education sciences

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Project Management Competences by Teaching and Research Staff for the Sustained Success of Engineering Education

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Received: 31 December 2018; Accepted: 18 February 2019; Published: 22 February 2019

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Abstract: Projects have become an essential instrument for the success of universities. In a context of globalization and increasing complexity, they must sharpen their resourcefulness to face these challenges and adapt to this changing environment. To reach these objectives, they undertake a series of activities of a unique, concrete and temporary nature, not always technical but managerial ones. If universities work with people on projects in the production, transmission and dissemination of knowledge, then they link with society to solve its problems. For this reason, teaching and research staff (TRS) should promote a range of professional project management (PM) competences in different areas for the proper management of the projects in which they take part. Through a Delphi technique, a panel of twenty-four accredited teaching experts who are carrying out significant research and holding directive roles, measured the importance of acquiring and/or improving professional PM competences by their TRS. Consensus and stability reached after two rounds of consultation confirmed there are a series of crucial competences for the practice of relevant teaching and pioneer research. Results obtained are the basis for a gap plan that allows the TRS to participate in and/or lead university projects with greater self-confidence and personal motivation.

Keywords: project management; competences; engineering education; teaching and research staff

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1. Introduction

In the university context, the TRS undertakes projects of diverse nature. However, despite their variety, their approaches are comparable to professional projects [1]. Firstly, there are research projects, with an administrative and documentary complexity normally proportional to their scope. Then, there are projects that arise from companies' needs, developed as collaborative initiatives through agreements, contracts or even industrial doctoral theses. Next, there are educational innovation and educative improvement projects. After that, there are entrepreneurship projects that help students engage themselves in real experiences. Finally, there is the university management itself, which covers many different types of projects, such as the design of internal management systems; the creation of research and educational innovation groups; the organization of faculties, technical schools, and departments; or even the assessment of degree programs, among many others. All these actions require stakeholder involvement, adapting their needs to specific requirements, and to carrying them out within planned schedules and budgets and with limited resources, considering risks and opportunities.

Teachers and researchers themselves usually formulate, manage, execute and/or evaluate different modalities of university projects. To do this, the TRS is not isolated but they are members of organizational structures, in which they administrate public and private resources, and engage both internal and external stakeholders to create, share and transfer knowledge to society. Even though research and educational innovation groups are autonomous organizations with their own strategies, governance, interests, culture and values, they insert within universities, supporting the formulation of projects. In this context, these groups manage their projects. Therefore, their members have to acquire and/or improve the necessary competences to work in projects.

Nevertheless, educational and research processes select and promote the TRS, without any consideration of management aspects, so they have to develop a range of competences in transversal areas, if they want to succeed in the projects in which they participate, as directors or as team members. Besides, if the recognition of their competences culminates in a formal process, including the issuance of a certificate of the competence possessed by an authorized institution [2], then the adaptability of the TRS is acquired, which facilitates their transferability in different contexts [3].

2. Background

2.1. Knowledge and Innovation Society

Universities are the center of the knowledge society. In fact, the link between universities and society and the organization of this around the abstract and universalized understanding of the world that universities provide are distinguishing features of the knowledge society [4]. The role of universities in stimulating innovation has long been accepted [5], bringing new ideas to society and being an integral economic engine. Figure 1 relates the sequence for the innovation process. Multiple factors and motivations that yield actions instigate innovation. These acts usually involve making inputs and driving research, development, production and distribution. Because of this, their outputs emerge as new knowledge and inventions, submit into outcomes as endeavors or enterprises, and impact on the promotion of more innovation activities.

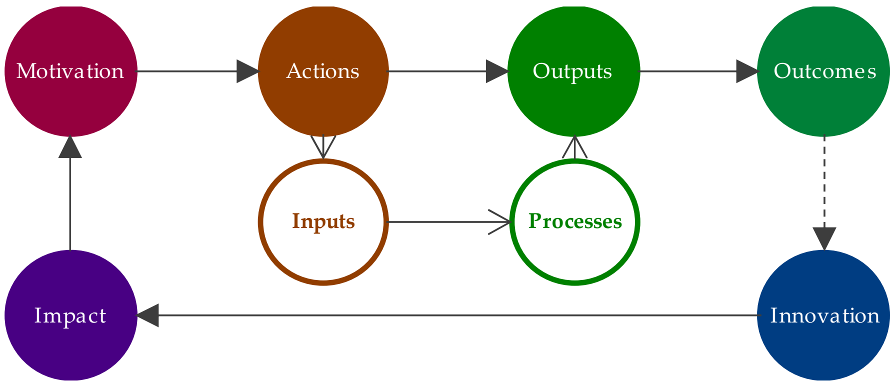


Figure 1. Innovation process in the knowledge society.

In this context, it is necessary to emphasize that knowledge adds value through its contribution to products, processes and people. Nevertheless, its management concerns with not only organizations but also universities, entities and public institutions. As shown in Figure 2, knowledge management includes its:

- Generation and development [6]
- Acquisition by an organization, identifying it from external environment and transforming it into an usable representation [7]
- Sharing, enhancing firms agility while improving stability [8]
- Capitalization, preserving and perpetuating the most critical one [9]
- Transfer, exchanging ideas, proofs and expertise and adding value [10]
- Application, maximizing organizational performance [11]

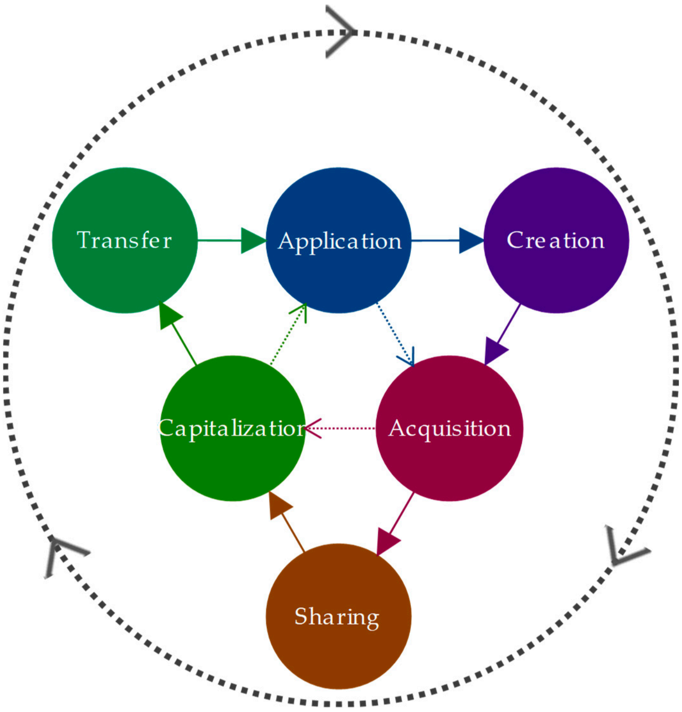


Figure 2. Knowledge management processes.

Furthermore, in a global and knowledge-driven economy, innovation is critical to competitiveness, long-term productivity growth, and prosperity. Thus, research bridges scientific discoveries and practical applications, as well as educates for giving skills to new generations, in order to convert knowledge into innovative products and services [12]. Consequently, several topics related to engineering appear in order to face challenges of the knowledge society. Under these circumstances, the address of complex problems that balance interdisciplinarity and commitment is the basis for the qualification of future engineers, once disciplinary skills are achieved [13].

2.2. Research Universities

In the knowledge and innovation society, research universities are key institutions for social and economic development. They are characterized by their global mission, research intensity, diversified funding, worldwide recruitment, increasing complexity, relationship with public administrations and industry, and global collaboration with other universities. These achievements are made through focusing on the discovery of new knowledge to develop the next generation of scholars, decision makers and entrepreneurs [14]. Moreover, research universities interact at different levels within the global market [15], including:

- Qualification possibilities which students benefit from
- Prestige associated with their publications
- Effectiveness and transferability of knowledge provided

On the other hand, the success of research universities depends on the TRS potential, funds in order to run, and a flexible structure. These properties allow them to succeed in different cultural and political contexts without sacrificing their autonomy and organizational vision. As summarized in Figure 3, research universities can be identified by [16]:

- Pioneer research, inspiring the TRS to generate new knowledge in a creative and useful way, as a stable driving force that ends connecting industry and university
- Relevant teaching, contributing to the strengthening and prestige of the institution in which it takes place, and being current, reflecting, suitable and not isolated

- Link with society, being significant to create substantial incomes in order to operate, and meeting social needs, at the forefront of progress, research and innovation

