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Analysis of Restrictions on Public Funding and Management of R&D Projects Arising from Legislation: The Case of the Spanish Context

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Abstract: This article examines the challenges posed by national legislative frameworks in the European Union Member States regarding the management of publicly funded research and development (R&D) projects. Taking the case of Spain and its General Subsidies Act as an example, this study analyzes 55 R&D funding calls published by the Spanish Central Administration in 2021 and 2022. This research identifies key challenges associated with change management in these projects. This research performed a detailed review of relevant legislation and its application to R&D projects, alongside an analysis of regulatory bases making use of a flexibility index (FI) to assess the adaptability of grant conditions. Also, quantitative methodologies like Pearson's correlation coefficient and principal component analysis were employed. The findings reveal that flexibility in project management, particularly concerning changes in scope, budget, and timeframes, is limited due to the rigidity of the legal framework. This lack of flexibility means a significant challenge for effective project execution, which inherently requires adaptability to manage uncertainty. This research suggests that future reforms should prioritize greater legal flexibility to improve the efficiency and success of publicly funded R&D initiatives. These findings contribute to the broader understanding of how regulatory constraints impact innovation management.

Keywords: R&D; project; management; grant; subsidy; funding; complexity

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1. Introduction

Public aids play a key role in correcting market failures. These deviations occur when the private sector and society are unwilling to invest adequately in certain areas, hindering the desired level of development (Acosta et al. 2015; Pérez Bernabeu 2015; Ziesemer 2021).

The field of innovation, particularly research and development (R&D), is a clear example of activities in which the associated risks and uncertainties result in lower levels of private investment than desired (Clausen 2009; Laine et al. 2015). Therefore, public funding, in all its forms, ranging from grants to soft loans, is intricately linked to R&D projects. Public support is widely used by countries to promote investment in R&D and innovation by both public and private entities (Mote et al. 2011; Nagesh and Thomas 2015; Spanos et al. 2014; González and Pazó 2008). Both the theoretical and the empirical literature identify government subsidies as one of the factors having a relevant impact on firms' innovation performance (Yin et al. 2023; Bakker 2013; Gao et al. 2021; Takalo et al. 2013).

In the European Union, the distribution of aids by Member States is regulated to ensure similar conditions in all countries. This ensures that there are no preferential treatments regarding aid beneficiaries based on their location within the Union. This is particularly crucial for companies as it could jeopardize the fundamental principle of free competition in the European Union's open market economy. In other words, and considering our case study, it means that in Spain, regulations that affect aids given to R&D projects are of two kinds: aids managed by the national government (State, regional and local levels) and aids

managed by the European Commission. In the case of those aids managed by the national government, they follow the General Law of Subsidies of the country, while aids managed by the European Commission follow their own rules which are in general more flexible in all that has to do with the R&D projects. Please also note that the situation is the same in all the EU countries, as aid given by each state should follow the state's own national subsidy laws and regulations.

Specifically, Articles 107, 108, and 109 of the Treaty on the Functioning of the European Union define the regulations on State aids at the EU level to avoid the aforementioned risks of imbalances in aid implementation (European Union 2012). However, paragraph 3 of Article 107 recognizes the compatibility with the internal market of any "aid to facilitate the development of certain economic activities or of certain economic areas, where such aid does not adversely affect trading conditions to an extent contrary to the common interest". Aids for R&D fall under one of these possible exceptions and are thus accepted, with their management carried out at the national level once approval from the European Union has been obtained regarding the appropriateness of such aid (Wendland 2015).

The Member States of the European Union have transposed this European legislation through various national laws and regulations. In the case of Spain, all grants awarded at national, regional, or local levels are subject to the General Subsidies Act 38/2003 (BOE 2003a). However, there is an exception for R&D grants directly funded by the European Commission to Spanish beneficiaries. These subsidies are not governed by Articles 107, 108, and 109 of the Treaty on the Functioning of the European Union. From the authors' perspective, it is essential to emphasize that, despite variations in the regulations among the Member States of the European Union, a shared legal framework exists due to the transposition of European Union directives into national legislation.

