

# Design and development of a comprehensive framework to enhance leadership skills in project management

Pablo Delgado-Valencia<sup>a</sup> & Pedro Sánchez-Caimán<sup>b</sup>

<sup>a</sup> Ejército Nacional de Colombia, Bogotá D.C., Colombia. [pablo.delgado@unimilitar.edu.co](mailto:pablo.delgado@unimilitar.edu.co)

<sup>b</sup> Facultad de Ingeniería, Universidad Militar Nueva Granada, Bogotá D.C., Colombia. [Pedro.sanchez@unimilitar.edu.co](mailto:Pedro.sanchez@unimilitar.edu.co)

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## Abstract

This research aimed to design a framework for leadership competence in project management training for industrial engineering professionals at universities in Bogotá, Colombia. Motivated by the observed absence of this competence among recent graduates. The study employed a sequential exploratory design using mixed methods. By characterizing global leadership models in project management theorized by academia and leading organizations, key variables were identified. Diagnosing the leadership competence of students generated relevant data, which were statistically analysed, facilitating academic recommendations and the framework's design. The outcome significantly contributes to the field by providing a functional and generalisable framework for universities in Bogotá, strengthening leadership competence in professional training. This research underscores the complexity and centrality of leadership in project management, highlighting the need for an adaptive and practical framework to guide the education of future professionals with holistic and applicable skills to effectively lead in volatile and ambiguous environments.

**Keywords:** educational standards; leadership skills; leadership structure; learning outcomes; project management.

# Diseño y desarrollo de un marco integral para potenciar las habilidades de liderazgo en la gestión de proyectos

## Resumen

Esta investigación tuvo como objetivo diseñar un marco de competencias de liderazgo en la formación en gestión de proyectos para profesionales de ingeniería industrial en universidades de Bogotá, Colombia. Motivada por la ausencia observada de esta competencia entre los recién graduados. El estudio empleó un diseño exploratorio secuencial utilizando métodos mixtos. Al caracterizar modelos globales de liderazgo en gestión de proyectos teorizados por la academia y organizaciones líderes, se identificaron variables clave. El diagnóstico de la competencia de liderazgo de los estudiantes generó datos relevantes, que fueron analizados estadísticamente, facilitando recomendaciones académicas y el diseño del marco. El resultado contribuye significativamente al campo al proporcionar un marco funcional y generalizable para las universidades en Bogotá, fortaleciendo la competencia de liderazgo en la formación profesional. Esta investigación subraya la complejidad y centralidad del liderazgo en la gestión de proyectos, destacando la necesidad de un marco adaptativo y práctico para guiar la educación de futuros profesionales con habilidades holísticas y aplicables para liderar eficazmente en entornos volátiles y ambiguos.

**Palabras clave:** estándares educativos; habilidades de liderazgo; estructura de liderazgo; resultado de aprendizaje; gerencia de proyectos.

## 1. Introduction

### 1.1 Leadership context and its importance

Leadership has been identified as an essential personal competence not only for facing the challenges of the 4.0

industrial revolution, but also for business success. In the context of this industrial revolution, leadership takes a particularly human dimension, emphasizing the need for an approach that focuses its attention on personal skills and abilities [1-3]. This vision is shared by managers of diverse organizations, who consider leadership not only as a valuable

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competence, but also as an essential element for achieving organizational objectives and the success of projects. The importance of having professionals with developed leadership skills is relevant to positively impact on business dynamics and outcomes [4]. This convergence of perspectives highlights leadership as a critical variable for innovation, Project Management (PM), and business sustainability in the era of digitalization and automation.

Contemporary organizations increasingly value the development of interpersonal skills or *power skills* [5]. This has motivated the inclusion of professionals trained in educational institutions that emphasize these competencies in their curricula. The World Economic Forum anticipated that automation and technological advances could result in the loss of 85 million jobs by 2020, underscoring the importance of a rapid adaptation to the changing labour landscape through the acquisition of these personal skills [6]. Countries like the Kingdom of Saudi Arabia and Australia have been reforming their educational systems to meet these needs, facing significant challenges, including the COVID-19 pandemic, which demand a rethinking of educational offerings to guarantee the professional future of new generations [6].

## 1.2 Current state of the research field

For the development of this research, an extensive literature review was conducted, where the search for academic articles and documents were essential for understanding the theme under research. The international and national analysis on leadership competence highlights the importance and the need for integrating leadership training. Countless studies have focused on the development of leadership skills among students, recognizing the relevance of these skills and abilities for professional success in the business sector.