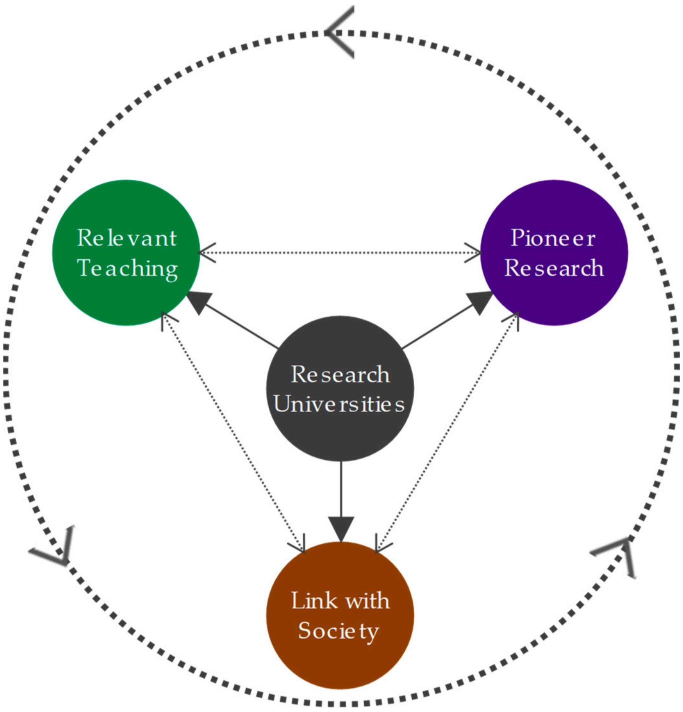


Figure 3. Intrinsic characteristics of research universities.

In summary, research universities serve the progress of society, solving its problems, threats, opportunities and/or needs [17]. Research universities are challenged to become the engine of transformation of society [18], recovering the original concept of the university as an institution of generation, tutelage and dissemination of knowledge [19]. International rankings such as the Academic Ranking of World Universities, Scimago Institutions Rankings, Center for World Global Universities Ranking, University Ranking by Academic Performance or the Ranking Web of Universities, among others, consider these aforementioned characteristics. In fact, if these are taken into account, then universities can lead to an improved position in rankings [20].

2.3. Project Management Competences

Projects have become omnipresent not only in economy but also in society [21]. However, they require an adjustment of organizational solutions, individual competences and changes in understanding their effects [22]. According to the Standish Group [23], almost twenty percent of all implemented projects are never finished, while forty-five percent are finished but with aberrations from their original goals, and only thirty-five percent can be described as efficiently implemented. In a context in which organizations face more and more challenges, it is necessary to find out what is needed to advance sustained and long-term solutions through increasingly more complex, fluid, and multicultural projects [24].

Additionally, the concept of competence in PM has been researched for many purposes, providing a detailed examination of its evolution [25] or explaining the role of knowledge in defining position descriptions [26]. However, the understanding and application of knowledge, tools and techniques recognized as good practices are not enough for effectively managing projects [27]. It also requires specific skills and general abilities.

Nevertheless, almost all PM standards are process-oriented. On the contrary, very few of them are competence-based, defining the specifications needed for a good performance of people in project environments [28]. While the first group of standards typically prescribes procedures and methods, ensuring organizations to have a universal approach in managing projects, the second one presents a wide spectrum of knowledge and skills that organizations need for success, holding people to perform tasks in projects [29]. From this perspective, the development of competences by personnel and maturity by organizations leads to the success of projects and related business [30].

On the other hand, the most extended and oldest PM associations worldwide are the International Project Management Association (IPMA) and the Project Management Institute (PMI). IPMA is a federation founded in 1965 and composed of seventy national associations. PMI is a professional membership association founded in 1969, with over half a million members and certification holders in one hundred eighty-five countries. Both IPMA [31–33] and PMI [34–36], as well as the International Standards Organization (ISO) 21500 [37] and European Union (EU) PM2 [38] standards, among others, guide their foundational standards, bodies of knowledge, methodologies, practical guides, baselines and frameworks focused on three approaches, as represented in Figure 4:

- Projects: Knowledge and practices to manage individual projects
- Organizations: Knowledge and practices to manage projects, programs and portfolios
- People: Development, counselling, registration and certification

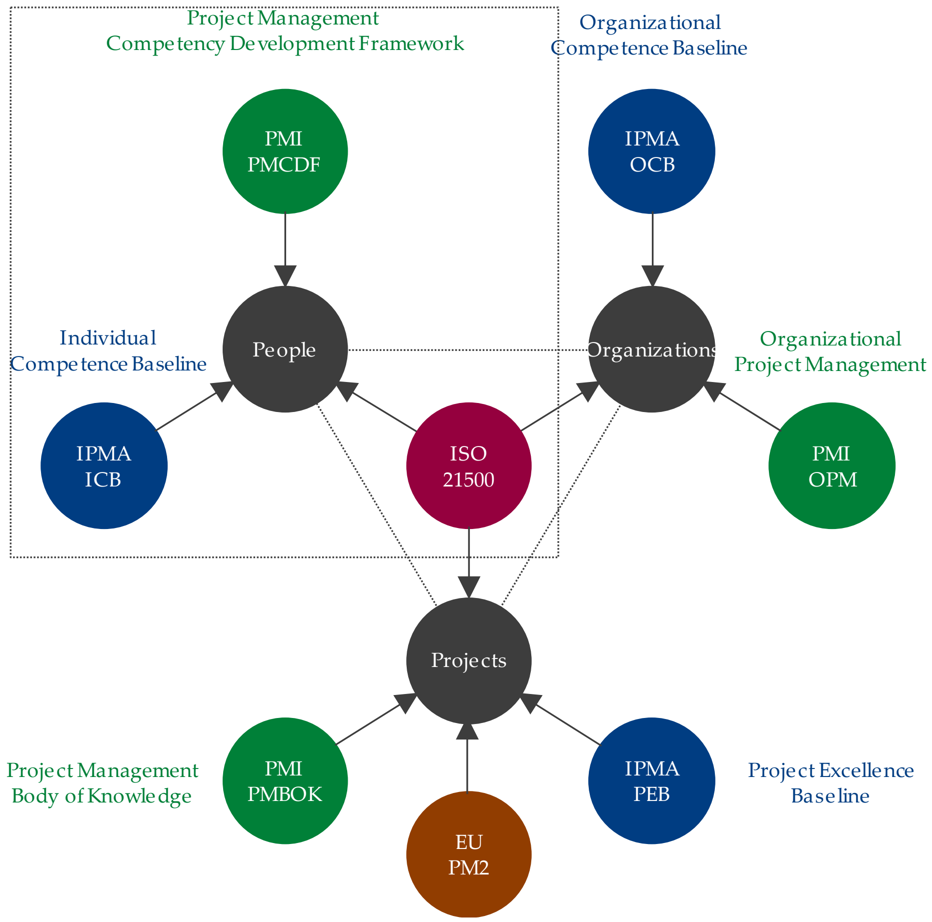


Figure 4. EU, IPMA, ISO and PMI project management approaches.

In the context of PM, competences include a set of abilities to mobilize knowledge, skills and resources to reach the expected performance in work, adding them economic and social value [39]. This combination of elements, related to work contexts (such as abilities, capabilities, expertise, experience, knowledge and skills), complement and integrate in conjunction with personal attributes (such as attitude, behavior, motivation, personality and personal values) [40].

The importance of both "hard" competences (relating to processes) and "soft" ones (dealing with people and their environment) is widely recognized in PM [41,42], but managers are ultimately responsible for balancing and optimizing their application. From this perspective, to learn about individual and organizational competences (and not only about technical ones) is critical, in order to complete the role transformation from engineers and other technicians to managers [43,44].

EU and ISO organizations and IPMA and PMI associations also group individual competences into three blocks:

- For IPMA ICB4 [31] and EU PM^2 [38]: Perspective, practice and people
- For PMI PMBOK6 [36]: Strategic-business, technical and leadership
- For PMI PMCDF3 [34]: Knowledge, performance and personal
- For ISO 21500 [37]: Contextual, technical and behavioral

Many researchers classify PM competences analogously as professional associations and international organizations:

- For Cheng, Dainty and Moore [45]: Occupational, understanding and attitudinal
- For Crawford [46]: Input, personal and output
- For Le Deist and Winterton [47]: Social, functional and cognitive
- For Binkley et al. [48]: Living in the world, tools for work and ways of thinking
- For Onisk [49]: Compliance, professional and behavioral
- For Omidvar et al. [50]: Contextual, job and personal
- For Teijeiro, Rungo and Freire [51]: Instrumental, interpersonal and systemic
- For Chipulu et al. [29]: Knowledge and expertise, managerial and personal traits

In summary, PM by competences, thanks to its intrinsic transverse and humanistic condition, covers management requirements in any sector [52], including research and education, which is considered as a professional sector as any other in this research. Within this framework, development of competences by the TRS allows achieving better project performance, thanks to growing motivation, better self-organization and reduced need for centralized control [53]. However, there are many ways of acquiring and improving them, depending on the organizational structure and its integrated management system, as well as on singularities and functions found in the organization chart in which they are located, as professional workers of the research and education sector.