The aim of the present research was, through empirical research conducted on the specific case of R&D subsidies granted by the Central Administration (State) in Spain during the period 2021–2022, to describe the resulting scenario for the execution of such publicly funded R&D projects, setting conclusions regarding the limitations imposed by regulations that impact their effective management.

For this purpose, the present paper has been structured as follows: After this introductory section, a literature review that served to motivate this topic is presented. It is followed by a materials and methods section that gives sufficient background about the current regulations of R&D funding in the EU and Spain. This section also includes a description of the database employed and the quantitative and qualitative methodologies that have been employed. The next section presents the most relevant results found. Afterward, another section discusses the findings of this research, and, finally, a conclusions section in which future lines of research are detailed is included.

2. Literature Review

Research and development are two of the main key points for the economic development and competitivity of nations. In this context, a good strategy of public funding of the R&D of private companies is mandatory to promote innovation. It can be said that public funding is those resources provided by governments, international organizations, and any other kind of organizations with the purpose of stimulating research and development activities in private companies. This funding can be provided in different ways (Hall and Van Reenen 2000).

R&D activities are essential for the development of new products and services and, also, for the improvement of companies competitivity. According to previous research, investment in R&D is required for economic growth and the improvement of productivity (Coccia 2008), and, also, the cooperation of private companies and public entities would create synergies that increase innovation (Lee and Vavitsas 2021).

Among the different kinds of R&D funding that governments would apply, there are three main categories. The first of them, and probably the most important and the one under study in the present research, is public subsidies. This type of funding is common

in many countries, and its purpose is to alleviate the financial burden of investing in innovation (Hottenrott et al. 2017). Another mechanism is tax credits. Tax credits allow companies to deduct a percentage of their RD expenses from their taxes. This mechanism has been adapted by several countries to encourage investment in innovation without the need to provide direct financing (Czarnitzki et al. 2011). The third possible strategy is innovation programs. These programs include R&D subsidies as part of a broader strategy. One example of this kind of program could be Horizon Europe, which allocates significant resources to R&D projects in private companies (Husiev et al. 2023).

Also, and due to is great interest, the economic impact of R&D funding has been studied. It is well known that it has a positive impact on the economy, and a previous study has found that those companies that receive funding for R&D tend to increase their own investment in this issue, which also impacts their productivity (Lin and Zhang 2024) and causes a growth in employment (Kállay and Takács 2023).

The importance of public subsided has been confirmed in recent years by the literature. In the case of Spain, previous studies (Fernández-Zubieta and Sánchez 2024; Acebo and Miguel-Dávila 2023) have led to the conclusion that public support has a positive effect on a firm's R&D resources, although this impact varies largely from one sector to another. The results of another recent study (Gasser et al. 2022) performed in the Nordic countries are in the same line, as it confirmed that public funding serves as an effective catalyst in advancing research and development in the field of green energy technologies. Another study in the same line (Cecere et al. 2020) states that public funding is effective in improving the firm's ability to introduce eco-innovations as it is perceived by firms as complementary to other external finance.

Grants can act as a catalyst for innovation. Research shows that companies that receive financial support for R&D are able to develop more innovative products, which help them to improve their competitivity ranking in the markets in which they take part (Magrassi 2004).

Despite the already-mentioned benefits of R&D subsidies, there are also certain concerns about them. The most important is the difficulty in measuring the real impact of those subsidies on innovation and business growth which has led to a debate about their justification (Görg and Strobl 2006). In this line, recent research published in 2020 (Jin and Lee 2020) stated that government funding given for R&D activities to Korean companies has had a positive effect on their management. There is also a recent study about the Baltic Sea Region that led to the conclusion that, at least in the planning and implementation phases of policy, multi-level innovation policy mixes from different administrations do not have the negative side effect of overlapping, but synergies should be improved (Vītola 2015). Another study (Mulligan et al. 2019) demonstrated that ignoring subsidy mixes significantly biases the evaluations of subsidies from individual sources and, also, that subsidy mixes can be a highly effective means of stimulating forms of firm-level innovation with the highest social returns where market and systemic failures are most acute.