Internationally, the following research studies in this field were identified.

- In the Autonomous Community of Aragon, Toledo, et al. [7] identified a shared perception among managers and teachers about the insufficiency of leadership training within educational institutions, highlighting the need for improving training programs to include social, communication, mediation, and conflict resolution skills. This research suggested that leadership training should be inclusive and encompass the entire educational community, including students and teachers to enhance the development of this essential competency.
- Dávila Quintana, et al. [8] focused on the impact of teaching methods and practices in higher education on leadership development, concluding that a combination of pedagogical approaches facilitates the development of leadership competencies in students which benefits their job performance. This research underscored the importance of preparing graduates to demonstrate leadership from the beginning of their professional career.
- Bruce and Stephens [9] addressed the development of specific tools to facilitate leadership learning. They proposed a toolkit for leadership learning facilitators

which supports the transition of students from high school to college and from college or universities to the workplace. Yen, et al. [10] described the development of a digital toolkit, at the University of Washington, was aimed at promoting leadership among academic staff, highlighting the need for professional development opportunities focused on leadership skills.

Nationally, the following research in this field of study was identified.

- López [11] examined student leadership at the Santo Tomás University in Bucaramanga, Colombia, proposing a training program in social and political leadership. This research recognised leadership training as an important need to face current social challenges, highlighting deficiencies in communicative skills and group management as key areas for improvement.

The review of additional literature, represented in other scientific articles, complements these findings, emphasizing the relevance of leadership not only in the educational context, but also in PM and in a broader professional sphere. The inclusion of leadership training in university curricula emerges as an imperative to provide future professionals with the necessary competencies to navigate and succeed in dynamic and challenging work environments.

## 2. Methodology

This research was conducted as a mixed-method study with a descriptive scope because data collection was performed qualitatively and quantitatively. The integration of these methods allowed a discussion of the gathered information to gain a better understanding of leadership competency. Mixed-method research enables the expansion and enhancement of knowledge about the objects or phenomena under study through the use of numerical and textual variables, formulas, and narratives, that is, the combination of quantitative and qualitative approaches [12]. The application of the mixed method arose from the need for addressing the complexity of the problem through different realities, facilitating not only the acquisition of objective concepts, but also subjective ones [13].

The mixed method allowed adding value to this research and conducting an in-depth analysis during the study of the problem, using two methodological approaches to mitigate the uncertainty of the results. The implementation of this method, however, required considering a larger number of perspectives during the research, which enabled a more holistic and comprehensive analysis of the problem and greater certainty in the scientific conclusions [12]. The capitalization and complementarity of qualitative and quantitative approaches meant that the weaknesses and strengths of both methods were considered, contributing firstly to a greater understanding of aspects related to leadership competency associated with PM, and secondly, to an increase in the confidence of the results concerning the analysis of the problem under study [14].

The Sequential Exploratory Design (SED) was also adopted for this research. This design allowed the analysis of quantitative data collected, to be developed based on qualitative information that was identified, thus connecting

both types of data and enabling an integration of both approaches [12]. This comparison was followed by the presentation of a leadership framework for PM based on quantitative and qualitative results, allowing a deepening of the results in favour of the research product [15]. Similarly, within this design, the derivative modality according to its characteristics was the foundation for the research development. The SED enabled the research to be conducted based on constructivist principles.

The SED was chosen because it possesses the necessary elements to develop instruments which facilitated the collection of relevant information, such as a diagnostic questionnaire [16]. This design generally comprised three phases to investigate a theme in depth. In the first phase, to characterize leadership models applicable to PM through a literature review, allowing the identification of variables to be developed in this research. In the second phase, the qualitative results enabled the design of an instrument to diagnose the leadership competency associated with PM and to administer the instrument to two groups, whose collected data was analysed statistically.

Finally, a shift was made to a post-positivism principle to identify and measure quantitative variables. The quantitative data was identified and interpreted in ways that generalized and expanded the qualitative results and could be employed in the proposal for designing a leadership framework for PM.

### 3. Results

The initial result of this research was the generation of a co-occurrence matrix using the T-Lab software, which identified eleven (11) clusters (see Fig. 1), which were lemmatized in relation to the group of words forming them (see Table 1). This matrix was generated thanks to the development of a qualitative approach, where a detailed review of the literature was conducted. The verification of eight of the main organizations (Project Management Institute® - PMI®; Centre of Excellence in PM<sup>2</sup> - PM<sup>2</sup>, International Project Management Association – IPMA; Association for Project Management – APM; Projects in Controlled Environments - PRINCE2; Guidance on Project Management - ISO 21500; Australian Institute of Project Management – AIPM; and Project Management Association of Japan – PMAJ) focused on the study of PM at a global level was performed [16-19], allowing the analysis of specific information regarding leadership from guide books or texts on PM from these organizations to be the main inputs for the generation of the clusters. This verification ensured that the mentioned organizations encompassed knowledge developed in projects across different continents, such as: America, Asia, Europe, and Oceania.

