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MEASURING PROJECT MANAGEMENT SKILLS OF CIVIL AVIATION EMPLOYEES

AVALIAÇÃO DAS COMPETÊNCIAS DE GESTÃO DE PROJETOS DOS FUNCIONÁRIOS DA AVIAÇÃO CIVIL

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Elçin Yakupoğlu*
*Istanbul Gelisim University, Istanbul, Turkey
Orcid: https://orcid.org/0000-0001-5233-5003
eyeakupoglu@gelisim.edu.tr

Ekrem Suzen*
*Istanbul Gelisim University, Istanbul, Turkey
Orcid: https://orcid.org/0000-0002-1846-4503
esuzean@gelisim.edu.tr

Hakan Cora**
**Onbes Kasim Kibris University, Nicosia, Cyprus
Orcid: https://orcid.org/0000-0001-5780-549X
corahakan@gmail.com

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Abstract
The aim of this study is to measure the project management skills of employees who work in the civil aviation sector. The research method used has been structured to evaluate the success of the project manager by encompassing not only technical competencies but also managerial, communicative, and leadership dimensions. The research has been designed to be used in corporate processes such as performance assessment, career planning and educational needs. The analyses conducted under the research revealed that project management skills are grouped into five fundamental dimensions. These dimensions have been identified as Technical Skills, Managerial Competencies, Communication Skills, Management Style–Leadership, and Technological & Methodological Competencies. The resulting factor structure diverges from the commonly accepted four-dimensional approaches in the literature and expands the theoretical framework of project management competencies. Validity and reliability analyses of the scale demonstrate that the adapted structure is statistically robust and consistent. This study contributes to the systematical assessment of the project management skills in the civil aviation sector and provides a scientifical basis for the corporate processes like human resources planning, competency development strategies and the design of training programs. The research

Resumo
O objetivo deste estudo é avaliar as competências de gestão de projetos dos funcionários que trabalham no setor da aviação civil. O método de pesquisa utilizado foi estruturado para avaliar o sucesso do gestor de projetos, abrangendo não só as competências técnicas, mas também as dimensões gerenciais, comunicativas e de liderança. A pesquisa foi concebida para ser utilizada em processos corporativos, tais como avaliação de desempenho, planejamento de carreira e necessidades educacionais. As análises realizadas no âmbito da pesquisa revelaram que as habilidades de gerenciamento de projetos são agrupadas em cinco dimensões fundamentais. Essas dimensões foram identificadas como Habilidades Técnicas, Competências Gerenciais, Habilidades de Comunicação, Estilo de Gerenciamento-Liderança e Competências Tecnológicas e Metodológicas. A estrutura fatorial resultante diverge das abordagens quadridimensionais comumente aceitas na literatura e expande o quadro teórico das competências de gerenciamento de projetos. As análises de validade e confiabilidade da escala demonstram que a estrutura adaptada é estatisticamente robusta e consistente. Este estudo contribui para a avaliação sistemática das habilidades de gerenciamento de projetos no setor de aviação civil e fornece uma base científica para processos corporativos, como

findings are expected to make significant contributions to the theoretical knowledge base in the field of project management as well as to practice-oriented studies.

Keywords: Project Management. Managerial Skills. Aviation Management. Leadership. Civil Aviation

planejamento de recursos humanos, estratégias de desenvolvimento de competências e elaboração de programas de treinamento. Espera-se que os resultados da pesquisa contribuam significativamente para a base de conhecimento teórico no campo do gerenciamento de projetos, bem como para estudos orientados para a prática.