It is also of interest to highlight that recently a study (Hervás-Oliver et al. 2021) covering 220 regions across 22 European countries was published. This research found that regions in Europe differ significantly in terms of small and medium-sized enterprises' innovation depending on their location. Those small and medium-sized enterprises in more innovative regions benefit to a far greater extent from a combination of internal R&D, external collaboration of all sorts, and non-R&D inputs, while those small and medium-sized companies located in less innovative regions rely fundamentally on external sources and, particularly, on collaboration with other firms. According to this study, greater investment in public R&D does not always lead to improvements in regional innovation, regardless of context, and collaboration among companies plays also a key role.

The findings of the article discussed above are in line with other research (Rubiera Morollón and García 2023) that found that in the case of Horizon 2020 and Horizon Europe, a greater concentration of funds is observed in the most advanced and dynamic economies, capable of promoting more competitive research teams and projects. In other words, this means that EU R&D funds are preventing cross-regional convergence in Europe by driving

growth mainly in wealthier regions. Based on these results, it seems relevant to consider spatial correction mechanisms for the distribution of R&D resources so that they achieve greater territorial cohesion in Europe.

Other authors (Shin et al. 2018) have analyzed the great risk management that exists in R&D projects. From their point of view, such risks necessitate a systematic risk management methodology, like Failure Mode and Effect Analysis (FMEA), to address legislative and process-related restrictions during the project life cycle. Studies like this are in line with the one proposed in the present paper where the analysis of the impact of regulatory constraints on R&D projects is performed.

The uncertainty regarding the request for modifications related to the scope, such as objectives, deliverables, expected results, or task breakdown is particularly significant. This has an impact on a project's definition phase, where the scope and workplan are established, aiming to strike a balance between specificity and sufficient flexibility to redirect the project technically if necessary.

Some authors have studied the management challenges in R&D projects associated with the application of regulations linked to public funding. In these types of projects, complex scenarios arise in balancing the ever-changing nature of R&D projects and the rigidity and fixed limits imposed by regulations (Nagesh and Thomas 2015; Cassanelli et al. 2017). While government control of publicly funded projects a priori improves the efficiency of project management, over-regulation can have the opposite effect (Nishimura and Okamuro 2018; Zuo and Lin 2022). Moreover, this is perceived by project teams as extra complexity in the management, generating tension during the execution of a project (González-Varona et al. 2023). Nevertheless, complexity in innovation projects should be seen not only as a challenge, but also as an opportunity to foster creativity in order to achieve the project's objectives (Mata et al. 2023; Ruoslahti 2020).

There is no consensus in the literature about a unique methodology for managing R&D projects. The approaches are as diverse as the projects themselves. For some of them, traditional methodologies such as PMI are the best option. For others, agile approaches such as Scrum are recommended (Kuchta and Skowron 2016).

Both classical and agile approaches are based on the well-known project management triangle or iron triangle. The original representation of the iron triangle identified its three vertices with the components of time, cost, and quality. However, the original concept has evolved, and literature shows consensus on the vertices related to time and cost, but not on the one related to quality (Pollack et al. 2018). Quality can be understood as the ability to achieve the project specifications (Ogunlana 2010). Thus, the triangle can comprise three vertices: project scope, cost due to required resources, and execution time (Lamers 2002).

Nevertheless, regulations for R&D subsidies prioritize control and supervision criteria over efficiency, favoring planned and approved aspects rather than change management oriented to flexibility for efficiency (Coca et al. 2022). As a result of this context, part of the research in this field has been oriented towards the improvement of the evaluation of public R&D project performance (Zemlickienė and Turskis 2022; Li et al. 2021).