The results of the qualitative analysis, which identified eleven (11) clusters, served as the basis for designing a questionnaire aimed at diagnosing leadership in PM among final-semester students from universities in Bogotá, Colombia and Colombian business professionals. To ensure the overall relevance and precision of the statements, the questionnaire design was based on the Leadership Competency Development Framework, established in the Project Management Competency Development Framework (PMCD) of the PMI®, adjusted to the needs of both groups.

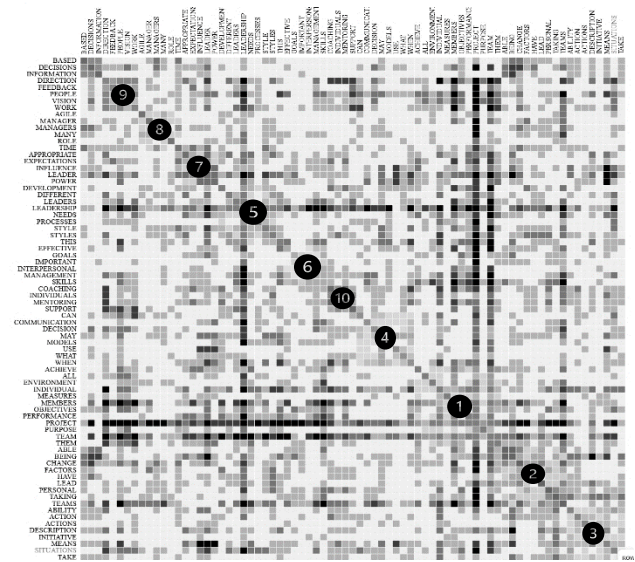


Figure 1. Concurrence matrix.

Source: Own elaboration by using T-Lab software.

Table 1.  
Clusters.

Cluster	Themes
1	Development and management of teams in projects.
2	Leadership in the context of changes and adaptability in team management.
3	Proactive competence and adaptability in changing situations through the use of skills and resources.
4	Interaction of communication and decision-making based on established frameworks or reference structures.
5	Development and adaptability in leadership style based on changing needs.
6	Integration of management and interpersonal skills to achieve objectives effectively.
7	Role of influence and power in leadership and managing expectation in PM.
8	Role of the manager in an agile context and their temporal and functional relationship in PM.
9	Process of guiding a team toward a vision through interaction and feedback in PM.
10	The role of guidance and support in the development of individuals within PM.
11	Decision-making based on information.

Source: Own elaboration.

The questionnaires were structured with three statements per cluster (these statements were also referred to as the cluster variables within this study), formulated to be answered using the Likert scale [20]. The questions, although adapted in wording for students and business professionals, maintained a coherence which allowed the comparison of the mean of the independent populations. Additionally, control questions were strategically placed and added to assess the seriousness and consistency of the answers. This approach not only enabled the creation of a solid instrument to measure leadership competence, but also facilitated a meaningful and detailed diagnosis for both groups.

The validation process of the instrument was conducted in two phases. First, a pilot test was administered to eighth-semester industrial engineering students and business

professionals which allowed verification of the clarity and relevance of the questions and received direct feedback on the comprehensibility of the questionnaire. Second, the validation was performed by academics and expert business professionals with high academic qualifications, who made recommendations to adjust the instrument, ensuring that it reflected leadership skills in the Colombian business context. In both cases, the *omega coefficient* (see Fig. 2) was applied as a method to estimate the reliability of the instrument [21].

For the students, the omega coefficient yielded a value of 0.99, indicating excellent reliability. Similarly, the omega coefficient applied to the instrument for the business professionals confirmed a high reliability, with a value of 0.97.

This process enabled the creation of a robust and reliable questionnaire with a solid theoretical foundation, which was administered to fifty (50) students and twenty-two (22) business professionals. The comparison between both populations offered valuable insights into the differences and similarities in the perception of leadership in PM within the field of industrial engineering. The high reliability of the instruments, demonstrated by the omega coefficient values, supported the quality of the results obtained in both groups.

