perusahaan F	1	1	0
	Perusahaan I	1	0	0
	Perusahaan J	1	0	0
	Perusahaan K	1	0	0
Provider	Perusahaan G	0	2	0
	Perusahaan H	1	0	0
Grand Total		34	23	6

The respondents represent diverse organizational segments and professional roles within the telecommunications industry, including operators, vendor and infrastructure providers. In addition, the respondents reflect different job segmentation that are project staff, managers, and executives, this diversity of respondent was intentionally considered to obtain a more representative understanding of the basic requirements of project management tools based on user preferences.

Table 2. Operational Variable

Kode	Variable	Kode S	Variable
X_1	Easy Customize	X_{12}	Contract Status
X_2	Trigger System	X_{13}	Working Time Management
X_3	Real Time	X_{14}	Material Information
X_4	Backup System	X_{15}	Partner Management
X_5	User Friendly	X_{16}	Payment Manage
X_6	Role Type	X_{17}	Mobile Integration
X_7	Location Management	X_{18}	Document Approval
X_8	Team Status	X_{19}	Report & Dasboard
X_9	Expor-Impor	X_{20}	Notification
X_{10}	Speed, Capacity	X_{21}	Dispatch Task
X_{11}	Project Status		

The 21 variables are directly representing the core operational features of project management tools used in the telecommunication industry. These variables comprise key functional aspects including system usability, technology, tools maturity and business process. In this study, all variables serve as operational indicators to measure and analyze user priority needs, enabling the identification of the most critical features required to support effective project management. Before conducting further analysis, data feasibility was assessed through validity and reliability to ensure that the measurement instruments.

The validity test results show that all variables (X_1–X_{21}) have r-count values higher than r-table (0.2227) at $\alpha = 0.05$ (df = 76) (Adams & McGuire, 2022). The r-count values range from 0.796 to 0.910, indicating strong correlations between variables. The next test is reliability, which was conducted using the total variance value of all variables. The instrument is considered reliable if the Guttman split-half coefficient > 0,80, and the result of the test is 0,98 (Raharjanti et al., 2022). Given that all variables meet the validity and reliability criteria, the data are deemed adequate for subsequent factor analysis. Data analysis was conducted in two stages; factor analysis was conducted to simplify and group the variables into more concise latent factors (Hair et.al, 2024), which were used as the basis for the priority weighting stage. Before performing factor extraction, data suitability was assessed using the Kaiser–Meyer–Olkin (KMO) measure. A KMO value > 0.50 and a p-value < 0.05 indicate that the data are adequate and sufficiently correlated for factor analysis. The SPSS results show a KMO value of 0.591 and a p-value of 0.001, confirming that the data are suitable for factor extraction.

FACTOR ANALYSIS RESULT

The next step was the Measure of Sampling Adequacy (MSA) analysis to evaluate each variable's contribution to the factor model. Statistically, the MSA value must exceed 0.50 to indicate that a variable is sufficiently suitable for inclusion in factor analysis variables with an MSA value > 0.50 are considered suitable for factor analysis, while those < 0.50 should be excluded.

Table 3. Anti Image Matrix Variable

Variable	Extraction	Variable	Extraction
X_2	0,548	X_{11}	0,729
X_3	0,649	X_{12}	0,567
X_4	0,677	X_{13}	0,664
X_5	0,769	X_{14}	0,735
X_6	0,645	X_{15}	0,552
X_7	0,732	X_{16}	0,668
X_8	0,533	X_{20}	0,577
X_9	0,645	X_{21}	0,568
X_{10}	0,631		

The results show that only 17 met this criterion therefore, the variables that were excluded are Easy to Customize (X_1), Partner Management (X_{15}), Mobile Integration (X_{17}), and Document Approval (X_{18}) were removed due to insufficient contribution to a valid factor model. Field implementation indicates that variables are functionally substitutable by other variables and has limited contribution to the factor. The variable easy to customize (X1) is practically reflected in the level of user friendliness (X5) perceived by users. Similarly, partner management (X15) and document approval (X18) are operationally integrated within contract status (X12) and project status (X11), as partner coordination and contract management are typically embedded within overall project progress monitoring.