2.3.1. Competences for PM practitioners

To manage projects requires a series of competences including interpersonal skills, technical abilities, cognitive aptitudes, abilities to understand both context and people and integrate leadership behaviors [54]. In fact, many studies highlight the impact of individual competences on project success [54–59]. In this regard, managerial skills and personal traits are critical to manage complex environments characterized by rapid changes and uncertainty [29].

In general, if organizations adjust their work arrangements to accommodate professional standards in PM, coordination is facilitated and performance is improved [60]. Among contrasted professional models, IPMA and PMI ones are internationally recognized in professional PM [61], and actually appear as more flexible and adaptive approaches than rigid frameworks [62].

On the one hand, the standard ICB 4 by IPMA [31] offers unique and role-specific competence development guidelines for improving project success, training and certifying practitioners. These professionals will probably work in disseminated environments with overlapping and conflicting stakeholder interests. In most cases, real-time data and performance management tools will shape them, too much information and not enough communication will challenge them, and their ability to deliver outcomes that align with short- and long-term strategies will judge them.

On the contrary, the standard PMCDF 3 by PMI [34] proposes the necessary specific skills and general management proficiencies required to domain for projects. At the same time, the standard PMBOK 6 by PMI [36] provides guidelines for managing individual projects and defines PM related concepts, such as methods, processes and practices.

To learn and train them, PMCDF and PMBOK by PMI standards focus on the end itself, from the premise that competences have a direct effect on performance. In opposition to them, the ICB by IPMA approach pays attention to the method itself, offering a series of proposals for individual development. Among them, self-study, peer-to-peer development, education and training, coaching and mentoring, and simulation and serious games are highlighted.

This approach based on international professional standards has demonstrated its utility for strategic projects (aligning objectives [63]), for educational projects (connecting teaching subjects with real-world problems [64]), and for research projects (driving the formation of the personnel [65]), influencing their effectiveness [66]. In Table 1, PM competences of the IPMA model are compared in pairs with PMI ones.

Table 1. Comparative between IPMA and PMI approaches.

IPMA ICB 4	Code	PMI PMCDF 3 and PMBOK 6
Perspective:		**Strategic and business management:**
Strategy	C01	Strategy and business
Governance, structures and processes	C02	Organizational process assets
Compliance, standards and regulations	C03	Organizational systems
Power and interest	C04	Politics and power
Culture and values	C05	Enterprise environmental factors
People:		**Personal:**
Self-reflection and self-management	B01	Managing
Personal integrity and reliability	B02	Professionalism
Personal communication	B03	Communicating
Relations and engagement	B04	Personality
Leadership	B05	Leading
Teamwork	B06	Being collaborative
Conflict and crisis	B07	Dealing with people
Resourcefulness	B08	Cognitive ability
Negotiation	B09	Getting things done
Result orientation	B10	Effectiveness
Practice:		**Technical:**
Design	T01	Tailoring
Requirements, objectives and benefits	T02	Goals and objectives
Scope	T03	Scope
Time	T04	Time
Organization and information	T05	Communication
Quality	T06	Quality
Finance	T07	Cost
Resources	T08	Human resources
Procurement and partnership	T09	Procurement
Plan and control	T10	Scheduling
Risk and opportunities	T11	Risks
Stakeholders	T12	Stakeholders
Change and transformation	T13	Integration
Select and balance	T14	Prioritization

2.3.2. Competences for Students

In education, cooperative project-based learning proposals and coworking competence-based training initiatives can introduce professional PM competences into theoretical educational frameworks [67,68]. In the case of the EU and Latin America, these approaches are broadly covered by [52]:

- Definition and Selection of Competencies (DeSeCo) Project by the Organization for Economic Co-operation and Development (OECD) [69] during the pre-university stage. It tries to instill that students assert rights and duties, communicate, conduct plans and projects, construct alliances, cooperate, empathize, make decisions, negotiate, recognize merits, resolve conflicts, are self-aware, suggest alternatives, support others, and take responsibilities.
- European Higher Education Area (EHEA) and the Latin America Academic Training (ALFA) Tuning Projects [70,71] during the university stage. They try to ensure that students analyze, appreciate diversity, are competitive, creative and critical, commit, communicate, lead, learn, make decisions, motivate, solve problems, synthesize, take initiative, and work as a team.

It is possible to organize both projects, as shown in Table 2, if knowing how to:

- Understand: Theoretical knowledge of academic fields
- Act: Practical application of knowledge to specific situations
- Be: Value as an integral element in social contexts

Table 2. Comparative among DeSeCo Project and Tuning Project competences.

OECD DeSeCo Project	ALFA amd EHEA Tuning Project
Use tools interactively:	**Instrumental:**
Reframe the problem	Problem solving
Learn from past actions	Applying knowledge in practice
Evaluate the value of information	Basic general knowledge
Analyze issues and interests	Working in international context
Understand of debate	Judgement of cultures and customs
Interact in heterogeneous groups:	**Interpersonal:**
Understand own interests	Criticism and self-criticism
Know rules and principles	Ethical commitment
Use communication skills effectively	Communication
Be empathetic	Appreciation of diversity
Make decisions	Leadership
Present ideas and listen to others	Teamwork
Manage emotions	Motivation
Suggest alternative solutions	Creativity
Negotiate	Cooperation
Identify action consequences	Initiative and entrepreneurial spirit
Act autonomously:	**Technical:**
Define projects and set goals	Project design and management
Prioritize needs and goals	Will to succeed
Have an idea of the system	Learning
Construct arguments	Research
Organize knowledge and information	Information management
Choose among available options	Concern for quality
Use technology	Elementary computing
Evaluate necessary resources	Working autonomously
Construct tactical alliances	Interaction with technical experts
Monitor progress	Organization and planning
Understand patterns	Analysis and synthesis
Identify areas of agreement	Working in heterogeneous teams
Access adequate information sources	Adaptation to new situations
Balance resources to meet goals	Decision making

First, the DeSeCo project helps young people develop as individuals and professionals in training projects that will last a lifetime, addressing complex demands by putting into action, in specific situations, psychological resources, skills and attitudes. After that, the Tuning projects seek to enable university students to prepare and carry out sufficiently and responsibly the tasks entrusted to them, as future professionals.

2.3.3. Competences in Engineering Education

In the field of engineering, companies require future engineers to have a wide range of competences that allow them to meet labor market expectations and to face successfully challenges that the changing world is promoting [72]. From this point of view, engineering education must add to main subject areas those competences that help them into entrepreneurial, environmental and social contexts and the understanding of professionals' characteristics [73–76]. Consequently, technical competences are no longer enough. Instead, the engineers' profile has to be based on the ability and willingness for learning, solid knowledge of basic natural sciences and good knowledge of any field of technology, in addition to general human and social values [77].

In the context of engineering education, three competence-based programs accreditation stand out for their dissemination and assurance of results:

- Accreditation Board of Engineering and Technology (ABET) accreditation [78]
- Conceive → Design → Implement → Operate (CDIO) initiative [79]
- European Accredited Engineer (EUR-ACE®) label [80]

Comparative analyses among ABET, CDIO and EUR-ACE frameworks have been realized in the last years [72,77,81–86], concluding that there are many more similarities than differences, with all of them placing individual competences at the center of educational systems in which they have been implemented.

Firstly, the Accreditation Board of Engineering and Technology (ABET) was founded in 1980 in the United States by a series of member engineering societies. ABET shows the indispensable competences for engineers classifying them in two categories: hard skills (technical ones in nature) and professional ones (makers of real differences among professionals) [87], as exposed in Table 3. Besides, it underlines the importance of the competences needed for professional practice rather than emphasizing the curriculum [88]. Currently, almost eight hundred institutions of more than thirty countries are participating in ABET accreditation programs.

Table 3. ABET competences for engineering students.

Hard skills:
Apply knowledge of mathematics, science, and engineering
Design and conduct experiments, as well as to analyze and interpret data
Design a system, component, or process to meet desired needs within realistic constraints
Identify, formulate, and solve engineering problems
Use the techniques, skills, and modern engineering tools necessary for engineering practice
Professional skills:
Function on multidisciplinary teams
Understand of professionalism and ethical responsibility
Communicate effectively
Understand the impact of engineering solutions in a global, economic, environmental, and societal context
Engage in life-long learning
Know contemporary issues

Secondly, the Massachusetts Institute of Technology, in collaboration with Chalmers University of Technology, Linköping University and the Royal Institute of Technology, proposed in 2000 the CDIO initiative (Conceive → Design → Implement → Operate). The CDIO framework defines competences that students must own when completing their training as engineers, including not only generic, personal and interpersonal competences but also those that have traditionally been identified as typical of engineering [89], as shown in Table 4.