The diagnosis applied to the two (02) independent populations —final-semester students and Colombian business professionals— was subjected to a rigorous statistical analysis using SPSS software. This enabled to compare the responses between both groups and evaluate the difference in perception regarding leadership competence in PM, the Mann-Whitney test was employed [22]. This test is widely recognized in non-parametric statistics for its ability to compare two independent samples, especially when variables are measured on ordinal scales, as is the case with the responses obtained through Likert scale-based surveys.

The analysis using the Mann-Whitney test enabled the examination of each of the eleven clusters separately. In most cases, the resulting *p-value* was less than 0.05, leading to the rejection of the null hypothesis [22, 23]. This means that, in general, there were significant differences between the perceptions of students and business professionals regarding leadership competencies. The results indicated that both groups had different experiences and expectations concerning how leadership skills were developed and applied in PM.

An interesting aspect of the analysis was that, in some clusters, specifically cluster 6 (Integration of management and interpersonal skills to achieve objectives effectively) and cluster 8 (Role of the manager in an agile context and their temporal and functional relationship in PM.), certain variables presented a *p-value* > 0.05. In these cases, the null hypothesis was not rejected, indicating that there were not significant differences between the responses of students and business professionals. This suggested that both groups shared a similar view on specific aspects of leadership, such

as the integration of technical and social skills in the work environment, and the ability to assume relevant roles in agile work contexts. These findings indicated that universities have been playing an important role in the development of these key leadership skills, and the employers value these abilities positively in recent graduates.

Following the Mann-Whitney analysis, an exploratory factor analysis was conducted to validate and simplify the previously generated clusters. The main objective of this analysis was to identify underlying relationships among the variables that would allow them to be grouped into factors, thereby reducing the complexity of the initial clusters and facilitating a clearer interpretation of leadership competency in the field of industrial engineering. To ensure the suitability of the data for this type of analysis, two fundamental tests were applied: the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity.

The KMO test evaluates whether the correlations among the variables are strong enough to justify reducing them to a smaller number of factors [24]. The results of the analysis yielded KMO values ranging between 0.65 and 0.90, indicating that the correlations were adequate for conducting factor analysis. A KMO value close to 1.0 suggests that the variables are highly correlated, while values below 0.5 would indicate the correlations are not strong enough to proceed with the analysis. In this case, the obtained values reinforced the validity of the analysis and the suitability of the selected variables to be grouped into factors.

On the other hand, Bartlett's test of sphericity is used to determine if there is a significant correlation among the variables which constitute the data matrix [24]. The result of this test was evaluated through the *p-value*, where a value less than 0.05 indicated that the correlations among the variables were significant and it enabled to proceed with the factor analysis. In this study, the obtained *p-values* were consistently less than 0.05, which statistically validated the use of factor analysis. This test was crucial to ensure that the variables were not independent of each other, justifying their grouping into factors.

Using these results, the exploratory factor analysis allowed the grouping of the eleven (11) clusters into four (04) main factors, which represent different dimensions of leadership in PM. Each of these factors was identified based on the correlations found among the variables and the nature of leadership competency, as presented in Table 2.

The grouping of the clusters into these four factors provided a clearer and more structured view of the leadership competencies in industrial engineering which is necessary to effectively manage projects. The statistical validation of these

$$\omega = \frac{[\sum_{i=1}^I \lambda_i]^2}{[\sum_{i=1}^I \lambda_i]^2 + [\sum_{i=1}^I 1 - \lambda_i^2]}$$

Figure 2. omega coefficient.

Source: Ventura-León and T. Caycho-Rodríguez, 2017.

Table 2.  
Clusters comprising the factors.

Factor	Clusters grouped by the factor	Denomination of the factor
1	C1 y C2	Adaptive Team Management
2	C3, C4 y C5	Strategic Adaptability and Effective Communication
3	C6 y C7	Management of Influence and Integrated Skills
4	C8, C9, C10, C11	Agility in Leadership and Support

Source: Own elaboration.

factors, supported by the KMO measure and Bartlett's test of sphericity, ensured that the selected variables were adequately correlated, and the generated factors were reliable representations of the dimensions of leadership. This process facilitated the understanding and the use of the obtained results, enabling a more efficient evaluation and a more coherent interpretation of leadership skills in PM, both for industrial engineering students and for business professionals.

