ISBN: 978-628-96613-3-0. ISSN: 2414-6390. Digital Object Identifier: https://dx.doi.org/10.18687/LACCEI2026.1.1.293

Critical Success Factors in Research and Development Project Management: Evolution Based on a Systematic Review

Viktor Preciado Rojas, MSc[1], Sonia Lidia Romero Vela, PhD[1]
[1]Instituto Científico y Tecnológico del Ejército, Perú, 43703296@icte.edu.pe, sromerov@icte.edu.pe

Abstract*– This study examines the evolution of critical success factors in research and development project management based on a systematic literature review conducted between 1989 and 2023. The PRISMA methodology was applied, allowing the identification of 24 high-quality articles sourced from Scopus and Web of Science. The results show that these factors consistently fall into four dimensions: environmental, market, organizational, and technological. Early research focused on internal aspects such as the project manager's role, organizational structure, and the use of formal methodologies, whereas more recent studies incorporate external factors such as public policies, risks, customer involvement, and technological maturity. This evolution reflects a shift from models centered on individual capabilities to systemic approaches in which environment, market, organization, and technology interact. The study provides an up-to-date overview that explains how these factors have changed over time and offers a solid conceptual foundation for improving management practices, guiding strategic decision-making, and strengthening technology transfer across academic, industrial, and governmental contexts.

***Keywords:** Critical success factors, technology transfer, research and development management, project management, organizational innovation, research and development.*

I. INTRODUCTION

Research and development projects are essential pillars for the scientific, technological, and economic growth of countries worldwide. These projects not only drive innovations that transform entire industries but also strengthen global competitiveness through knowledge generation and the continuous improvement of production processes. As noted in [1], the impact of investment in research and development extends to the increase of international trade, the sophistication of manufacturing, and the consolidation of sustained technological advantages. This has led governments, the private sector, and academic institutions such as universities to develop more complex cooperation models that bring together incentives, strategic alliances, and technology transfer programs that help strengthen innovation ecosystems [2]. In these environments, the project manager's experience, the team's technical expertise, and systematic interaction with end users emerge as highly influential elements in project performance [3].

Research and development project management therefore becomes strategically important due to the intrinsic characteristics of these initiatives, such as high levels of uncertainty, variability in expected results, long development cycles, and dependence on emerging technologies. These challenges are particularly evident in sectors where technology is a critical component, such as defense institutions and public research organizations. In these contexts, ineffective management can lead to delays, higher costs, or final products that fail to meet operational objectives, while effective management enhances overall performance and strengthens institutional adaptability [4]. Studies carried out in public institutions, military organizations, and academic environments show that adopting appropriate methodologies, together with strategic planning and continuous training, supports goal achievement and optimizes resource allocation [5], [6].

The R&D Project Management (R&D PM) framework is grounded in the evolution of the management concept, which has shifted from resource control to a comprehensive process of planning, organizing, and directing [7][8]. Today, it is understood as a dynamic system oriented toward adaptation and change in complex environments [9][10]. Within this context, R&D PM is responsible for coordinating resources and activities to address the inherent uncertainty of scientific and technological projects, incorporating strategies for planning, monitoring, and risk mitigation [11]. Its performance also reflects the cognitive and social capabilities of project managers [12]. R&D projects are, by definition, uncertain, have their own life cycles, and due to their complexity may require traditional, agile, or hybrid approaches [13][14]. The literature highlights multiple relevant aspects of R&D PM, including the identification of variables that influence project performance [15], management models, maturity models [11], and the tools and indicators used to evaluate outcomes (see Figure 1).

In this context, Critical Success Factors (CSFs) emerge as an essential component for understanding project behavior and results. CSFs help determine the conditions that must be in place for a project to meet its intended objectives within acceptable limits of time, cost, and quality [4]. Specialized literature shows that several factors, including team expertise, availability of funding, organizational coherence, and appropriate personnel selection exert a decisive influence on R&D projects [6].

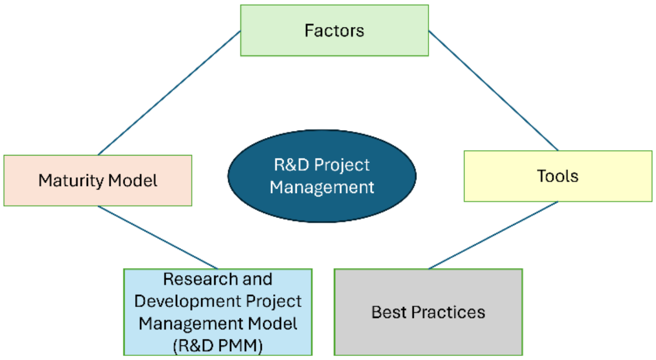

Fig. 1. Key Aspects of R&D Project Management (R&D PM)

In sectors where the pressure to innovate is constant, the ability of teams to solve complex problems, generate creative solutions, and maintain high levels of productivity becomes a key differentiator, as highlighted in [16]. These factors are far from static; they respond to changing environmental conditions, the technological maturity of organizations, and the ongoing evolution of management models. The historical trajectory of CSFs in R&D project management shows a progressive evolution that reflects broader transformations in how technological innovation is conceived. Early work by [12] emphasized the personal skills of the project manager, underscoring the importance of effective communication, leadership capacity, and decision-making under pressure. Over the years, subsequent studies incorporated new variables linked to organizational structure, managerial support, information management, and corporate culture, demonstrating that success depends on both individual attributes and institutional dynamics [3], [17], [18].

This historical progression reveals that CSFs have shifted from approaches primarily centered on the figure of the manager toward more comprehensive models that integrate technical, strategic, organizational, and human factors. Despite these advances, a fundamental challenge remains understanding how Critical Success Factors in R&D projects have evolved and what elements explain the changes in priorities, methodologies, and management approaches over time. This question is crucial in a context where organizations face increasing pressure to accelerate innovation, compete in global markets, and respond to technological transformations that continually reshape knowledge domains and development cycles.

To address this challenge, the present study conducts a Systematic Literature Review focused on the CSFs of R&D project management between 1989 and 2023, while also incorporating key references from the late 1980s to capture the historical evolution of the field. The study offers three main contributions: (i) an updated conceptual analysis of R&D project management; (ii) a comprehensive and structured inventory of the CSFs identified in recent academic literature; and (iii) a detailed examination of the changes, trends, and evolutionary patterns of CSFs from 1989 to 2023, aimed at guiding strategic decision-making and strengthening future research agendas.