Table 4. CDIO competences for engineering students.

Technical knowledge and reasoning:	**Interpersonal skills:**
Basic science Fundamental engineering Advanced engineering	Teamwork Communication Foreign languages
Personal and professional attributes:	**CDIO in business and social contexts:**
Engineering reasoning Problem solving Experimentation and discovery Systemic thinking Personal attitudes Professional skills	Social context Business context Conceive Design Implement Operate

Likewise, the CDIO proposal masters a deep knowledge in fundamental techniques, leading the promotion of new products, processes and systems, and understanding the importance and strategic impact of research and technological development in society [90,91]. Currently, almost one hundred fifty institutions of almost forty countries are participating in CDIO accreditation programs.

Thirdly, the European Network for Accreditation of Engineering Education created the European Accredited Engineer (EUR-ACE®) system in 2006, after the Bologna Process. The EUR-ACE project formulates framework standards for the accreditation of higher education programs in engineering [92], as an entry route to the engineering profession. It has proved to be a powerful tool to improve both academic quality and relevance for the workplace [93]. Its main objective is to promote the quality of engineering graduates in order to facilitate their professional mobility and strengthen their personal and collective skills, as collected in Table 5. In summary, the EUR-ACE label assures that educational programs prepare graduates who are able to assume relevant roles in the job market [94]. Currently, more than three hundred institutions of more than thirty countries have accredited their engineering programs.

2.3.4. Competences for Workplace

Employability includes an array of technical and non-technical competences, encompassing knowledge, skills, expertise and even experience, to ensure that students are able to put them into practice, which is why educational stages must include them [95]. In the twenty-first century, organizations seek versatile individuals, even for entry-level jobs [96]. In this context, executives consider competences a very important attribute in labor applicants [97], becoming extremely important for job hires in many occupations [98], thanks to their potential role in maximizing business success [99].

Numerous studies have compared and compiled competences demanded by the labor market [100–103]. All of them agree on those related to or present in projects, such as communication, creativity, critical thinking, ethics, leadership, problem solving, professionalism, results orientation, self-management, or teamwork, among others. Shortly, candidates who add value with their competences have the ability to make a difference in obtaining and retaining the jobs for which they have been prepared [104].

Table 5. EUR-ACE competences for engineering students.

Knowledge and Understanding:
Scientific and mathematical principles underlying own engineering branch Key aspects and concepts of own engineering branch Forefront of own engineering branch
Engineering Analysis:
Identification, formulation and resolution of engineering problems using established methods Analysis of engineering products, processes and methods Selection an application of relevant analytic and modelling methods
Engineering Design:
Development and realization of designs to meet defined and specified requirements Use of design methodologies
Investigation:
Search of literature and use of data bases and other sources of information Design and conduction of appropriate experiments and interpretation of the data and drawing Workshop and laboratory skills
Engineering Practice:
Selection and use of appropriate equipment, tools and methods Combination of theory and practice to solve engineering problems Understanding of applicable techniques and methods, and of their limitations Awareness of the non-technical implications of engineering practice
Transferable skills:
Function effectively as individuals and as members of a team Use of diverse methods to communicate effectively with engineering community and society at large Awareness of health, safety and legal issues and responsibilities of engineering practice Commitment to professional ethics, responsibilities and norms of engineering practice Awareness of project management and business practices Engagement in independent and life-long learning

3. Objectives

The main objective of this research was to establish the importance of the TRS acquisition and improvement of professional PM competences in the university context. From the list of competences proposed by IPMA, the most important ones are the priority competences. If the development of professional PM practices had the necessary resources, then the universities would be closer to succeeding in the projects they have undertaken, and consequently they would contribute efficiently to society. The context of the research is schemed in Figure 5.

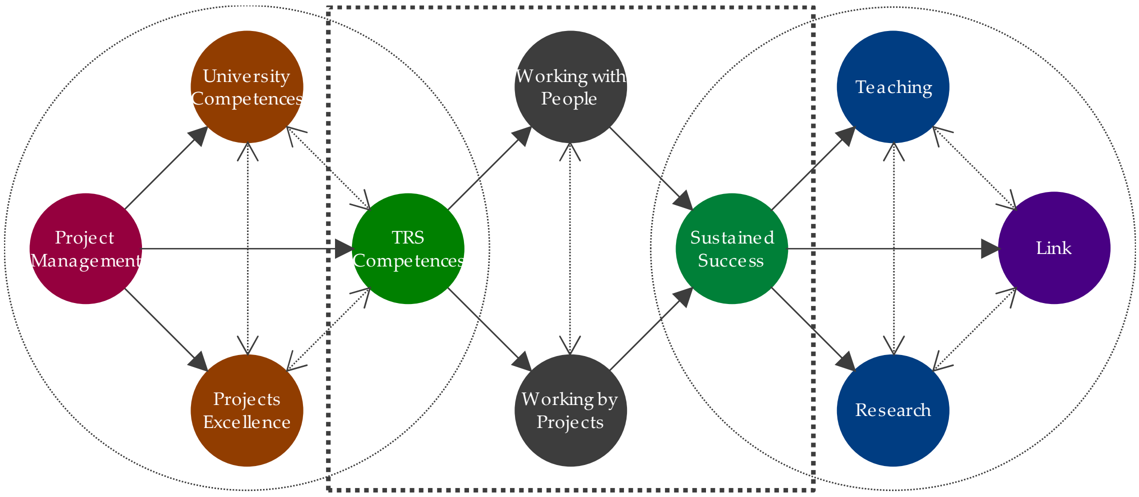


Figure 5. Framework of the research.

Knowledge society needs the transfer of new ideas to the market in order to make use of them. For this reason, universities become an essential economic driver and also play a crucial role in its construction, in terms of prosperity [105,106]. From an external perspective, universities confront these challenges undertaking projects that allow them to implement their strategies. At the same time, it requires a management system that responds to demands of adaptability, flexibility and availability, constituting itself as a device of change, adaptation and transformation [107,108].

PM tools and techniques can be applied to higher education sector [109,110], helping to affront challenges and barriers and improving its efficiency. If university projects are managed by PM methods to teach [111,112], research [113,114] and transfer [115,116], then the application of PM competences by the TRS can promote success in achieving objectives, providing value and generating synergies among institution members, universities, companies and social agents.

The IPMA ICB model focuses on people and helps to relate to a changing context and establish fundamental values to enhance society [64], incorporating human relations and social dynamics to the technical and technological dimensions. From a holistic point of view, the IPMA ICB approach is the most potentially applicable and useful professional PM framework at the university and incorporating sustained success principles [117,118]. However, other professional PM methodologies, such as PMI PMBOK or PMI PMCDF, which focus on processes, contribute the success of teaching and research projects, as flexible, open and transversal tools [119,120]. It can be noted that both are completely compatible. The former empowers the TRS and the latter establish a management system for their support.

4. Methodology

The purpose of this research was to emphasize the most relevant competences by the TRS for the development of projects undertaken in the university context. To achieve it, a Delphi technique was used. Figure 6 summarizes the process steps.

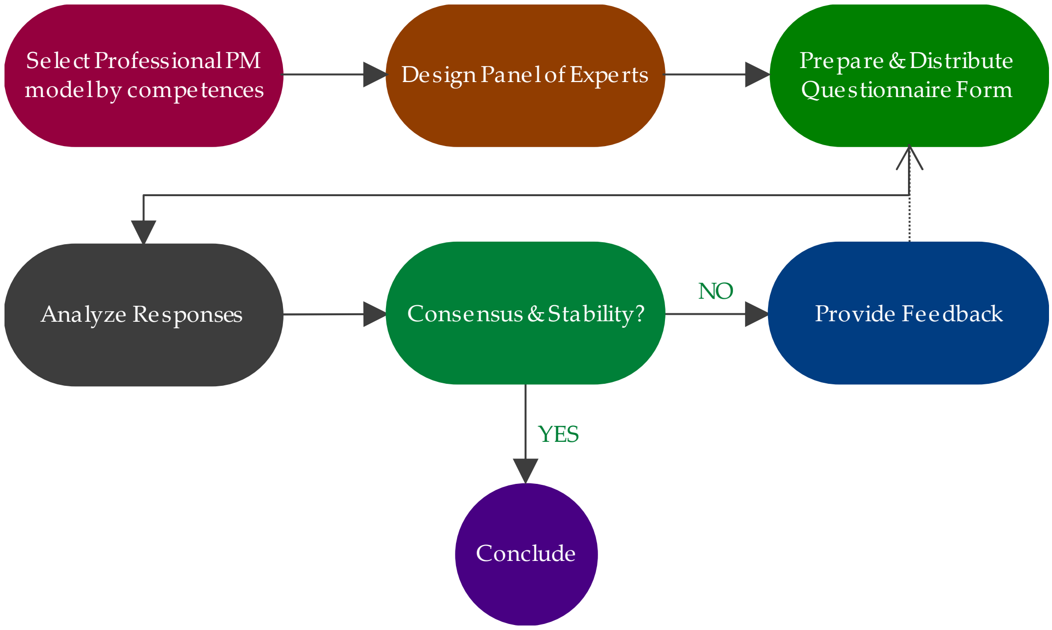


Figure 6. Research methodology.