Table 4. Variable Contribution Values

Variable	Extraction	Variable	Extraction
X_2	0,548	X_{11}	0,729
X_3	0,649	X_{12}	0,567
X_4	0,677	X_{13}	0,664
X_5	0,769	X_{14}	0,735
X_6	0,645	X_{15}	0,552
X_7	0,732	X_{16}	0,668
X_8	0,533	X_{20}	0,577
X_9	0,645	X_{21}	0,568
X_{10}	0,631		

The presented data is about variable contribution values, which indicate the proportion of each variable's variance explained by the extracted factors. The extraction values range from 0.533 to 0.769, showing that all retained variables contribute adequately to the factor structure, as each value exceeds the acceptable threshold. This indicates that the selected variables are sufficiently represented in the factor model and are appropriate for further analysis. Then the number of factors formed was determined based on the results of Principal Component Analysis (PCA) factor extraction. In factor analysis, the number of factors is commonly determined using the eigenvalue ≥ 1 criterion and cumulative explained variance.

Tabel 5. Principal Component Analysis (PCA)

Factor	Eigenvalue	Variance (%)	Cumulative (%)
1	2,912	17,129	17,129
2	1,761	10,359	27,488
3	1,423	8,371	35,859
4	1,345	7,912	43,771
5	1,300	7,647	51,418
6	1,225	7,206	58,624
7	1,175	6,912	65,536

The eigenvalue ≥ 1 rule states that only factors with eigenvalues greater than or equal to 1 are retained, as factors below this threshold are considered insignificant in explaining data variation (Goretzko, 2024). In this study, seven factor groups were selected because they adequately represent the data variation and provide a comprehensive overview of user needs in selecting project management tools in the telecommunication industry. Based on the eigenvalue ≥ 1 criterion, the seven factors explain more than 65.53% of the cumulative variance. After identifying seven factor groups, the next step is to determine the factor membership of each variable using the rotation matrix, where variables are assigned to the factor with the highest loading value (Hair et.al., 2024).

Tabel 6. Rotated Component Matrix

Rotated Component Matrix							
	Component						
	1	2	3	4	5	6	7
X_2	-,006	-,525	,175	,124	,297	-,355	-,239
X_3	,214	,044	,056	-,060	,418	,673	,205
X_4	-,142	-,048	,012	-,023	-,205	,758	-,227
X_5	-,130	-,067	-,119	-,064	,023	-,061	,830
X_6	-,039	,171	,755	-,004	-,016	,054	-,017
X_7	,710	-,184	,345	,245	-,155	,050	,172
X_8	,428	,137	,260	,032	,455	-,128	-,063
X_9	,624	,101	-,101	,112	,330	,104	-,325
X_{10}	-,052	,106	,012	,022	,834	,004	-,001
X_{11}	,200	,646	,101	-,086	,099	-,161	-,196
X_{12}	,109	,758	,110	,205	,219	,042	,064
X_{13}	,798	,309	-,016	,002	-,047	-,100	-,110
X_{14}	,012	,177	,131	,650	-,165	-,023	,416
X_{16}	-,194	,414	,324	,372	,098	,324	-,166
X_{19}	-,046	,254	-,196	-,558	-,059	,263	,248
X_{20}	,245	,095	-,249	,701	,128	,060	-,134
X_{21}	,166	-,039	,674	,013	,101	-,031	-,079

The component matrix shows the strength of each variable's association with the formed factors or components. The values, known as loadings, represent the magnitude of the relationship between variables and components; higher values indicate stronger contributions. Therefore, each variable is assigned to the factor where it has the highest loading, with the final factor grouping presented.

Tabel 7. Results of Factor Analysis Interpretation

Factor		*Variable*	*Eigen values*	Factor Loading	Variance (%)	Cumulative (%)
1	X7	Location Management	2,912	0,710	17,129	17,129
	X9	Export-Import		0,624		
	X13	Working Time Management		0,798		
2	X11	Project Status	1,761	0,646	10,359	27,488
	X12	Contract Status		0,758		
	X16	Payment Manage		0,414		
3	X6	Role Type	1,423	0,755	8,371	35,859
	X21	Dispatch Task		0,674		
4	X14	Material Information	1,345	0,650	7,912	43,771
	X20	Notification		0,701		
5	X2	Trigger System	1,300	0,297	7,647	51,418
	X8	Team Status		0,455		
	X10	Speed, Capacity		0,834		
6	X3	Real Time	1,225	0,673	7,206	58,624
	X4	Backup System		0,758		
	X19	Report & Dashboard		0,263		
7	X5	User Friendly	1,175	0,830	6,912	65,536

The factor analysis produced seven distinct factors, each representing different functional dimensions of project management tools as described below.