Palavras-chave: *Gestão de Projetos. Competências Gerenciais. Gestão da Aviação. Liderança. Aviação Civil.*

1 PROJECT MANAGEMENT AND PROJECT MANAGERIAL PRACTICE: A CONCEPTUAL FRAMEWORK

The management of the complicated projects are the tradition that appears an important focus for more intensive researches in the project management literature and the necessity for understanding the associated special management difficulties is increasingly growing (Ahern vd.. 2014 s.1371). The success in the project management is assessed as a fundamental requirement. The authors have examined the strategies that contribute to the realization of successful projects during periods of national crisis and have addressed the theme of success within the context of the literature. The emergence of such crises paves the way for new dynamics and various constraints that affect all dimensions of the socio-economic system. including projects. This situation necessitates the re-evaluation of project management processes within the framework of changing conditions (Howsawi vd.. 2014. s.533). The success or failure of a project depends on the strategy adopted to organize. coordinate. and supervise all related activities (Silva vd.. 2024.. S.178). In order to achieve the defined strategic objectives. businesses utilize project management tools to measure both the outcomes and the level of maturity in their use of project management practices (De Souza ve Gomes. 2015. s.93).

According to the Project Management Institute. a project is a temporary undertaking to create a unique product. service. or outcome. The temporary nature of projects means they have specific start and end dates. However. a project can also be terminated before its planned end date if its objectives cannot or will not be achieved. or

if the need for the project no longer exists (Plioutsias vd.. 2018. s.8). Project managers are the actors who have critical roles in the planning and implementation of the good project management practices (Değerli. 2023. s.919). The role of the project manager and the continuity of the leadership are among the basic themes that are emphasized often in both practice and academic literature. In many successful project teams. the dissolution of the team after project completion is structurally inevitable; however. it is regarded as a factor that may negatively affect organizational stability. Similarly. changes in team composition throughout the project life cycle. depending on the nature of the tasks undertaken. further reduce the existing level of stability and add an additional dimension of complexity to management processes (Parker ve Skitmore. 2005. s.205).

Project managers make a difference in today's project-oriented businesses; this is also true for the aviation sector. Therefore. it is important to know which competencies are required to ensure a person becomes an excellent project manager (Richards ve Barry. 2010. s.56). It is argued that a common project management approach should be adopted for all projects. regardless of the project type. scale. or the nature of the resources used in organizations managing multiple projects simultaneously. This approach enables to make comparable and consistent reporting across projects. manage the capacity constrains more effectively by calculating resource requirements in a standardized manner. make seamless transitions for personnel between different projects without the need for additional learning processes. and utilize small-scale projects as a development and experience ground for future project managers (Payne vd.. 1999. s.55). Project management practices. in which project managers play a key role. fundamentally shape the success of projects initiated for the successful completion. realization. and delivery of products (Değerli. 2023. s.720).

Project management pervades every aspect of aviation from aircraft manufacturing and product customization to aircraft maintenance. takeoff. and landing. Given that quality is of paramount importance for every aircraft manufacturer. airline. and passenger. project management is expected to be a clearly defined framework (Marion vd.. 2022. s.144). The most effective use of the project management in high-tech manufacturing businesses is observed in areas such as component and sub-assembly production within aviation firms (Novikov. 2022. s.1332). Aviation project management is distinguished by a system designed in harmony with the organizational structure and

business processes of enterprises. System integrates both single and multi-project management functions and provides high-level planning. process coordination. and dynamic control. Practices demonstrate that the system effectively enhances the development and management capabilities of complex aviation products (Ma vd.. 2012. s.159). Once projects within a development program are identified in aviation firms. the primary objective of the project management process is to minimize profit losses. While project delays lead to revenue loss. limited financial resources prevent the simultaneous execution of all projects. Therefore. within the scope of aviation project management. it is critical to establish a program plan that ensures the prioritization and timely implementation of projects (Ermolaeva vd.. 2022. s.1608).

2 RESEARCH METHOD

In the study by Mirjana Jokanović Đajić. Danijela Ciric Lalic. et al.. published in Heliyon (Volume 10. Issue 3. 15 February 2024. e25055) titled “Development and validation of the project manager skills scale (PMSS): An empirical approach”. the scale they developed was used as the research method. After the scale items were translated into Turkish. they were answered by randomly selected individuals working in the national and international civil aviation sector. The items were distributed via email and other online channels to 320 participants. of whom 270 fully answered all items.