II. METHOD

The methodology for this study is based on a four-phase procedure commonly applied in various research works related to R&D factors, such as entrepreneurship [19], startups [20], and technology transfer [21]. These phases are described as follows:

- Planning: Definition of the research questions, delimitation of the study period, formulation of the search string, and specification of the inclusion and exclusion criteria.
- Development: Execution of the search process and selection of articles that address the proposed research questions.
- Statistical Results: Presentation of statistical data on the selected articles, including trends, quality, and institutional affiliation.
- Results Analysis: Interpretation of the findings in relation to the research questions established during the planning phase.

A. Planning

To understand the evolution of R&D project management, the following research questions were formulated:

- RQ1: How are the Critical Success Factors (CSFs) categorized?
- What CSFs exist for R&D Project Management (R&D PM)?
- What models or theories have been used to support the CSFs in R&D PM?
- RQ4: How are the CSFs in R&D PM validated?

To ensure reproducibility and methodological consistency, the search was restricted to peer-reviewed journal articles published up to December 2024, in English and Spanish. Conference proceedings, theses, technical reports, and gray literature were excluded. A selection protocol with predefined operational criteria was established: (i) inclusion of studies explicitly addressing critical success factors (CSFs) in R&D projects; (ii) inclusion of empirical studies, systematic reviews, and relevant theoretical frameworks; and (iii) exclusion of studies focused solely on the management of startups, incubators, research centers, or approaches not directly related to R&D projects. The search strategy combined the terms “research and development,” “scientific research and innovation,” and “R&D” with “project management” and “success factor,” “critical factor,” or “factor.” It was applied to the Title, Abstract, and Keywords fields in Scopus and to the Topic field in Web of Science. The exact search execution dates were recorded, with the final query conducted on December 15, 2024.

TABLE I
INCLUSION AND EXCLUSION CRITERIA

Inclusion Criteria	Exclusion Criteria
• Journal articles that address at least one	• Articles not related to R&D projects.

Inclusion Criteria	Exclusion Criteria
of the research questions. • Articles written in English. • Articles published up to 2024.	• Articles not associated with R&D project management, such as startup management, business incubator management, or research center management. • Duplicate articles. • Retracted articles.

B. *Development*

The search protocol described in the planning section was applied, following the recommendations of the PRISMA methodology [22]. A total of 544 potential articles were initially retrieved from the two databases: 498 articles from Scopus and 46 from WoS. After applying the initial search filters (specifically "Review," English language, and Spanish language), the number of articles was reduced to 239 in Scopus and 45 in WoS. A subtotal of 284 unique potential articles was identified prior to the duplicate removal stage. Subsequently, 19 duplicate articles appearing in both databases were removed, leaving a total of 265 articles for eligibility assessment. Rigorous exclusion criteria were then applied, specifically excluding studies that did not address CSFs or R&D project management. These criteria were applied sequentially to the title, abstract, introduction, and conclusions, and finally to the full text of each article. This filtering process resulted in the exclusion of numerous studies, leaving 24 articles that met all inclusion criteria for the final synthesis of the review. This process is illustrated in Figure 2.

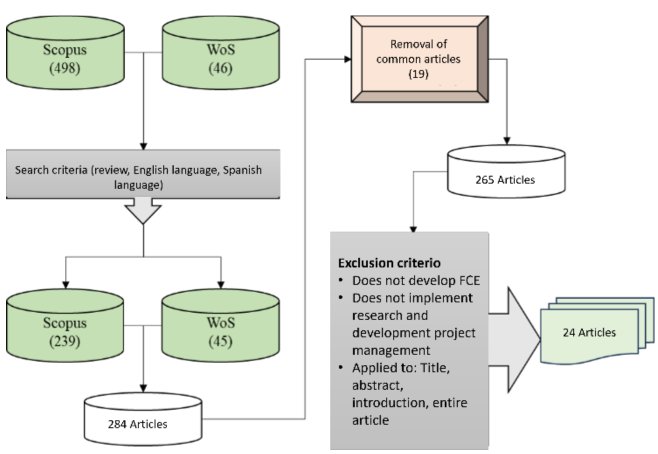

Fig. 2. Research Selection Process

C. *Statistical Results*

Regarding the distribution of articles by database, 17 were selected from Scopus and seven from Web of Science (see Figure 3).

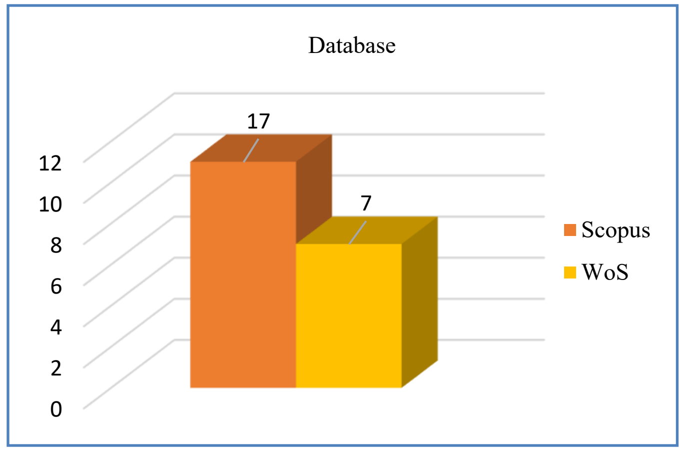

Fig.3. Articles by Database

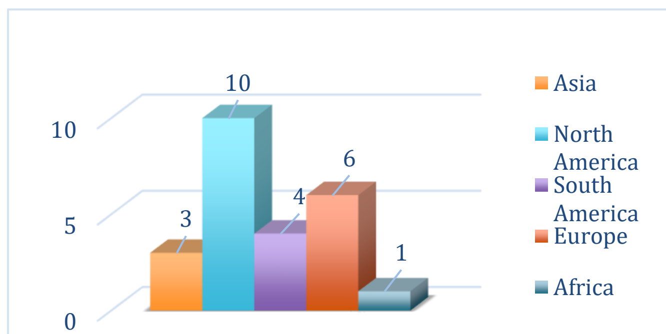

Fig. 4. Origin of articles by continent

Regarding the origin of the articles, they were grouped by continent. The Americas contributed 14 articles (10 from North America and 4 from South America), Asia contributed 3, Africa 1, and Europe 6 (see Figure 4). The temporal distribution of the publications analyzed shows a scattered academic output in the early years, with isolated contributions between 1989 and 2012. Starting in 2013, a gradual increase becomes evident, with notable peaks in 2014 and 2023, which recorded three and two studies, respectively. The highest concentration occurs in 2021, with four articles identified, making it the year with the most contributions in the dataset. This trend reflects a growing recent interest in the topic, with clear emphasis in the last decade, during which most of the scientific evidence used in this review is concentrated (see Figure 5).