Once the four factors and their respective variables were identified, which ranged from six (06) to eleven (11) variables per factor, an effort was made to simplify the Framework under investigation by verifying the weighting of the factors' variables. This verification was conducted using multiple linear regression models through SPSS software [24]. The statistical analysis allowed the identification of the two (02) most statistically significant variables within each factor which became the main inputs for constructing a comprehensive framework to enhance leadership skills in PM.

For each of the four (04) factors, multiple linear regression analysis allowed to determine the relative importance of the variables. This methodology enabled the identification of which variables within the factors required greater emphasis in the education of students in university industrial engineering programs in Bogotá, aligning with the needs of the business sector. The results also showed a clear correspondence between the expectations of both students and business professionals regarding leadership competencies.

#### Factor 1: Adaptive team management

This factor groups variables related to adaptability and leadership in constantly changing environments. The statistical analysis indicated that the most relevant variables were: *V<sub>5</sub> Guiding teams through unexpected changes and challenges* and *V<sub>6</sub> Capability to reinvent oneself based on shifts in the work environment to guide a team towards success*.

The multiple linear regression analysis yielded a correlation coefficient of 88.1% for the first model, which means that variable 5 explains this percentage of the factor. By adding variable 6 to the model, the coefficient increased to 94.7%, indicating that these two variables together explain a significant portion of adaptive team management. The other four (04) variables of the factor contributed a minimal percentage to the model; therefore, they were not elaborated upon further for the purposes of this study.

#### Factor 2: Strategic Adaptability and Effective communication

This factor addresses competencies related to making informed decisions and the ability to anticipate and adapt to changing situations. The key variables were: *V<sub>13</sub> Making informed decisions based on clear frameworks of reference* and *V<sub>8</sub> Anticipation of obstacles and proactive response in changing work situations*.

In this case, the correlation coefficient for the first model was 85.4%, indicating that variable 13 had a high explanatory weight in the factor. By incorporating variable 8, the correlation coefficient increased to 92.3%. The other seven

(07) variables of the factor showed a minimal contribution to the model.

#### Factor 3: Management of Influence and Integrated Skills

This factor is related to the ability to influence teams and manage expectations in a balanced manner. The variables identified as most relevant were: *V<sub>23</sub> Managing team members' expectations and conducting negotiations to influence individuals* and *V<sub>17</sub> Balancing administrative tasks and interpersonal relationships to ensure the achievement of goals within an organization*.

The correlation coefficient for the first model was 84.1%, indicating that the variable 23 had a high explanatory weight in the factor. For the second model, which included the variable 17, a coefficient of 91.7% was obtained. This result underscored the importance of these two variables for this factor.

#### Factor 4: Agility in Leadership and Support

This last factor focused on the ability of leaders to guide their teams in agile environments and provide effective support. The two most important variables were: *V<sub>33</sub> Supporting and promoting decision-making in work teams, based on concrete data and information* and *V<sub>27</sub> Capability to establish and articulate a clear vision to a work team within a workplace context*.

The correlation coefficient for the first model was 85.5%, increasing to 93% when including the variable 27 in the second model. The other eleven (11) variables of the factor contributed minimally to the model.

Table 3.  
Variables comprising the factors.

Factors	Variables comprising the factor	Variables' names
1. Adaptive Team Management	Variable 5	Guiding teams through unexpected changes and challenges.
	Variable 6	Capability to reinvent oneself based on shifts in the work environment to guide a team towards success.
1. Strategic Adaptability and Effective Communication	Variable 13	Making informed decisions based on clear frameworks of reference.
	Variable 8	Anticipation of obstacles and proactive response in changing work situations.
2. Management of Influence and Integrated Skills	Variable 23	Managing team members' expectations and conducting negotiations to influence individuals.
	Variable 17	Balancing administrative tasks and interpersonal relationships to ensure the achievement of goals within an organization.
3. Agility in Leadership and Support	Variable 33	Supporting and promoting decision-making in work teams, based on concrete data and information.
	Variable 27	Capability to establish and articulate a clear vision to a work team within a workplace context.