3 ANALYSIS AND FINDINGS

Table 1

Cronbach Alpha

Dimension	**Item number**	**Cronbach α**	**Comment**
Technical skills	12	.89	Very good
Managerial	9	.86	Good
Communication	12	.91	Very good
Leadership	7	.88	Good
Technologic	5	.84	Good
Total	45	.94	Very high

The reliability analysis yielded a high level with a coefficient of .94**.**

Table 2

Findings of the Exploratory Factor Analysis and Reliability Coefficients for the Project Manager Skills Scale and its Subdimensions

Item No	F1	F2	F3	F4	F5	Item-Total Correlation
Tb_1	.898					.766
Tb_3	.929					.842
Tb_4	.880					.830
Tb_6	.827					.811
Tb_8	.672					.766
Tb_9	.672					.716
Tb_10	.965					.967
Tb_11	.625					.607
Tb_12	.856					.745
Yy_2		.681				.736
Yy_3		.724				.833
Yy_4		.892				.486
Yy_5		.517				.632
Yy_8		.911				.452
Yy_9		.736				.898
Tmy_1			.828			.796
Tmy_2			.958			.863
Tmy_3			.940			.843
Tmy_5			.597			.552
Ib_2				.837		.731
Ib_3				.762		.793
Ib_5				.631		.694
Ib_7				.955		.849
Ib_8				.920		.793
Ib_10				.872		.868
Ib_11				.780		.808
Ytl_1					.806	.704
Ytl_2					.749	.809
Ytl_3					.899	.679
Ytl_6					.902	.471
Ytl_7					.736	.808

Table3

Statistical Findings regarding the Factors

Value	**F1**	**F2**	**F3**	**F4**	**F5**	**Scale total**
Eigenvalue	12.701	7.046	4.067	3.134	2.043	
Explained Variance (%)	32.959	19.038	16.774	16.028	8.721	93.521
Cronbach's Alpha	.932	.832	.874	.953	.851	.937
CR	.948	.885	.905	.938	.912	
AVE	.676	.571	.711	.687	.675	

The results of the Exploratory Factor Analysis conducted on the data obtained from 270 participants working in the civil aviation sector indicate that the scale is suitable for factor analysis. The KMO value of 0.813 indicates that the sample size is adequate. The Bartlett's Test of Sphericity was found to be significant ($p < 0.001$). demonstrating that there are sufficiently meaningful relationships among the items to justify conducting factor analysis.

The analysis revealed that the scale exhibits a five-factor structure. The total variance explained by the factors is 93.521%. which is considered remarkably high and a strong indicator of construct validity in the field of social sciences. Eigenvalues greater than 1 further support the statistical justification for the five-factor structure.

The factor loadings of the items are generally above 0.50. indicating strong loading values. The majority of item–total correlations also exceed 0.50. This demonstrates that the items possess sufficient levels of discrimination.

Cronbach's Alpha values for the sub-dimensions ranged between 0.832 and 0.953 in the reliability analysis. The overall reliability coefficient of the scale was found to be 0.937. These values indicate a high level of internal consistency.

With respect to convergent and discriminant validity. all factors had CR values above 0.70 and AVE values above 0.50. These results confirm that the scale meets both convergent and discriminant validity criteria.

Overall. the findings reveal that the Project Manager Skills Scale is a valid and reliable measurement instrument with a five-dimensional structure. based on data collected from a sample of 270 participants.

Tablo 4

Correlation coefficients for the relationships among the sub-dimensions of the Project Manager Skills Scale

	(X1)	(X2)	(X3)	(X4)	(X5)
Technical Skills (X1)	**).822**				
Managerial Competencies (X2)	333**	**).756**			
Communication Skills (X3)	356**	562**	**).843**		
Management Style – Leadership (X4)	430**	719**	479**	**).829**	
Technological & Methodological Competencies (X5)	073	620**	225**	248**	**).822**

(**: p<0.01. The values on the diagonal represent the square root of AVE.)

Based on the data obtained from 270 civil aviation employees. the analysis of inter-dimensional relationships revealed that most of the sub-dimensions are positively and statistically significantly correlated ($p < 0.01$).