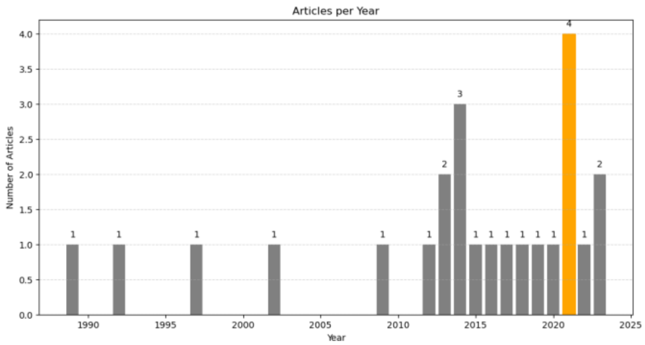

Fig. 5. Articles Published per Year

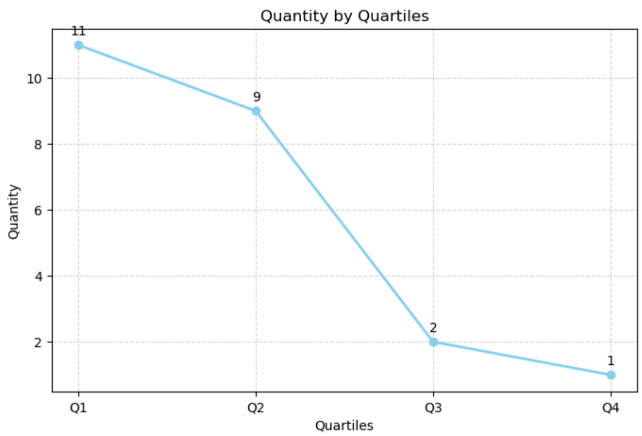

Fig. 6. Research Selection Process

Figure 6 shows that most of the articles are concentrated in the upper quartiles, with Q1 and Q2 predominating (11 and 9 articles, respectively), while Q3 and Q4 have minimal representation, reflecting the high quality of the publications.

III. RESULTS AND DISCUSSION

A. Critical Success Factors for Research and Development Project Management

The analysis of the 24 reviewed studies shows that the critical success factors (CSFs) identified in R&D projects can be consistently organized into four major dimensions: environmental, market, organizational, and technological (see Table II). The environmental dimension includes the external conditions surrounding the project, such as resource availability or the level of social acceptance, elements that may facilitate or limit its progress [23]. Market-related factors refer to the commercial potential of the development, the size of the demand, and the product life cycle, aspects repeatedly highlighted in the literature [23], [24]. Within organizations, organizational factors encompass structure, culture, available resources, and the level of managerial support, all of which are necessary to sustain R&D activities [23], [24], [25]. Finally, technological factors relate to the degree of innovation achieved, technical feasibility, and the maturity level of the technology used in the project [23].

TABLE II
DIMENSIONS OR CATEGORIES OF CRITICAL SUCCESS FACTORS IN R&D PROJECTS

Cod.	Dimensions	Description
C01	Environmental	External factors include the external conditions that may affect the project, such as the availability of raw materials and the social acceptance of the product [23].
C02	Market	These factors consider the likelihood of market success, the potential market size, and the product life cycle [23], [24].
C03	Organizational	These encompass strategic alignment and internal factors related to the organization's structure, culture, and resources, including aspects such as project management and top management support [23], [24], [25].
C04	Technological	These refer to the importance of innovation and the perceived value of the product, and are related to the technical feasibility of the project, including the availability and maturity of the required technology [23].

The environmental dimension encompasses external factors that condition the progress of R&D projects (see Table III). These include internal and external uncertainties that affect the relationship with the client [1], as well as the importance of maintaining an environment free from political pressures [3]. The willingness, capacity, and context for knowledge transfer also play a role [26], along with the need for a clear definition of the problem [27].

Other key elements include risk management, the availability of funding, access to laboratories, and competent external resources [28]. Finally, stable government policies, regulatory compliance, environmental policy, and social factors such as sustainability and health are also highlighted [29], [30].

TABLE III
CRITICAL SUCCESS FACTORS WITHIN THE ENVIRONMENTAL DIMENSION

Id	Factor	Description
F01	Internal and external uncertainties	Internal and external uncertainties can moderate the relationship between the mode of customer involvement and project success. For instance, in highly uncertain environments, greater customer participation may be beneficial to reduce uncertainties [1].
F02	Politically neutral project environment	This refers to the absence or minimization of conflicts, interests, or negative influences that may affect the development of the knowledge creation (KC) process or the project outcome [3].
F03	Willingness to transfer knowledge	The willingness of both knowledge providers and recipients to share and absorb knowledge is essential [26].
F04	Capacity for knowledge transfer	The skills of knowledge providers and recipients to transfer and assimilate knowledge are key [26].
F05	Context for knowledge transfer	Factors such as leadership support, the size of the recipient organization, and mutual distance influence the efficiency of knowledge transfer [26].
F06	Clarity of the problem	Clearly defining the research problem is essential to address current industry issues [27].

F07	Risk	Identification, assessment, and mitigation of events that could negatively affect the project. Risks are anticipated and response plans are developed to minimize their impact, balancing probability and severity [28].
F08	Availability of financial resources	Ensuring the availability of the necessary financial resources from the start of the project [28].
F09	Access to regional laboratories	Having access to suitable laboratories and equipment [28].
F10	Stable governmental policies	Relying on stable governmental policies that support the project [28].
	Environmental policy	Assessing the environmental impact of the project and ensuring alignment with ecological policies and sustainability goals [29].
F11	Competent external resources	Access to competent external resources [28].
F12	Social factors such as sustainability and health	Considering and addressing social aspects such as sustainability and health can improve project acceptance and impact [30].
F13	Regulatory compliance	Ensuring that the project complies with environmental and economic regulations, thereby minimizing legal risks and potential penalties [29].