The Delphi Technique is a prospective method for structuring an effective communication process that allows a group of individuals, as a whole, to deal with complex problems [121]. This process ends when the answers by a group of experts from a series of intensive questionnaires reach a reliable consensus and stability [122]. These iterations combine with controlled comments thanks to the provision of feedback from participants, who own expertise in the key area. At the same time, it is particularly useful to collect ideas on the specific topic and establish agreement to discover the underlying assumptions or perspectives among them, while avoiding the loss of its theoretical framework [123]. Once the process starts, the Delphi technique allows determining experts' points of arrangement, level of consensus and hierarchy of their importance.

The initial step to be done is the selection of experts [124]. That is, the Delphi technique has to be executed with the participation of individuals who have knowledge and competence in the study subject [123], as well as a deep understanding of the problem [125]. Therefore, the selection of the panel is one of the most critical actions of the process [126].

Thus, to be part of the initial sample, it was necessary that experts relate to engineering education, come from institutions where DeSeCo and Tuning projects are implemented and work in structures accredited (or in process of accreditation) by ABET, CDIO and/or EUR-ACE programs. Besides, with the aim of avoiding partiality, diversity and even lack of expertise, candidates had to comply additional requirements:

- Experience managing innovation educational and international research projects: At least five of each of them
- Experience in directive roles in universities: Faculty deans or directors of higher technical schools, departments, educational innovation and research groups Accredited relevant teaching experience: At least ten years of recognition (two quinquennia)
- Pioneer research at an international level: At least twelve years of impact and quality research (two sexennia)

Afterwards, it was necessary to design the research question that would be asked to the experts. The original research question was formulated in Spanish language and distributed among professors and researchers from Spanish and Latin American engineering schools, whereas both institutions and individuals had to meet the requirements set out above. The research question is translated exactly in the following terms:

> "On a scale from 0 to 10, being 0 trivial and 10 essential, indicate the degree of importance that you grant to the acquisition and improvement of the following competences, by the teaching and research staff -TRS-, in the university context, in order to carry out the projects in which they participate, both for the practice of a relevant and sustainable teaching, especially in educational innovation projects, and for developing their research, in R+D+i projects, among others."

Then, the list of twenty-nine competences of the IPMA model and their definition (brief description, including purpose, knowledge needed and skills involved) was presented to experts asking them to rate their importance on a scale of 0–10, both for educational innovation projects on the one hand, and research projects on the other hand. Next, two stop criteria were predefined: achievement of consensus and stability. The fulfilling of the conditions imposed are [127,128]:

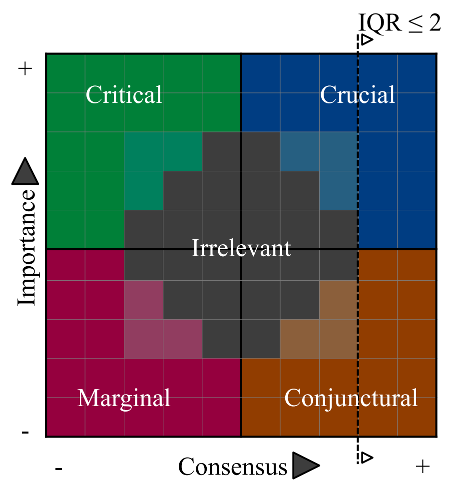
- Consensus was scored through the interquartile range (IQR):

  Definition: Difference between the third quartile (Q3) and the first one (Q1)
  Acceptance: Variation of equal or less than twenty percent

- Stability was calculated using the relative interquartile range (RIR):

  Definition: IQR divided into the second quartile (Q2)
  Admission: Variation within the twenty-five percent of the value range

Finally, it was necessary to evaluate answers obtained once reliable data were also validated. To this end and for every question, the results of the Delphi technique were distributed and categorized into five blocks through a double entry table, depending on their importance (much or little) and consensus (majoritarian or scarce) [129], as presented in Figure 7. According to it, crucial factors re those that have a high consensus and importance. Consequently, in this research, they must be the primary focus of attention for the acquisition, development and improvement of professional PM competences by the TRS.



Being:

Crucial:	Importance	Δ	Consensus	Δ
Critical:	Importance	Δ	Consensus	∇
Irrelevant:	Importance	~	Consensus	~
Conjunctural:	Importance	∇	Consensus	Δ
Marginal:	Importance	∇	Consensus	∇

Figure 7. Competences' categorization according to importance and consensus.

5. Results

A total of twenty-four respondents meeting the requisites established participated from 25 January to 25 July 2018. The group of experts of the international academic community invited belong to sixteen universities from Spain and Latin America, as shown in Table 6.

Table 6. Location of experts.

Institutions	Country	Characteristics
Monterrey Institute of Technology	Mexico	Polytechnic
Polytechnic University of Catalonia (2)	Spain	
Polytechnic University of Madrid (4)	Spain	
Polytechnic University of Valencia (2)	Spain	
Salesian Polytechnic University	Ecuador	
Jaume I University	Spain	Generalist
Pontifical Catholic University	Chile	
University of Cadiz (2)	Spain	
University of Cordoba	Spain	
University of Granada (2)	Spain	
University of Huelva	Spain	
University of Oviedo	Spain	
University of Piura	Peru	
University of Seville (2)	Spain	
University of Valladolid	Spain	
National Distance Education University	Spain	Distance

Furthermore, expert applicants develop their activities in eighteen knowledge areas related to engineering, as summarized in Table 7.

Table 7. Knowledge areas of experts.

Knowledge Areas
Architectural projects
Business administration
Construction engineering (2)
Education science
Electrical engineering
Energy efficiency
Engineering projects (4)
Environmental technology
Industrial organization (2)
Inorganic chemistry
Market trading
Manufacturing processes (2)
Materials science
Mechanical engineering
Prospecting and mining
Rural development
Statistics and operational research
Structures

Finally, experience managing and leading teaching and research projects are briefed in Table 8, including the range of minimum and maximum values obtained.

Table 8. Experience and participation in teaching and research projects.

Teaching Experience	Teaching Projects	Research Experience	Research Projects
~ 24 years (from 11 to 39 years)	~ 9 (from 7 to 33 ones)	~ 20 years (from 12 to 41 years)	~ 25 (from 6 to 140 ones)

5.1. Competences for teaching

Consensus and stability were met after two rounds of consultation for teaching projects. In fact, only six of the twenty-nine elements of competence did not reach consensus in the first round (which are marked in **brown**). However, sixteen experts modified their opinions not only in those ones but also in fourteen other items in the second round (marked in **green** or **blue** if importance assigned increased and in **magenta** or **purple** if decreased), augmenting their respective consensus, as well as promoting a significant level of importance, as can be checked in Table 9.

Table 9. Results of Delphi panel for teaching.