Source: Own elaboration by using multiple linear regression models, which allowed the identification of the most significant variables within each factor

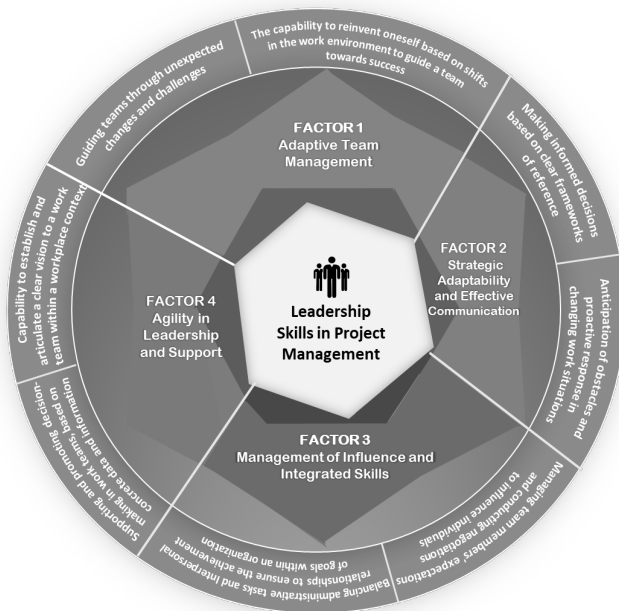


Figure 3. Comprehensive framework to enhance leadership skills in project management.

Source: Own elaboration

In summary, the statistical analysis enabled the simplification of the initially identified factors by highlighting the two most relevant variables of each factor. These variables provided a solid foundation for creating innovative tools which support the strengthening of leadership among students in industrial engineering programs in Bogotá D.C., Colombia, while also aligning with the expectations of the business sector. The key variables of each factor are summarized in Table 3.

The result of the qualitative and quantitative analysis was the creation of a Comprehensive Framework for Strengthening Leadership Skills in Project Management (see Fig. 3). This framework offers a holistic view of the key skills which constitute leadership in project management, providing an integrated approach to understanding and developing this competency. The framework highlights four (04) main factors, each composed of two (02) variables identified as critical for effective leadership performance in the context of project management.

#### 4. Conclusions

This research, conducted through the co-occurrence analysis of words with tools like T-LAB, demonstrated a close relationship between leadership and PM, highlighting the complexity of leadership. The identification of key terms such as leadership, teams, and communication revealed that leadership competency goes beyond merely supervising tasks to encompass comprehensive management involving team development, adaptability, and informed decision-making, pointing towards effectiveness and support which promote agility. The structuring of thematic clusters offered a clear perspective on how these terms intertwine within the project context, providing a replicable framework to enhance

relevant leadership skills in PM.

Additionally, the research underscored a critical challenge in the educational field of industrial engineering programs, where, despite the commitment to foster leadership among students, there is a demonstrated need for a well-defined framework which encompasses leadership in PM for the field of industrial engineering knowledge, guiding the methodology of professional teaching. The diversity in teaching methods, far from being seen as a hindrance, presents multiple opportunities for innovation. However, this also highlights the importance of adopting a more adaptive and practical approaches based on scientific research, to adequately prepare future professionals for the demands of the business environment.

This research proposes a comprehensive framework to enhance leadership skills in project management as the result of a sequential qualitative and quantitative analysis aiming not only to theoretically strengthen leadership in the professional training of industrial engineers in relation to PM, but also to promote its practical application in real work contexts. Training industrial engineering leaders capable of guiding teams towards success in increasingly volatile and ambiguous global project-based markets was a priority during the development of this research and the research product could undoubtedly have a positive impact on orienting such training in a more functional way.

Finally, this document is the result of the master's research work in project management, titled: Toolkit for Strengthening Leadership Competency Associated with Project Management in Professional Training. This research was developed in collaboration with the research group: Production and Innovation and Technology of the Faculty of Engineering at Universidad Militar Nueva Granada.

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- P. Delgado-Valencia**, received the BSc. in Business Administration and Military Sciences, as well as a MSc. in Higher Education. He is also a Colfuturo scholar and holds a MSc. in Project Management, with a distinguished thesis. Currently, he is a Major in the Colombian National Army. Since 2018, he has been involved in teaching, in subjects such as: research methodology applied to strengthening defensive capabilities, logistics and sustainability of armored vehicles, English language instruction, port security, and higher education topics. He has worked on structuring investment projects in public institutions and is a developer of military doctrine. He is certified as a scientific researcher by the Colombian Army. His research interests include leadership, military innovations, and studies in higher education.  
ORCID: 0000-0002-8598-4728
- P. Sánchez-Caimán**, received the BSc. Eng. in Industrial Engineer of Nueva Granada Military University in Colombia, as well as a Dr. in Engineering and MSc. in Logistics of National University of Cuyo, Mendoza, Argentina. Currently, he is assistant Professor of the Faculty of Engineering of Nueva Granada Military University since 2006 in Production, Innovation and Technology research group. His research interests include supply chain management, Digital Manufacturing and leadership and innovation.  
ORCID: 0000-0001-5719-7164