Table IV presents the market dimension, which highlights the central role of the client. Their ongoing involvement, capabilities, and innovation culture have a direct influence on the development and performance of the project [4], [1], [30]. The literature also notes that assessing success through objective indicators, as well as the possibility that a weak relationship with the client may lead to difficulties during execution, are relevant considerations [5], [17]. Additionally, proper dissemination of results [27], continuous consultation and effective communication with the client [31], and the appropriate prioritization and selection of projects according to organizational strategic goals are emphasized [6]. Other critical aspects include the client's active participation, an accurate understanding of the market and its needs [28], and the strategic value that the project represents for the client [30]. Finally, this dimension is complemented by factors such as market size, timing of entry, range of applications, market and economic risks, and the use of financial metrics such as Net Present Value (NPV) and analyses of product value added to determine the project's relevance and viability [29].

TABLE IV
CRITICAL SUCCESS FACTORS WITHIN THE MARKET DIMENSION

Id	Factor	Description
F14	Client-related Factors	Active and continuous client involvement throughout the project is essential, as it allows the project team to receive timely feedback and make the adjustments needed to ensure that the final outcome meets the client's expectations [4]. Client characteristics such as their technical capability and their autonomy in decision-making, also influence how they participate and how they contribute to project success [1].
	Client's R&D Culture	The client's research and development culture, including their openness to innovation and their willingness to collaborate, plays a relevant part in achieving positive project results [30].
F15	Project Success Evaluation	Project performance is assessed through four objective indicators: cost overruns, delays, technical performance, and client satisfaction. These measures provide a quantitative basis to determine the project's level of achievement and the degree to which stakeholder expectations have been met [5].
F15	Poor Client Relationship	A weak relationship with the client, marked by limited communication, insufficient feedback, and low engagement may lead to ambiguous requirements, unexpected changes, and unmet expectations during agile processes [17].
F16	Effective Dissemination	Having a plan to disseminate project outcomes ensures that the results generate meaningful impact [27].
F17	Client Consultation	Maintaining communication, consultation, and active listening with all affected stakeholders strengthens the project's direction and responsiveness [31].
F18	Project Prioritization and Selection	Prioritizing and selecting projects through strategic portfolio management helps align initiatives with organizational objectives, including the development of new products that address economic needs [6].
F19	Active Client Participation	Active client participation throughout the project supports coordination and decision-making [28].
F20	Market Understanding	A solid understanding of the market and customer needs is essential for guiding the project appropriately [28].
F21	Strategic Value of the Project for the Client	Aligning the project with the client's strategic objectives ensures that the results are valuable and hold relevance for the client [30].
F22	Potential Market Size	Estimating the potential market size helps anticipate expected demand, return on investment, and the possibility of expanding the project's reach to new clients [29].
F23	Time to Market	Time-to-market is a critical factor for gaining competitiveness and capturing early market share [29].
F24	Range of Applications	Identifying whether the technology can be applied in multiple areas expands its potential use and adaptability across different business domains [29].
F25	□ Market Risk	Market risk involves analyzing external conditions, such as competitors or regulatory changes, that could influence market acceptance [29].
F26	Economic Risk	Economic risk considers financial uncertainties, including variations in costs or economic conditions, that may affect profitability [29].
F27	Net Present Value (NPV)	Net Present Value (NPV) provides an estimate of expected financial returns by discounting projected income and expenses, supporting the evaluation of financial feasibility [29].
F28	Product Added Value	Assessing the added value of the product determines how it complements or strengthens the existing portfolio, either through improved efficiency or by enhancing the overall offering [29].

In the organizational dimension (see Table V), the studies mainly highlight the influence of the project manager's competencies, experience, and leadership style [4], [16], [25], [3], [2]. The role of senior management is also emphasized; its support, strategic involvement, and ability to promote different leadership approaches are essential for guiding the project and motivating the team [6], [28], [32]. Other relevant factors include the type of project, producer characteristics, the presence of clear objectives, and the use of methodologies, standards, and management tools [1], [4], [5]. Literature additionally underscores the importance of thorough planning, both operational and strategic [3], [31], [32], together with practices such as continuous improvement, professional development, and interinstitutional support [3], [2], [31]. The studies further stress the need for competent teams, trained professionals, experience with similar projects, and proper allocation of resources and infrastructure [6], [27], [29], [33], [30]. Effective communication, cooperation, and teamwork emerge as central elements for coordinating efforts and reducing errors [3], [30], [32]. Other factors considered include organizational flexibility, internal culture, process control in suppliers, structural and institutional conditions, and the overall quality of the management process [3], [17], [36]. Alignment among strategy, projects, and processes is also identified as a determinant for maintaining project direction [33], [25], [6], [29]. Finally, the studies incorporate operational elements such as time, cost, and quality management; staff availability; team selection and integration; as well as more human variables such as commitment, risk tolerance, trust, and adaptability to change [34], [28], [30].