Code	Round 1					Round 2				
	Importance			Consensus		Importance			Consensus	
	M [1]	SD [2]	Q2 [3]	IQR [4]	RIR [5]	M [1]	SD [2]	Q2 [3]	IQR [4]	RIR [5]
Contextual:										
C01	8.10	1.25	8	1	0.13	**8.30**	**0.98**	**8**	**1**	**0.13**
C02	**7.10**	**2.05**	**7**	**2.75**	**0.39**	**7.60**	**1.35**	**7.5**	**1.75**	**0.23**
C03	7.90	1.68	8	2	0.25	7.90	1.68	8	2	0.25
C04	7.25	1.89	7.5	1.75	0.23	**7.40**	**1.43**	**7.5**	**1.75**	**0.23**
C05	7.85	1.95	8	2	0.25	**8.05**	**1.70**	**8**	**1.75**	**0.22**
Behavioral:										
B01	7.85	2.30	8.5	2	0.24	**8.00**	**2.05**	**8.5**	**2**	**0.24**
B02	8.80	1.20	9	2	0.22	8.80	1.20	9	2	0.22
B03	9.05	0.89	9	1.75	0.19	9.05	0.89	9	1.75	0.19
B04	7.80	1.51	8	2	0.25	7.80	1.51	8	2	0.25
B05	7.75	1.59	8	1.75	0.22	7.75	1.59	8	1.75	0.22
B06	8.25	1.25	8.5	2	0.24	8.25	1.25	8.5	2	0.24
B07	7.90	1.45	8	2	0.25	7.90	1.45	8	2	0.25
B08	8.60	1.35	9	1	0.11	**8.80**	**0.83**	**9**	**1**	**0.11**
B09	7.35	1.39	7	1.75	0.25	7.35	1.39	7	1.75	0.25
B10	8.60	1.14	9	1.75	0.19	8.60	1.14	9	1.75	0.19
Technical:										
T01	8.40	0.99	8	1	0.13	**8.55**	**0.89**	**8.5**	**1**	**0.12**
T02	8.75	1.45	9	1.75	0.19	**8.85**	**1.23**	**9**	**1.75**	**0.19**
T03	7.35	1.53	7.5	1.75	0.23	**7.50**	**1.47**	**8**	**1**	**0.13**
T04	7.75	1.71	8	1.75	0.22	**7.90**	**1.68**	**8**	**2**	**0.25**
T05	7.35	1.31	7.5	1.75	0.23	**7.50**	**1.19**	**8**	**1**	**0.13**
T06	7.25	1.80	7.5	1	0.13	**7.50**	**1.43**	**7.5**	**1**	**0.13**
T07	**7.00**	**1.78**	**6.5**	**2.75**	**0.42**	**7.45**	**1.19**	**7**	**1.75**	**0.25**
T08	7.00	1.56	7	2	0.29	**7.35**	**1.09**	**7**	**1.75**	**0.25**
T09	5.70	2.30	6	2	0.33	**6.20**	**0.77**	**6**	**1**	**0.17**
T10	**7.60**	**2.26**	**8**	**3.75**	**0.47**	**8.00**	**1.65**	**8**	**2**	**0.25**
T11	**6.75**	**1.62**	**7**	**2**	**0.29**	**6.65**	**1.31**	**7**	**1.75**	**0.25**
T12	**8.15**	**1.53**	**8**	**2.75**	**0.34**	**8.25**	**1.21**	**8**	**2**	**0.25**
T13	**7.35**	**1.84**	**7**	**2.75**	**0.39**	**7.60**	**0.99**	**7**	**1.75**	**0.25**
T14	7.80	0.95	8	0.75	0.09	**7.70**	**0.92**	**8**	**1**	**0.13**
Average	**7.74**	**1.72**				**7.88**	**1.44**			

Note: [1] M: Mean; [2] SD: Standard deviation; [3] Q1: 1st Quartile (25th percentile); [3] Q2: 2nd Quartile (50th percentile), Q2 = Median; [3] Q3: 3rd Quartile (75th> percentile); [4] IQR: Interquartile Range, IQR= (Q3−Q1), ≤ 2.00 for consensus; [5] RIR: Relative Interquartile Range, RIR = (Q3−Q1)/Q2, ≤ 0.25 for stability.

5.2. Competences for Research

Consensus and stability were met after two rounds of consultation for research projects. In fact, only three elements of competence did not reach consensus in the first round (which are marked in **brown**) by the experts. However, eighteen experts modified their opinions in not only those but also in fifteen other items in the second round (marked in **green** or **blue** if importance increased), augmenting their respective consensus and promoting a significant level of importance, as can be checked in Table 10.

Table 10. Results of Delphi panel for research.

Code	**Round 1**					**Round 2**				
	Importance			**Consensus**		**Importance**			**Consensus**	
	M [1]	**SD [2]**	**Q2 [3]**	**IQR [4]**	**RIR [5]**	**M [1]**	**SD [2]**	**Q2 [3]**	**IQR [4]**	**RIR [5]**
Contextual:										
C01	9.10	0.85	10	1	0.11	**9.15**	**0.81**	**9**	**1**	**0.11**
C02	7.70	1.78	8	1.75	0.22	**7.95**	**1.19**	**8**	**1.75**	**0.22**
C03	8.60	1.14	9	1.75	0.19	8.60	1.14	9	1.75	0.19
C04	7.65	1.84	8	1.75	0.22	**7.85**	**1.39**	**8**	**1.75**	**0.22**
C05	**8.10**	**1.74**	**8.5**	**2.75**	**0.32**	**8.25**	**1.29**	**8.5**	**2**	**0.24**
Behavioral:										
B01	7.75	1.68	8	2	0.25	**7.90**	**1.33**	**8**	**2**	**0.25**
B02	8.95	1.00	9	2	0.22	8.95	1.00	9	2	0.22
B03	8.80	0.95	9	1.75	0.19	8.80	0.95	9	1.75	0.19
B04	8.20	1.28	8	2	0.25	8.20	1.28	8	2	0.25
B05	8.70	1.03	9	1.75	0.19	**8.90**	**0.97**	**9**	**2**	**0.22**
B06	9.00	0.92	9	1	0.11	**9.05**	**0.94**	**9**	**1**	**0.11**
B07	8.45	1.15	8	2.5	0.31	8.45	1.05	8	1	0.13
B08	8.90	0.79	9	1.75	0.19	8.90	0.79	9	1.75	0.19
B09	7.60	1.43	8	2	0.25	**7.80**	**1.06**	**8**	**2**	**0.25**
B10	8.85	1.04	9	2	0.22	8.85	1.04	9	2	0.22
Technical:										
T01	9.05	0.89	9	1.75	0.19	**9.20**	**0.77**	**9**	**1**	**0.11**
T02	8.90	1.33	9	1.75	0.19	**9.05**	**1.10**	**9**	**1.75**	**0.19**
T03	8.25	1.48	8	1	0.13	**8.45**	**1.19**	**8**	**1**	**0.13**
T04	8.45	1.36	8.5	1.75	0.21	8.45	1.36	8.5	1.75	0.21
T05	8.25	1.16	8	1	0.13	**8.30**	**1.13**	**8**	**1**	**0.13**
T06	7.90	1.68	8	1.75	0.22	**8.15**	**1.14**	**8**	**1.75**	**0.22**
T07	8.70	1.22	9	1.75	0.19	8.70	1.08	9	1	0.11
T08	7.95	1.67	8	1.75	0.22	**8.20**	**1.06**	**8**	**1.75**	**0.22**
T09	7.00	1.81	7	1.75	0.25	**7.10**	**1.02**	**7**	**1.75**	**0.25**
T10	**8.15**	**1.95**	**8**	**2.75**	**0.34**	**8.50**	**1.36**	**8.5**	**2**	**0.24**
T11	7.80	1.64	8	2	0.25	7.80	1.11	8	1.75	0.22
T12	8.15	1.60	8	1.75	0.22	**8.45**	**1.05**	**8.5**	**1**	**0.12**
T13	**7.65**	**1.60**	**8**	**2.75**	**0.34**	**7.90**	**1.17**	**8**	**2**	**0.25**
T14	8.20	0.77	8	1	0.13	8.20	0.89	8	1	0.13
Average	**8.30**	**1.45**				**8.42**	**1.18**			

Note: [1] M:Mean; [2] SD: Standard deviation; [3] Q1: 1st Quartile (25th percentile); [3] Q2: 2nd Quartile (50th percentile), Q2 = Median; [3] Q3: 3rd Quartile (75th percentile); [4] IQR: Interquartile Range, IQR= (Q3−Q1), $\leq$ 2.00 for consensus; [5] RIR: Relative Interquartile Range, RIR = (Q3−Q1)/Q2, $\leq$ 0.25 for stability.

6. Discussion of Results

The discussion of results consists of five subsections. First, the sample of experts is analyzed. Afterwards, the consensus and stability reached in answers is checked. Then, the importance given to each competence as isolated elements, both for educational innovation projects and for research ones, is assessed. Next, the network formed by the relationship among crucial competences, to highlight main nodes, is studied. Finally, the structure for a gap plan is developed.

6.1. Sample Representativeness

On the one side, EHEA or ALFA higher education areas insert universities to which experts belong, so traceability from the DeSeCo project to the Tuning one is ensured. In addition, these universities are either accredited or in the process of accreditation in a competence-based program (ABET, CDIO and/or EUR-ACE) in engineering. The entire sample complies with these institutional requirements. In relation to their physical location, twelve universities are Spanish and the other four are Latin American.

On the other side, the Delphi technique is a widely accepted method for gathering data, but only if respondents are within their domain of expertise [130]. Among knowledge areas related to main disciplines of engineering (construction, environment, industry, and technology), eighteen are included in the sample. Therefore, the different types of university projects related to engineering are widely represented. Finally, the size of the group is suitable if it is within the optimum range recommended, i.e. from six to thirty experts [131]. Twenty-four recognized experts composed the sample, thus it can be considered acceptable.

6.2. Validity and Reliability of Results

Validity and reliability increase transparency and decrease opportunities to insert researchers' bias in qualitative research [132]. Whereas reliability refers to the repeatability of findings, validity represents the truthfulness of findings [133]. Both refer to the consensus and stability of the results obtained [134].