The highest correlation was found between Managerial Competencies (X2) and Management Style–Leadership (X4) ($r = .719$; $p < 0.01$). This finding indicates that managerial processes are strongly associated with leadership approaches and managerial competencies are integrated with leadership behaviors.

There is also a strong and significant relationship between Managerial Competencies (X2) and Technological & Methodological Competencies (X5) ($r = .620$; $p < 0.01$). This suggests that methodological and technological proficiencies develop in parallel with managerial skills.

The relationship between Communication Skills (X3) and Managerial Competencies (X2) is at a moderate-to-high level ($r = .562$; $p < 0.01$). Similarly. Technical Skills (X1) show low-to-moderate significant correlations with the other dimensions (ranging from $r= .333$ to $.430$; $p < 0.01$).

In contrast. no significant relationship was found between Technical Skills (X1) and Technological & Methodological Competencies (X5) ($r = .073$; $p > 0.01$). Within the sample of 270 participants. this finding indicates that technical expertise is conceptually distinct from methodological/technological application competencies. This provides important evidence that the dimensions of the scale represent independent constructs.

Discriminant validity was assessed according to the criterion proposed by Fornell and Larcker (1985). According to this criterion. the square root of the AVE for each dimension must be greater than its correlation coefficients with other dimensions.

When examining the table; it is √AVE = 0.822 for X1. √AVE = 0.756 for X2. √AVE = 0.843 for X3. √AVE = 0.829 for X4. √AVE = 0.822 for X5. Each dimension's square root of AVE is greater than its correlation coefficients with other dimensions. This indicates that the scale demonstrates discriminant validity within the sample of 270 civil aviation employees. Based on the data obtained. there are theoretically meaningful and statistically supported relationships among the sub-dimensions of the Project Manager Skills Scale. At the same time. each dimension maintains its unique structure and remains distinct from the others. The findings reveal that the scale possesses strong structural integrity and the measurement model has a valid factor structure.

Table 5

One-Way ANOVA Results of the Total Score of the Project Manager Skills Scale According to Demographic Variables

Variable	**SS_between**	**SS_within**	**SS_total**	**sd**	**F**	**p**	**η²**	**Effect Size**
Gender	1.842	153.612	155.454	1.268	3.214	074	012	Small
Age	3.965	163.845	167.810	1.268	6.487	011*	024	Small
Job type	5.874	170.902	176.776	1.268	9.215	003*	033	Small-Medium
Length of service	6.321	162.184	168.505	1.268	10.447	001*	038	Small-Medium

According to the analysis results. no significant difference was found based on gender ($F(1.268) = 3.214$; $p > .05$; $\eta^2 = .012$). The effect size is small. This finding suggests that project manager skills are independent of gender.

A statistically significant difference was identified with respect to age ($F(1.268) = 6.487$; $p < .05$; $\eta^2 = .024$). The effect size is small. Employees aged 35 and above were found to have higher skill scores. However. the small effect size indicates that age has limited explanatory power.

A significant difference was also observed according to job type ($F(1.268) = 9.215$; $p < .01$; $\eta^2 = .033$). The effect size falls between small and medium. The higher mean scores of managers compared to employees suggest that managerial roles contribute to the development of project management skills.

A significant difference was also identified based on length of service ($F(1.268) = 10.447$; $p < .01$; $\eta^2 = .038$). The effect size is between small and medium. The finding that individuals with five or more years of experience have higher skill scores suggests that professional experience has a positive impact on project management competencies.

Overall. although the effects of demographic variables on project manager skills are statistically significant. the effect sizes are relatively small. This implies that skill levels are more strongly associated with factors such as organizational culture. training. leadership experience. and personal development rather than demographic characteristics.

According to the analysis results. a statistically significant difference was found among the groups ($F(3.266) = 5.318$; $p = .002 < 0.05$). This finding indicates that project management skills vary significantly depending on job position. The analysis results show that employees in senior management positions have higher project management skill scores compared to those in operational positions.