TABLE V
CRITICAL SUCCESS FACTORS WITHIN THE ORGANIZATIONAL DIMENSION

Id	Factor	Description
F29	Project manager’s experience	The experience and skills of the project manager are essential to achieving project success. A manager with solid expertise can anticipate potential issues, make informed decisions, and provide effective leadership to the project team [4], [16], [25].
F30	Project manager’s leadership	This factor refers to the ability to guide, motivate, and coordinate the knowledge-management team, as well as to communicate effectively with stakeholders and manage both change and risk throughout the project [3], [2].
	Senior management involvement	Active involvement from senior management is also critical. This includes shaping the organization’s strategic direction, identifying strategic projects, motivating personnel, and maintaining constructive labor relations [6].
	Strategic project leadership	Dynamic, motivational, team-building, visionary, and business-oriented leadership styles stand out. These approaches help strengthen team commitment and motivation throughout the project [6].
	Adaptive leadership	The ability of different team members to take on leadership roles when necessary, particularly when problems arise, is also emphasized [28].
F31	Type of project	The type of project may influence the optimal level of client involvement. For instance, more innovative projects may require a higher degree of client participation [1].
F32	Characteristics of the project developer	The characteristics of the producer, such as the ability to manage client involvement and maintain a customer-oriented approach, can influence project success [1].
F33	Clear and well-defined objectives	Having clearly defined and well-specified objectives from the outset is essential. Clear goals provide direction for the project team and function as reference points for evaluating success upon completion. They also help align the expectations of all stakeholders [4].
F34	Use of project management methodologies, standards, and tools	In project-oriented activities, including investment, innovation, and information projects, this factor refers to the use of a coherent and structured system for planning, executing, monitoring, and closing projects, following internationally recognized best practices and standards [5].
F35	Knowledge management planning	It refers to defining the objectives, activities, resources, responsibilities, and indicators associated with the knowledge management (KM) process, as well as its monitoring and control mechanisms [3].
	Corporate strategic planning	It also involves establishing clear goals and ensuring that project objectives are aligned with the broader objectives of the organization [32].
F36	Detailed project planning and scheduling	This includes providing a detailed specification of the individual action steps required for project implementation [31].
F37	Continuous improvement practices	It encompasses the application of methodologies aimed at assessing the performance and maturity of the KM process, as well as identifying and addressing actual or potential weaknesses or issues [3].
F38	Equal opportunities for professional development in knowledge management roles	It also refers to the existence of a career development plan for employees involved in the KM process, enabling them to progress toward roles with greater responsibility or recognition within the organization [3].
F39	Support from senior management in both institutions	The senior leadership of both institutions, university and industry must support the implementation of the PgPMO and acknowledge the value of the formal and standardized program and project management practices established by the PgPMO [2], [31].
	Corporate executive support for R&D initiatives	Top management commitment is also essential for the successful execution of R&D projects [32].
F40	Competent professionals	This refers to the qualifications, experience, and training of the personnel involved in the KM process, as well as their commitment, creativity, and recognition within the organization [3].
F41	Experience in similar projects	It examines the organization’s background in similar projects, which helps reduce the learning curve and enhances development efficiency [29].
F42	Competent Team	It also involves selecting a team equipped with the necessary skills and collaborative abilities required for the project [6], [27].
F43	Adequate Resource Allocation	This factor concerns the availability and efficient use of human, financial, material, and technological resources needed for the development of the KM process [3].
	Resources	High-performing companies allocate the specific and necessary resources to support innovation processes, including sustained backing from top management [33].
	Resource-Related Aspects	Efficient management of available resources, including time, budget, and personnel, is essential for ensuring project success [30].
	Resource Availability	This factor assesses whether the necessary material resources (such as equipment and laboratory facilities) are in place to carry out the project without setbacks and with the expected level of quality [29].
	Availability of Facilities	It also examines whether the existing infrastructure (laboratories, testing environments, and related facilities) is adequate for the project, thereby optimizing its scope and execution [29].
F44	Effective Communication	This refers to the timely, clear, and accurate exchange of relevant information on the KM process among the various stakeholders, both within and outside the organization [3].
	Quality of Communication and Cooperation	Clear and effective communication, along with smooth cooperation among all parties involved, is fundamental to driving the project forward [30].
	Communication and Collaboration	The effectiveness of communication and collaboration among team members, as well as with other stakeholders, is essential for ensuring coordinated progress throughout the project [32].
F45	Effective Control of the Knowledge Management Process at the Supplier’s Facilities	This factor concerns the oversight and verification of compliance with requirements and GC standards by subcontractors, suppliers, or partners involved in the design or development of the product or system [3].

F46	Flexibility in Knowledge Management Practices	It refers to the ability to adapt the GC process to the specific characteristics and needs of the product or system, as well as to the context and environment in which it is being developed [3].
F47	Organizational Culture	This factor encompasses the set of values, beliefs, behaviors, and norms that characterize the organization and shape how the GC process is conducted [3].
F48	Teamwork	It relates to the degree of collaboration, cooperation, and integration among the GC team members, as well as with other teams or departments involved in the project [3].
F49	Primary Activities of R&D Managers	These managerial activities account for approximately 70% of the total variance in R&D managerial performance and differ according to the level of supervision, with R&D managers engaging in a broader range of activities as they progress from lower to higher management levels [12].
F50	Productivity, Performance, and Use of Authority	This factor refers to the capacity to produce high-quality results, achieve project objectives, and use authority effectively to guide team members [16].
F51	Emotional Control, Active Listening, and Perseverance	It involves the ability to manage one's own emotions and those of others, listen attentively, and persist through challenges until objectives are met [16].
F52	Negotiation and Foreign-Language Skills	This factor pertains to the ability to negotiate mutually beneficial agreements and communicate effectively in foreign languages [16].
F53	Organizational Structure	It relates to the design and configuration of the organization responsible for the R&D project, including sub-dimensions such as formalization, specialization, differentiation, coordination mechanisms, decentralization, and managerial authority [6], [18].
F54	Project Management	This factor involves the implementation of effective project management practices aimed at enhancing the efficiency and effectiveness of product development [32].
	Schedule Management	It refers to the planning and control of time and resources allocated to the R&D project, including defining the scope, estimating duration, sequencing activities, and developing and monitoring the schedule [18].
	Corporate Project Management Capabilities	Project management skills and competencies within the firm are essential for coordinating and executing the project effectively [30].
F55	Gradual implementation of the PgPMO's functions and responsibilities	The functions and responsibilities of the PgPMO should be implemented progressively to ensure an orderly and effective adoption of its practices [2].
F56	Lack of agile logistical arrangements	This factor concerns the lack or insufficiency of resources, infrastructure, tools, and technologies needed to support agile development. Such limitations may lead to delays, errors, and inefficiencies [17].
F57	Insufficient competency in project management	This factor refers to the project manager's inability or insufficient capacity to plan, coordinate, communicate, lead, and solve problems within an agile environment, which can result in conflicts, deviations, and project failure [17].
F58	Structural conditions	These aspects include regulatory and legal frameworks, financial resources, and contextual conditions that influence the project's capacity to succeed [36].
F59	Institutional conditions	This factor relates to the organizational capability of both the beneficiary entity and the implementing agency, including accountability mechanisms and public participation [36].
F60	Management conditions	These aspects pertain to project leadership, design, monitoring, and stakeholder coordination, all of which are essential for successful project delivery [36].
F61	Strategy	Successful firms integrate their innovation strategy across all organizational levels and establish well-defined objectives aligned with the company's overall strategy [33], [25].
F62	Alignment of projects with the organization's strategic direction	Projects must be aligned with the organization's broader strategy to improve performance and ensure that selected initiatives are feasible and strategically relevant [6].
F63	Strategic alignment of initiatives	This factor assesses whether the project is consistent with the organization's strategic objectives, which helps secure continued support and enhances effectiveness [29].
F64	Project-related determinants	These aspects include the availability of resources, as well as the project's complexity and duration [25].
F65	Process management	This factor refers to the existence of a structured and rigorous process for new product development, emphasizing the importance of the early phases of the innovation process [33].
	Project management processes	It involves the implementation of proven processes and techniques to manage the project life cycle, resources, communication, and the handling of change, issues, and risks [6].
F66	Organizational climate	This factor relates to an organizational environment that promotes a culture of innovation, where leaders actively support and translate the company's vision into concrete action [33].
F67	Tools and methodological instruments	It refers to the use of diverse tools and techniques during the early stages of the innovation process, such as the lead user method and TRIZ, to generate and evaluate ideas [33].
F68	Knowledge accumulation within the project	The recipient's prior knowledge base influences the effectiveness of the knowledge transfer process [35].
	Technical knowledge and professional skills	This factor evaluates the technical experience and capabilities of the personnel involved, which increases the likelihood of effectively addressing technical challenges [29].
	Knowledge sharing across teams	It refers to the ability to transfer and share knowledge within the team and with other stakeholders [32].
F69	Characteristics and nature of the knowledge involved	The complexity, tacit nature, and systemic characteristics of knowledge influence how easily it can be transferred [35].
F70	Commitment of the project's lead researcher	The project leader's dedication is essential for securing resources and guiding the team effectively [27].
F71	Time	Total duration of the project and its activities. This entails planning and controlling the schedule to meet established deadlines and minimize delays [34].
F72	Cost	Expenses associated with project execution, including materials, labor, and other resources. The focus is on estimating, budgeting, and monitoring costs to ensure the project remains within its financial limits [34].
	Project cost	Estimation of the budget required for project development, ensuring that the investment is justified in relation to the expected benefits [29].
F73	Quality	Degree to which the project meets its requirements and expectations. This ensures that project outcomes are appropriate, comply with quality standards, and maximize value and client satisfaction [34].
F74	Maximization of R&D within the organization	Promoting an R&D-oriented culture, establishing efficient R&D processes, ensuring the availability of appropriate personnel, implementing robust information systems, and defining key performance indicators (KPIs) for R&D activities [6].
	Team efficiency	An efficient and well-structured team [28].
F75	Project team competence	Training in project management and in the technical areas related to the organization's mandate is essential. The need for access to modern technologies and the development of future-oriented competencies is likewise emphasized [6].