IQR and RIR indexes measure consensus and stability, respectively. In this context, there is no need for experts to participate a third time, because variations were minimal after two rounds of consultation, thus results can be considered stable. At the same time, consensus was achieved. Therefore, for most questions, both IQR and RIR of the final round were lower than those of the initial one. In fact, convergence of responses was more common than divergence with more rounds [121].

However, the process reached consensus and stability for teaching projects in twenty-three competences in the first round, except C02, T07 and T10–T13. Analogously, the process achieved consensus and stability for research projects in twenty-six competences in the first round, except C05, T10 and T13. In summary, consensus and stability needed only one round of consultation on forty-nine of fifty-eight issues. Plan and control (T10) and Change and transformation (T13) were the competences with the least consensus and stability. On the contrary, Strategy (C01) and Select and balance (T14) were the competences with the most consensus and stability.

6.3. Grade of Importance

Once the process achieved the minimum level of consensus and stability thanks to the agreement of the experts, it was necessary to discuss the degree of importance obtained by each element of competence, for both educational innovation and research projects. If the importance was low, the element of competence was classified as conjunctural. On the contrary, if it was high, it was crucial.

In brief and to focus on the most crucial ones (those that realized a greater value of importance, once consensus and stability were ensured), a prioritized list of competences was extracted, as summarized in Table 11. However, it can be noted that all of them were crucial. Indeed, all elements of competence received more than half of the maximum score, for both types of projects.

The average score for the importance of professional PM competences based on the IPMA model for educational innovation projects was almost eight out of ten points. For educational innovation projects, two elements scored between 6–7 points, fifteen between 7–8 points, eleven between 8–9 points and one (B03) between 9–10 points. More in detail, technical competences reached an average of 7.5 points, contextual competences reached an average of 7.7 points and behavioral competences reached an average of 8.4 points.

Table 11. Prioritization of elements of competence according to their individual results.

Code	Element of Competence	Teaching	Research	Average	Priority
	Contextual:				
C01	Strategy	8.30	9.15	8.73	6
C02	Governance, structures and processes	7.60	7.95	7.78	22
C03	Compliance, standards and regulations	7.90	8.60	8.25	12
C04	Power and interest	7.40	7.85	7.63	26
C05	Culture and values	8.05	8.25	8.15	15
	Behavioral:				
B01	Self-reflection and self-management	8.00	7.90	7.95	19
B02	Personal integrity and reliability	8.80	8.95	8.88	3
B03	Personal communication	9.05	8.80	8.93	2
B04	Relations and engagement	7.80	8.20	8.00	17
B05	Leadership	7.75	8.90	8.33	10
B06	Teamwork	8.25	9.05	8.65	8
B07	Conflict and crisis	7.90	8.45	8.18	13
B08	Resourcefulness	8.80	8.90	8.85	5
B09	Negotiation	7.35	7.80	7.58	27
B10	Result orientation	8.60	8.85	8.73	7
	Technical:				
T01	Design	8.55	9.20	8.88	4
T02	Requirements, objectives and benefits	8.85	9.05	8.95	1
T03	Scope	7.50	8.45	7.98	18
T04	Time	7.90	8.45	8.18	14
T05	Organization and information	7.50	8.30	7.90	21
T06	Quality	7.50	8.15	7.83	23
T07	Finance	7.45	8.70	8.08	16
T08	Resources	7.35	8.20	7.78	25
T09	Procurement and partnership	6.20	7.10	6.65	29
T10	Plan and control	8.00	8.50	8.25	11
T11	Risk and opportunities	6.65	7.80	7.23	28
T12	Stakeholders	8.25	8.45	8.35	9
T13	Change and transformation	7.60	7.90	7.75	24
T14	Select and balance	7.70	8.20	7.95	20
Average		**7.88**	**8.42**	**8.15**	

Note: ▒ Eight most crucial competences.

By contrast, the average score in research projects was almost eight and a half points out of ten. For research projects, seven elements scored between 7–8 points, eighteen between 8–9 points and four (C01, B03, T01 and T02) between 9–10 points. Technical competences reached an average of 8.3 points, contextual competences reached an average of 8.4 points, and behavioral competences reached an average of 8.6 points.

Although the value obtained for educational innovation projects was almost 90%, in the case of research projects, the importance rose to almost 85%. Besides, there is a need to emphasize the relevance of behavioral competences for both educational innovation projects and research ones. However, as shown in Table 11 and considering all possible situations in a university context, between the most valued competence and the eighth, there was the same difference as between the eighth and the ninth, which implies that these competences make up the first gap.

6.4. Net of competences

In practical project situations, elements of competence are not isolated, because they are related each other. For that reason, the individual value of their importance should not be the unique criterion for their assessment. As competences are trained, performance is achieved not only by these elements but also by those with which they are related, contributing to each other's improvement [31]. Table 12 compiles the relationships among the eight most crucial competences, from the basis of the proposal of the IPMA ICB 4 model [31]. These relationships are multi-lateral, but being important enough for providers and receivers (establishing strong relations) or only for one of them (establishing weak or medium relations between providers and receivers).

Table 12. Relationships among crucial elements of competence.

Code		C01	B02	B03	B06	B08	B10	T01	T02
C01	Strategy	-	Weak	Weak	Weak	Weak	Strong	Strong	Strong
B02	Integrity and reliability	Weak	-	Strong	Strong	Strong	Strong	Weak	Weak
B03	Communication	Weak	Strong	-	Strong	Strong	Strong	Weak	Medium
B06	Teamwork	Weak	Strong	Strong	-	Strong	Strong	Weak	Weak
B08	Resourcefulness	Weak	Strong	Strong	Strong	-	Strong	Strong	Strong
B10	Result orientation	Strong	Strong	Strong	Strong	Strong	-	Strong	Medium
T01	Design	Strong	Weak	Weak	Weak	Strong	Strong	-	Strong
T02	Requirements and objectives	Strong	Weak	Medium	Weak	Strong	Medium	Strong	-

Note: ▒ : Weak relationships; ▒ : Medium relationships; ▒ : Strong relationships.

Based on the relationships from Table 12 and according to the influences they exert on each other, as shown in Figure 8, the competence Result orientation (B10) is the center of the net of crucial elements of competence. It was the most relevant, having a relationship with the seven other ones. Next, Resourcefulness (B08) is highlighted, with six relations. This is followed by Communication (B03) and Requirements and objectives (T02), with five each. Then, Teamwork (B06), Integrity and reliability (B02) and Design (T01) with four and Strategy with three relations, the most isolated.

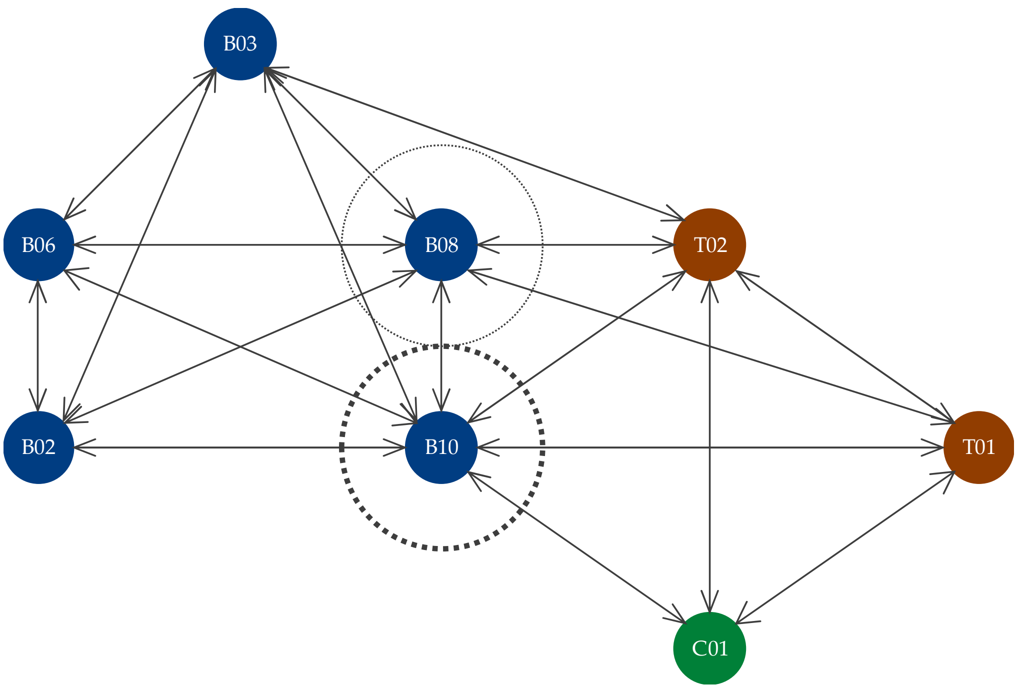


Figure 8. Net of essential elements of competence.