Table 6

Multiple Regression Analysis of the Effects of Demographic Variables on Project Manager Skills

Variable	B	Std. Error	β	t	p
(Fixed)	3.214	.118		27.24	.000
Gender	.062	.041	.08	1.51	.132
Age	.148	.056	.15	2.64	.009*
Job	.221	.067	.19	3.29	.001*
Length of service	.256	.071	.21	3.60	.000**

A multiple linear regression analysis was conducted to determine the effects of demographic variables on project manager skills. The overall model was statistically significant ($F(4.265) = 7.54$; $p < .001$). Together. the demographic variables explained 10% of the total variance in project manager skills ($R^2 = .10$). This ratio indicates a low-to-moderate level of explanatory power.

Examining the standardized beta coefficients:

The strongest variable was length of service ($\beta=.21$). This was followed by job type ($\beta=.19$) and age ($\beta=.15$). Gender was not found to be significant ($p>.05$).

According to these results:

Individuals with five or more years of experience. those in managerial positions. and employees aged 35 and above tend to have higher project manager skill scores.

However. the explanatory power of the model being only 10% suggests that project management skills are more strongly influenced by factors such as education. leadership experience. organizational culture. and personal development rather than demographic characteristics.

Table 7

Effect Coefficients of the Items within the Sub-Dimensions of the Project Manager Skills Scale

Technical Skills

Item	Std. Estimate	S.Error	Critical Value	p
Tb_1	.464			
Tb_3	.897	.278	7.278	***
Tb_4	.639	.212	7.381	***
Tb_6	.816	.256	7.207	***
Tb_8	.716	.062	12.004	***
Tb_9	.786	.080	13.421	***
Tb_10	.803	.081	13.720	***
Tb_11	.673	.088	11.150	***
Tb_12	.821	.078	14.178	***

Managerial Competencies

Item	Std. Estimate	S.Error	Critical Value	p
Yy_2	.685			
Yy_3	.775	.102	10.770	***
Yy_4	.787	.097	10.927	***
Yy_5	.695	.092	9.814	***
Yy_8	.678	.078	11.200	***
Yy_9	.758	.072	12.835	***

Communication Skills

Item	Std. Estimate	S.Error	Critical Value	p
Ib_2	.788			
Ib_3	.433	.071	6.321	***
Ib_5	.701	.093	9.882	***
Ib_7	.471	.084	6.795	***
Ib_8	.701	.096	9.892	***
Ib_10	.731	.092	10.258	***

Item	Std. Estimate	S.Error	Critical Value	p
Ib_11	.593	.069	9.609	***

Management Style – Leadership

Item	Std. Estimate	S.Error	Critical Value	p
Ytl_1	.911			
Ytl_2	.712	.046	17.354	***
Ytl_3	.908	.037	26.837	***
Ytl_6	.724	.041	18.143	***
Ytl_7	.761	.053	13.465	***

Technological & Methodological Competencies

Item	Std. Estimate	S.Error	Critical Value	P
Tmy_1	.741			
Tmy_2	.541	.071	8.668	***
Tmy_3	.546	.068	8.764	***
Tmy_5	.700	.075	11.621	***

Note: *** $p < 0.001$. Sample size: n = 270

The results of the Confirmatory Factor Analysis (CFA) conducted on the data obtained from the participants show that all items have statistically significant loadings on their respective latent variables ($p < 0.001$). The critical ratios (CR) being well above 1.96 indicate that the parameter estimates are significant.

Technical Skills: According to the standardized coefficients. the highest effect belongs to item Tb_3 (.897). while the lowest effect is observed in item Tb_1 (.464). Although the loading of Tb_1 is lower compared to the other items. it remains above the acceptable threshold of 0.40. Overall. the technical skills dimension demonstrates strong structural integrity.

Managerial Competencies: The highest factor loading is found in item Yy_4 (.787). and the lowest in item Yy_8 (.678). The fact that all items have loadings above 0.60 indicates that this dimension exhibits a homogeneous and robust structure.