	Qualified academic expert	Ensuring the participation of a qualified university expert [28].
	Adequate and ongoing training	Guaranteeing continuous and appropriate training for staff members [28].
F76	Selection and appointment of the project team	The selection process should be grounded in leadership abilities, teamwork skills, resilience under pressure, and a diverse range of technical competencies. Cohesion and stability within the team are essential [6].
F77	Project team integration	Collaboration across departments and the integration of multidisciplinary teams are required [32].
F78	Availability of research personnel	It assesses whether qualified and available personnel are in place for the project, preventing delays and preserving development quality [29].
F79	Project mission	Clear initial definition of objectives and overall direction is necessary [31].
F80	Strategic vision of the organization	Ensuring that the project is aligned with the organization’s strategic vision is critical [28].
F81	Administrative simplification	Administrative procedures for programs should remain streamlined [28].
F82	Flexibility of employees and organizational structures	The ability to adjust to changes and new circumstances is vital [28].
F83	Continuous needs assessment	Continuous evaluation of both project and client needs is recommended [28].
F84	Risk tolerance	Maintaining a high degree of risk tolerance is important [28].
F85	Confidence in achieving success	Confidence in the project’s potential to achieve successful outcomes is essential [28].
F86	Understanding Employee Roles within the Client Organization	Having a clear understanding of the client’s employee roles and responsibilities enables more effective collaboration and communication [30].

Within the technological dimension, the literature highlights that the success of R&D projects largely depends on the creative and analytical capabilities of the team, which are essential for generating new ideas and approaching problems from multiple perspectives [16]. Practical skills such as written communication, adaptability to change, and the effective use of digital tools, also play a significant role [16], [35]. At a technical level, factors such as the likelihood of success, the presence of a strong technical leader, and the availability of specialized expertise required to address project challenges are influential [24], [29]. In addition, the use of user-friendly software that supports tasks and aligns with knowledge-management processes is considered valuable [3]. The literature further emphasizes the organization’s ability to adapt methods, develop early prototypes, maintain an openness to innovation, and engage in continuous technology monitoring [28]. Finally, elements such as the technological superiority of the product [30], together with the level of readiness, applicability, and maturity of the technology, directly shape the project’s risk profile, timeline, and potential impact [29] (see Table VI).

TABLE VI
CRITICAL SUCCESS FACTORS WITHIN THE TECHNOLOGICAL DIMENSION

Id	Factor	Descripción
F87	Creative and analytical thinking	This factor refers to the ability to generate new and innovative ideas, as well as to analyze problems and situations from different perspectives to find effective solutions [16].
F88	Writing proficiency, adaptability, and effective use of computer tools	This factor involves the ability to communicate effectively in writing, adapt to changes, and use information technologies efficiently [16][35].
F89	Technical factors	These elements include the likelihood of technical success, the presence of a project champion, and the required technical competence [24].
	Required technical expertise	It examines the availability of specific technical skills and knowledge within the organization, which are essential for overcoming challenges and achieving effective development [29].
F90	User-friendly software tools	It refers to the use of software that facilitates and automates tasks within the knowledge-management process, is compatible with its practices and standards, and is easy for users to learn and operate [3].
F91	Organizational capacity to revise and adapt methods	Adjusting work methods throughout the process [28].
F92	Prototype development for testing	Developing a functional prototype prior to full-scale production [28].
F93	Openness to innovation	Being willing to adopt new technologies and methods [28].
F94	Ongoing technological monitoring	Maintaining continuous monitoring of emerging technologies [28].
F95	Technological superiority of the project	The project’s ability to deliver technological solutions that outperform those available on the market is a key determinant of its success [30].
F96	Technology readiness	It assesses the stage of technological development whether experimental, prototypical, or ready for deployment which directly influences project timelines and risk levels [29].
F97	Technology applicability	It measures the potential of the technology to be applied to other products or processes, increasing its organizational value by extending its benefits [29].
F98	Technology maturity	It evaluates the degree to which the technology has progressed toward a version suitable for production or market use, helping to optimize implementation times [29].