6.5. Basis for a Gap Plan

Once the most crucial elements of competence were identified and prioritized, isolated and together, it was necessary to lay the groundwork for their acquisition, development and improvement by the TRS. The following indicators can be used for their implementation, according to the guidelines of the IPMA ICB 4 model [31], with the help of the PMI PMCDF 3 and the PMI PMBOK 6 frameworks [34,36]:

- The competence C01 (Strategy) ensures the correlation between objectives and goals with the mission of the university. To do this, it is necessary to identify and exploit opportunities for influencing at the university strategy; develop and ensure the ongoing validity of its justification; and determine, assess and review critical success factors and key performance indicators.
- The competence T01 (Design) integrates demands, desires and influences, drafting how resources, funds, benefits, risks and opportunities, deliveries, priorities and urgencies are considered and deriving the proper approach to guarantee success. This requires acknowledging, prioritizing and reviewing success criteria; applying and exchanging lessons learned; determining complexity and its consequences for the approach; and selecting, if possible, the overall PM approach.
- The competence T02 (Requirements and objectives) deals with objectives, benefits, deliverables, requirements and outcomes and how they relate to each other. This implies defining and developing goals hierarchy; identifying and analyzing needs and expectations; and prioritizing and deciding on acceptance criteria.
- The competence B02 (integrity and reliability) builds integrity, reliability and responsibility from ethics, commitment and trust. For this, it is necessary to acknowledge and apply ethical values to both decisions and actions derived; to promote the viability and consolidation of outputs and outcomes; to take responsibility for own decisions and actions; to act, take decisions and communicate in a consistent way; and to complete tasks thoroughly in order to build confidence with others stakeholders.
- The competence B03 (Personal communication) exchanges adequate information and delivers it with precision and coherence to relevant parties. Because of it, there is clear and structured information to verify their understanding; to facilitate and promote open communication; to choose communication styles and channels to meet audience needs; to communicate effectively with virtual teams; and to employ humor and perspective when appropriate.
- The competence B06 (Teamwork) brings people together to realize common goals, building a productive team by forming (selecting right members), supporting (promoting orientation) and leading (managing the team). This involves selecting and building the team; promoting cooperation and networking between team members; supporting, facilitating and reviewing the development of members team; empowering teams by delegating tasks and responsibilities; and recognizing errors to facilitate learning from mistakes.
- The competence B08 (Resourcefulness) facilitates applying ways of thinking for the definition, analysis, prioritization, finding alternatives for, dealing with and solving challenges and problems, in order to manage better and more effective approaches. This means stimulating and supporting an open and creative environment; applying conceptual thinking to define strategies and analytic techniques for the analysis of situations, data and trends; and promoting creative techniques to find alternatives and solutions and a holistic view of the context to improve decision-making.
- The competence B10 (Result orientation) prioritizes resources to overcome problems, challenges and obstacles in order to focus on productivity, as a combination of effectiveness and efficiency. This implicates evaluating all decisions against their impact on success and objectives; balancing needs and means to optimize outcomes and success; creating and maintaining a healthy, safe and productive working environment; promoting projects, their processes and outcomes; and delivering results and getting their acceptance.

7. Conclusions

Projects are essential by their contribution to the sustained success of universities. In a scenario in which the production of knowledge results from scientific research, its transmission takes place through education and training, its dissemination thanks to information and communication technologies and its exploitation by innovation, universities postulate as the engine of social and economic change. From this point of view, research universities, working on projects with people in relevant teaching and pioneering research, link with society to influence a responsible development [15,135]. All these objectives, targets and goals, once formulated, lead to a series of projects.

Accordingly, to survive in this competitive environment, universities look for a competitive advantage, emphasizing the availability of potential competent staff, for which they can make a remarkable effort by increasing their competence. In engineering education, the TRS is a specialist at the highest level in engineering (science, technology and business, among others), which involves the capacity and investigative habits that allow them to approach and expand the frontiers of their branch of knowledge [136].

Frameworks based on competences in higher education have been successfully implemented [67,137–139]. At this point, this research joins previous ones demonstrating that professional PM competences help to improve in a sustained manner the results of university projects undertaken by the TRS. Although projects tackled in an unstructured way can succeed, the chances of repeating it significantly increase if the university structures create the appropriate conditions for the TRS. If teachers and researchers are university professionals, then they are equivalent to other sector practitioners, for whom project-based approaches are successfully operating. In this case, they can compare with each other to establish synergies.

Among projects that the TRS has to face, two of them stand out: educational innovation projects and research ones. To manage them, the TRS not only has to deal with the technical processes in which they are implied, but they also have to organize and coordinate, collaborate and cooperate as a team.

The twenty-four experts consulted agree that PM competences help the TRS to address their teaching and research, leading to a successful conclusion of their projects, based on a responsible formulation of objectives and management of the necessary activities. The Delphi panel showed that the acquisition and improvement of professional PM competences by the TRS is essential in order to engage projects in which they participate towards the achievement of results.

Among the twenty-nine elements of competence of the IPMA ICB 4 model (compatible with PMI PMBOK 6 and PMCDF 3 models), eight of them stood out, in consensus and stability (as valid and reliable sources), importance (as isolated elements) and influence (as interconnected nodes). Therefore, they are the necessary core to manage projects in the university community. These crucial competences are: Strategy from the contextual domain, Design and Requirements and objectives from the technical domain and Integrity and reliability, Personal communication, Teamwork, Resourcefulness and Result orientation from the behavioral domain.

In the university context, experts stress three elements of competence from the professional PM discipline for the proper resolution of projects. Strategy competence (C01) encompasses the formal justification of projects objectives and the establishment of long-term goals [140,141]. Design competence (T01) addresses the design, development, implementation and maintenance of an approach that takes into account all formal and informal factors that help to success of university projects [142,143]. Requirements and objectives competence (T02) establishes the relationship between what stakeholders (students, colleagues and institutions, among others) want to achieve and what projects are going to accomplish [144,145].

Reciprocally, the acquisition and improvement of PM competences by the TRS for carrying out the projects in which they are involved, both for the practice of a relevant teaching, especially in educational innovation projects, and for developing their research, predominantly in research, development and innovation projects, helps to ensure committed results. To manage them (leading people and administrating available resources), five elements of competence stood out, according to the experts.

Personal integrity and reliability competence (B02) enables making consistent decisions, taking congruous actions and behaving consistently in the projects undertaken [146,147], whereas Personal communication competence (B03) describes the essential aspects of an effective communication [148,149]. Teamwork competence (B06) promotes a team orientation, and effectively manages a team [150,151]. Resourcefulness competence (B08) effectively handles uncertainty and changes by searching for new, better and more effective solutions [152,153]. Results orientation competence (B10) enables focusing on the agreed outputs and outcomes and driving the success [154,155].

However, it is necessary to mention an observation. This research developed thanks to the collaboration of the experts panel, who come from Spain and four Latin American countries, which may be a limitation to the research findings. Nevertheless, the choice of experts, who are carrying out their work in centers in which the development of engineering competence-based accredited (or in the process of accreditation) programs (as ABET, CDIO or EUR-ACE) seeks to mitigate this potential cultural effect and can therefore be exported to other contexts where the Tuning project (from EHEA or ALFA areas) is implemented.

As a continuation of this research and future line of action, checking the degree of maturity in PM of the TRS that intervenes in educational innovation and research projects, using key competence indicators, is the following step. After that, with the measure and evaluation of the maturity level in PM of the TRS done, university structures can accordingly implement a customized breeding procedure, from the basis of the gap plan proposed, as the next step to develop the acquisition and improvement of their PM competences.

Author Contributions: Conceptualization, A.C.-N., I.d.l.R.C. and A.P.-F.; methodology, A.C.-N.; software, A.C.-N.; validation, A.C.-N., J.L.Y.B. and M.O.-M.; formal analysis, I.d.l.R.C. and A.P.-F.; investigation, A.C.-N.; resources, I.d.l.R.C. and A.P.-F.; data curation, A.C.-N.; writing—original draft preparation, A.C.-N.; writing—review and editing, A.C.-N., J.L.Y.B. and M.O.-M.; visualization, A.C.-N.; supervision, I.d.l.R.C. and A.P.-F.; project administration, A.C.-N., I.d.l.R.C. and A.P.-F.; funding acquisition, A.C.-N., A.P.-F. and M.O.-M.

Acknowledgments: To the GESPLAN Group of Technical University of Madrid, the INTELPREV Group of the University of Cadiz and the own Plan of aid for the promotion of research at the University of Cadiz.

Conflicts of Interest: The authors declare no conflict of interest.

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