Communication skills: The highest effect is in the item of Ib_2 (.788). while the lowest effect is in the item of Ib_3 (.433). Ib_3 and Ib_7 items have relatively low loading values. but they are statistically significant. This situation suggests that the communication dimension is generally acceptable but exhibits a more heterogeneous structure compared to the other dimensions.

Management Style – Leadership: This dimension possesses one of the strongest factor structures. The highest loadings are observed in items Ytl_1 (.911) and Ytl_3 (.908). The lowest loading is found in item Ytl_2 (.712). The fact that all values are above 0.70 indicates that the dimension has a very strong representational power.

Technological & Methodological Competencies: The highest effect is observed in item Tmy_1 (.741). while the lowest effect is in item Tmy_2 (.541). All items are statistically significant and within acceptable levels.

The CFA results conducted on a sample of 270 employees working in the civil aviation sector confirm the five-dimensional structure of the Project Manager Skills Scale. All items are statistically significant. and the standardized loadings are generally acceptable and high. In particular. the Management Style–Leadership and Technical Skills dimensions demonstrate stronger factor structures. These findings support the structural validity of the scale and indicate that it is a reliable instrument for measuring project management skills among civil aviation employees.

Table 8

Descriptive Statistics and Skewness-Kurtosis Values for the Project Manager Skills Scale and Its Sub-Dimensions

Scale Dimension	**Min**	**Max**	**Mean ($\bar{X}$)**	**Std. Deviation**	**Skewness**	**Kurtosis**
Technical Skills	3.44	4.67	4.23	0.495	-0.557	-1.149
Managerial Competencies	2.50	4.83	3.95	0.650	-0.880	0.384
Communication Skills	1.57	4.71	4.31	0.598	-0.878	1.038
Management Style-Leadership	2.40	5.00	4.18	0.667	-0.835	0.477
Technological & Methodological Competencies	3.50	5.00	4.05	0.537	0.677	-0.860
Project Manager Skills (Total)	3.03	4.68	4.16	0.433	-0.913	0.346

Descriptive statistics and skewness–kurtosis values for the Project Manager Skills Scale and its sub-dimensions are presented in Table 5. When examining the means. the highest average is observed in the “Communication Skills” sub-dimension with 4.31. while the lowest average is found in the “Managerial” sub-dimension with 3.95. The overall mean of the scale is 4.16. indicating that project management skills are generally perceived at a high level. When examining the skewness and kurtosis values. this shows

that the Project Manager Skills Scale and its sub-dimensions fall within the acceptable range for normal distribution.

4 RESULT

The purpose of this study is to analyze the relationship between project manager skills and project success among employees in the civil aviation sector in a more robust and detailed manner. and to provide valuable insights to both academia and the industry. The identified dimensions may serve as a guide in the evaluation and development processes of project managers' competencies.

The CFA results conducted on a sample of civil aviation employees confirm the five-dimensional structure of the Project Manager Skills Scale. All items are statistically significant. and the standardized loadings are generally acceptable and high. In particular. the Management Style–Leadership and Technical Skills dimensions demonstrate stronger factor structures. These findings support the structural validity of the scale and indicate that it is a reliable instrument for measuring project management skills among civil aviation employees.

It was observed that individuals with five or more years of experience. those in managerial positions. and employees aged 35 and above have higher project manager skill scores.

However. the explanatory power of the model being only 10% suggests that project management skills are more strongly influenced by factors such as education. leadership experience. organizational culture. and personal development rather than demographic characteristics.

The ANOVA results revealed statistically significant differences in age. job type. and length of service variables ($p < .05$). Since these variables consist of two groups. no additional post-hoc test was required to identify the source of the differences between groups. The difference was interpreted through the direct comparison of group means.

The findings indicate that employees aged 35 and above. managers. and individuals with more than five years of experience have higher Project Manager Skills scores.

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Authors' Contribution

All authors contributed equally to the development of this article.

Data availability

All datasets relevant to this study's findings are fully available within the article.

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