B. Evolution of the Critical Success Factors in Technology Transfer Management

The evolution of critical success factors in technology transfer management reflects a progressive broadening in how these processes are understood. Early research focused primarily on internal aspects, particularly the role of the project manager, their leadership and communication capabilities, and the clarity of project objectives [4], [16], [25]. During this initial stage, emphasis was placed on having a well-defined organizational structure, established management practices, and a team equipped to assume key responsibilities [3], [5], [6], [27], [30]. As the field advanced, studies began incorporating external considerations linked to the broader environment, shaping what is now known as the environmental dimension. This included elements such as the influence of public policy, the availability of financial resources, risk management practices, and institutional conditions that can either facilitate or hinder technology transfer [1], [3], [26], [28], [29], [30], [36]. Additional factors, such as the willingness to share knowledge, regulatory stability, and access to specialized infrastructure, also gained relevance. Subsequently, the literature expanded toward a market-oriented perspective, highlighting the role of clients in the transfer process. Within this dimension, aspects such as client involvement, the clarity of their expectations, associated economic risks, and the commercial feasibility of technological outcomes became central to explaining project success [1], [4], [5], [17], [28], [29], [30], [31]. This shift underscored that successful technology transfer depends not only on technical or organizational capabilities but also on the capacity to address real market needs. In parallel, the technological dimension gained prominence, with growing attention to the maturity of the technology, its potential applications, early prototype development, continuous monitoring of emerging trends, and openness to innovative approaches [3], [16], [24], [28], [29], [30], [35]. Several studies emphasize that success is strongly linked to technical readiness, specialized expertise, and the availability of appropriate tools to adapt to rapid changes in the technological landscape. Taken together, this progression reveals a shift from a predominantly inward-looking perspective to a more comprehensive view, where organizational, environmental, market, and technological factors interact. Recent studies give particular weight to university–industry collaboration, strategic alignment, the availability of specialized resources, and the technological maturity of the innovation under development [2], [6], [29], [30], [31], [32], [33], [35], [36]. Altogether, this body of work shows that technology transfer is a complex process in which success depends on the balanced interplay of multiple dimensions rather than solely on internal operational management.

The findings reinforce the need to shift the analytical emphasis from models centered on individual capabilities toward systemic and socio-technical theoretical frameworks that integrate agents, institutional resources, and governance structures. It is proposed that future research empirically validate an integrative model that simultaneously considers: (i) organizational structures and internal capabilities; (ii) public and regulatory governance; (iii) mechanisms and the quality of university–industry interaction; and (iv) technological maturity, with the aim of explaining variations in the success of R&D projects across different sectoral and national contexts.

IV. CONCLUSIONS

The study made it possible to identify and comprehensively examine the critical success factors that shape the management of technology transfer, showing that their understanding has evolved as organizations, markets, and technologies have grown in complexity. The systematic review indicates that early literature focused primarily on organizational aspects linked to the role of the project manager, internal coordination, resource availability, and the use of formal methodologies. Over time, however, the expansion of the field progressively incorporated new dimensions that reflect the multidisciplinary nature of technology transfer.

The findings confirm that the environmental dimension has gained substantial importance, as political, economic, institutional, and social conditions directly influence the feasibility of transfer processes. Likewise, market-related factors have taken on a significant role, particularly client involvement, assessments of commercial acceptance, and the management of economic risk. In parallel, the technological dimension has shown continuous transformation, integrating elements such as technical maturity, applicability, prototype development, and ongoing technology monitoring components that are critical in highly dynamic innovation ecosystems.

The evolutionary analysis of the critical success factors reveals a clear shift from approaches centered on internal capabilities toward systemic perspectives in which organizational, environmental, market, and technological elements converge. This transition demonstrates that successful technology transfer depends not only on operational execution but also on the coherent alignment of institutional strategies, technical capabilities, client interaction, and external conditions. Consequently, the results of this study provide a strengthened conceptual basis that can enhance management models, guide future research, and support policy design aimed at improving the effectiveness of technology transfer processes across academic, industrial, and governmental contexts.

Finally, this research highlights practical implications for managers and policymakers:
a) For R&D project managers: incorporate early-stage assessment of technological maturity and structured client involvement during the formulation phase; institutionalize objective success metrics (time, cost, technical performance, and client satisfaction); implement continuous training programs in project management; and promote continuous improvement practices and risk management.
b) For policymakers and funding agencies: design medium-term funding schemes that reduce resource volatility, facilitate access to shared infrastructure (e.g., regional laboratories), and promote governance mechanisms that incentivize university–industry partnerships with clear indicators of transfer and impact.

ACKNOWLEDGMENT

The authors express their gratitude to the Scientific and Technological Institute of the Army (ICTE) for the support provided throughout the development of this research, as well as for granting access to information, resources, and technical guidance that made this study possible. The authors also acknowledge the institution's commitment to promoting research and technological transfer in the country.