- Factor 1 called operational function, reflects operational and working-time management, emphasizing location control, data exchange, and scheduling efficiency.
- Factor 2 called monitoring function, represents project and contract monitoring with payment management, highlighting control over project progress and financial integration.
- Factor 3 called task assignment focuses on role and task management, emphasizing clear role allocation and task distribution.
- Factor 4 called the dashboard function, relates to material information and notification functions, supporting timely decision-making.
- Factor 5 called performance function, captures system and team performance, including system responsiveness and team monitoring.
- Factor 6 called dependability function, reflects system reliability and reporting, characterized by real-time data availability, backup systems, and dashboard reporting.
- Factor 7 represents usability, emphasizing user-friendly access as a key consideration for the project without requiring specialized training.
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IMPLEMENTATION IN INDUSTRY

The factor analysis identifies seven interrelated that should not be interpreted as isolated software features, but as interconnected capabilities that support the actual telecommunications project lifecycle, which typically involves planning, site management, task allocation, procurement and material management, field execution, progress monitoring, testing and integration, contract and payment management, and project acceptance. The practical significance of the findings lies in demonstrating that a project management tool must be capable of connecting these activities within a continuous workflow. The findings also provide an important basis for understanding why technical completeness alone should not determine the selection of project management tools. Telecommunications projects involve geographically dispersed sites, multiple organizational units, field engineers, contractors, vendors, and highly interdependent activities, making system usability, operational alignment, information reliability, and coordination particularly important. Conversely, a tool with fewer but well-integrated functions may provide greater practical value when it is aligned with existing project workflows. Furthermore, the seven factors provide an empirical foundation for further research on the prioritization and selection of project management tools in the telecommunications industry. The current factor analysis establishes what dimensions constitute the requirements, but it does not necessarily determine which dimensions should receive the highest priority when comparing alternative tools. This creates an opportunity for subsequent research to assign relative weights to the seven factors and evaluate alternative project management tools according to their level of alignment with these requirements. Methods such as AHP, BWM, ANP, TOPSIS, or other multi-criteria decision-making approaches could subsequently be employed to transform the factor structure into a Project Management Tool Selection and Prioritization Model. In this framework, the seven factors would function as higher-level evaluation criteria, while specific variables within each factor could serve as measurable indicators for assessing candidate tools.

CONCLUSION

This study aims to identify the fundamental user requirements for project management tools within the telecommunications industry by applying factor analysis to reduce and structure multiple requirement variables into meaningful dimensions. The results reveal seven key factors that represent the core functional requirements of project management tools, namely operational function, monitoring function, task assignment, dashboard function, performance function, dependability function, and usability. These factors collectively describe the essential capabilities required to support project execution, monitoring, coordination, and decision-making within complex telecommunications project environments.

The findings indicate that the effectiveness of project management tools is not determined solely by the breadth of technical features provided. Instead, user-centered considerations, such as usability, system reliability, and integration with existing workflows, play a critical role in influencing user adoption and operational effectiveness. In the context of telecommunications projects—characterized by multi-stakeholder coordination, dynamic project activities, and high operational complexity—tools that facilitate efficient monitoring, reliable reporting, and seamless task coordination.

By reducing numerous requirement variables into a structured set of latent factors, this study provides a systematic representation of user needs that can support more informed decision-making when selecting project management tools. From a practical perspective, the identified factor structure can serve as a reference framework for organizations, decision-makers, and technology vendors in evaluating, selecting, or improving project management systems that align with operational requirements in the telecommunications industry.

Overall, this study contributes to the project management literature by offering an empirically grounded understanding of the key functional dimensions underlying user requirements for project management tools. The results highlight the importance of aligning tool capabilities with user needs and organizational workflows to enhance project efficiency and effectiveness in technology-intensive industries such as telecommunications.ustness and generalizability across different industrial sectors.

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