REFERENCES

1. M. Peled and D. Dvir, "Towards a contingent approach of customer involvement in defence projects: An exploratory study," International Journal of Project Management, vol. 30, no. 3, pp. 317–328, Apr. 2012.
2. x|s, G., Santos, J. M. R. C. A., Ribeiro, P., Ferreira, L. M. D. F., Barroso, D., O'Sullivan, D., & Pinto, E. B. (2023). Critical Success Factors of University-Industry R&D Collaborations. Procedia Computer Science, 219, 1650-1659. https://doi.org/10.1016/j.procs.2023.01.458
3. Ali, U., & Kidd, C. (2013). *Critical success factors for configuration* management *implementation. Industrial Management & Data Systems, 113*(2), 250-264.
4. Berg, H., & Ritschel, J. D. (2023). *The characteristics of successful military IT projects: a cross-country empirical study. International Journal of Information Systems and Project Management*, **11**(2), 25–44. revistas.uminho.pt+2Aisel+2
   DOI: 10.12821/ijispm110202
5. Tulembayev, A., Adilova, A., & Serikbekuly, A. (2020). The effectiveness of the project management application analysis in the Kazakhstani defense *industrial* complex holding. Problems and Perspectives in Management, 18(3), 141-149. https://doi.org/10
6. Ugonna, C. U., Ochieng, E. G., & Otieno, H. N. (2021). *Determinants associated with the application of strategic project management: empirical evidence on research and development projects. International Journal of Business Process Integration and Management, 10*(3-4), 242-258. https://doi.org/10.1504/IJBPIM.2021.124029
7. Taylor, F. W. (1911). *The principles of scientific management*. Harper & Brothers.
8. Fayol, H. (1916). Administration industrielle et générale.
9. Drucker, P. F. (1973). *Management: Tasks, Responsibilities, Practices*. Harper & Row.
10. Kotter, J. P. (2012). *Leading Change*. Harvard Business Review Press.
11. Kerzner, H. (2017). Project Management: A Systems Approach to Planning, Scheduling, and Controlling (12th ed.). Wiley.
12. Friedman, L., Fleishman, E. A., & Fletcher, J. M. (1992). *Cognitive and interpersonal abilities related to the primary activities of R&D managers. Journal of Engineering and Technology Management, 9*(3–4), 211-242.
13. Mockevičienė, B. (2014). Research and development project management: study book, p. 23.
14. Wingate, L. M. (2014). Project management for research and development: guiding innovation for positive R&D outcomes. CRC press. Pag. 7–8, 17
15. Cooper, R. G. (2019). Winning at New Products: Creating Value Through Innovation. Basic Books.
16. Szczepańska-Woszczyna, K., & Gatnar, S. (2022). *Key Competences of Research and Development Project Managers in High Technology Sector.* Forum Scientiae Oeconomia, **10**(3), 107-130. DOI: **10.**23762/FSO_VOL10_NO3_6.
17. Abdelaziz, G. A. R., & Abdelshafy, A. F. (2023). *Information technology requirements for achieving strategic agility at the university level.* Migration Letters, 20(7), 1511–1521.
18. Hanif, H., Hanif, A., & Ahsan, A. (2021). *Identifying Critical Dimensions for Project Success in R&D Public Sector Using Delphi Study and Validation Techniques*. IEEE Access.
19. Cabrera, E. M., & Mauricio, D. (2017). *Factors affecting the success of women's entrepreneurship: A review of literature.* International Journal of Gender and Entrepreneurship, 9(1), 31–65. https://doi.org/10.1108/IJGE-01-2016-0004
20. Santisteban, J., & Mauricio, D. (2017). *Systematic literature review of critical success factors of information technology startups.* Academy of Entrepreneurship Journal, 23(2), 1–23.
21. López-Mendoza, X., & Sanchez, D. S. M. (2018). *A systematic literature review on technology transfer from university to industry.* International Journal of Business and Systems Research, 12(2), 197–225. https://doi.org/10.1504/IJBISR.2018.10012345
22. De Dios G, Álvarez B, Rodrigo A, González de Dios J, Buñuel Álvarez J, Aparicio Rodrigo M. Fundamentos de medicina basada en la evidencia. Listas guía de comprobación de revisiones sistemáticas y metaanálisis : declaración PRISMA. Evid Pediatr. 2011;7:7–97.
23. Balachandra, R., & Friar, J. H. (1997). Factors for success in R&D projects and new product innovation: A contextual framework. IEEE Transactions on Engineering Management, 44(3), 276–287.
24. Meade, L. M., & Presley, A. (2002). R&D project selection using the analytic network process. IEEE Transactions on Engineering Management, 49(1), 59–66.
25. Florescu, M., Coară, G., & Albu, L. (2014). Analysis of the Correlation Between Project Strategy and Impact Factors of Research and Development Projects. Revista de Pielarie Incaltaminte, 14(4), 251-259
26. Chu, Y.-F., & Huang, X.-Q. (2013). Empirical research on the affecting factors of knowledge transfer efficiency in CoPS R&D project. Mediterranean Journal of Social Sciences, 4(9), 696.
27. Kulatunga, U., Amaratunga, D., & Haigh, R. (2009). Critical success factors of construction research and development. Construction Management and Economics, 27(9), 891–900. https://doi.org/10.1080/01446190903186152
28. Gündüz, M., & Almuajebh, M. (2020). Critical Success Factors for Sustainable Construction Project Management. Sustainability, 12(5), 1990. https://doi.org/10.3390/su12051990
29. Zhang, Z., Chronopoulos, M., Dimitrova, D. S., & Kyriakou, I. (2024). Risk assessment and optimal scheduling of serial projects. OR Spectrum, 46(3), 709–736. https://doi.org/10.1007/s00291 023 00740 0
30. Gopalakrishnan Nair, T. R., & Kumar, S. N. R. (2014). Impact Analysis of Allocation of Resources by Project Manager on Success of Software Projects.
31. Pinto, J.K. & Covin, J.G. (1989). Critical factors in project implementation: A comparison of construction and R&D projects. Technovation, 9, 49-62.
32. Liu, G. H. W.; Huang Chua, C. E.; & Hu, Y. (2021). Partnership in Recruitment Process Outsourcing Projects: The Outsourcing Firm Perspective. Project Management Journal, 52(4), 354 366.
33. Giles, T. & Cormican, K. (2014). Best practice project management: an analysis of the front end of the innovation process in the medical technology industry. International Journal of Information Systems and Project Management, 2(3), 5–20. DOI: 10.12821/ijispm020301
34. Amoozad Mahdiraji, H., Sedigh, M., Razavi Hajiagha, S. H., Garza Reyes, J. A., Jafari Sadeghi, V., & Dana, L. P. (2021). A novel time, cost, quality and risk tradeoff model with a knowledge based hesitant fuzzy information: An R&D project application. Technological Forecasting and Social Change, 172, 121068. https://doi.org/10.1016/j.techfore.2021.121068
35. Chu, Y.-F. y Huang, X.-Q. (2013). Empirical Research on the Affecting Factors of Knowledge Transfer Efficiency in CoPS R&D Project. Mediterranean Journal of Social Sciences, 4(9), 696-700. doi:10.5901/mjss.2013.v4n9p696
36. Ika, L. A., & Donnelly, J. (2017). Success conditions for international development capacity building projects. International Journal of Project Management, 35(1), 44-63. https://doi.org/10.1016/j.ijproman.2016.10.005