3. Materials and Methods

3.1. Background

3.1.1. Uniqueness of R&D Projects

The literature states that R&D projects differ from other types of projects in that their outcomes have a longer-term focus. Additionally, they possess other singularities such as an elevated level of risk and evolving objectives and scope over time, depending on the results obtained throughout their life cycle (Lorente-Pedreille et al. 2019). Also, they are characterized by a high failure rate, unpredictability, and long time consumption (Yin et al. 2023). Thus, flexibility in management is a pursued attribute in such projects (Wang and Yang 2012). However, other authors state that generic methodologies for project management pose limitations in the management of disruptive R&D projects due to the

need for greater flexibility in decision-making and change management (Ogunlana 2010; Vila Grau and Capuz Rizo 2020; Fouz Varela et al. 2020).

The Spanish standard UNE166001 "R&D&i management: Requirements for R&D&i projects" (R&D&i Management: Requirements for R&D&i Projects 2006 2006) and the Portuguese standard NP4458 "Management of Research, Development, and Innovation (RDI) Requirements for an RDI project" (Management of Research, Development and Innovation (RDI) Requirements for a RDI Project 2007) describe the requirements for R&D&i projects. Similarly, the Mexican standard NMX-GT-002-IMNC-2008 "Technology management—technological projects—requirements" (Technology Management—Technological Projects—Requirements 2008 2008) outlines the characteristics of technology projects. These standards highlight a key differentiating aspect of such projects. Despite the inherent uncertainty in R&D activities, the results achieved may substantially differ from the initial expectations without jeopardizing their value (Idris and Durmuşoğlu 2021).

The UNE166001 standard also indicates another distinguishing feature of R&D&i projects. It is their occasional support by government administrations, which requires adherence to predetermined guidelines (e.g., topics, duration, collaborations) established by these institutions. The project management implications resulting from the regulations of public subsidy programs that may finance such projects are present throughout the entire life cycle of an R&D project (Coca 2008).

3.1.2. The Regulatory Framework in the EU and Spain

In the European Union, the management and distribution of aid by Member States is regulated to ensure that conditions are similar in all countries, and therefore, there is no preferential treatment for aid recipients based on their location within the EU territory. This is particularly important in the case of businesses, as it could compromise the fundamental principle of free competition in the European Union, in an open market economy. Specifically, Articles 107, 108, and 109 of the Treaty on the Functioning of the European Union, known by its acronym TFEU, define the rules on State aid at the community level, in order to avoid the aforementioned risks of imbalances in the application of aid. Article 107 TFEU defines State aid as aid granted by States that would have the capacity to distort competition, making it incompatible with the internal market of the European Union by affecting trade between Member States. In addition, this article allows exceptions, such as aid for R + D activities, provided that they do not alter commercial conditions to an extent contrary to the common interest.

In the specific case of Spain, any type of aid in the form of a subsidy is governed by Law 38/2003 on Subsidies, regardless of whether it is granted by the central (State) administration, autonomous communities, provincial councils or local administrations. R&D subsidies, as a type of subsidy, are therefore subject to the provisions of the aforementioned Law. It establishes the principles governing all aid granted by Spanish public administrations, based on the objectives of transparency and control of public spending, and establishes the minimum points that all aid must comply with throughout its life cycle, including the phases of design, application, evaluation, implementation, justification, and control.

Law 38/2003 is structured in 4 titles and 11 chapters. The Preliminary Title and Title I cover the aspects of the Law relating to the definition, monitoring, and control of subsidies, and Titles II and III deal with aspects relating to the reimbursement of subsidies in the event of non-compliance with the conditions and requirements of the subsidies, as well as the system of penalties in the event of malpractice.

The 11 chapters of the Law comprise 69 articles, of which 11 have been taken into consideration for the purposes of this research, namely those directly related to the management aspects of R&D projects and their characteristics relating essentially to their changing nature, due to the inherent risk of the activity and, consequently, the criticality of the decision-making and change management mechanisms, and to the documentation and registration requirements during their execution. The articles not taken into consideration

address other aspects relevant to the administrative processing of grant applications, but have no direct impact on the management and life cycle of R&D projects.

In addition, in order to clarify doubts regarding the implementation of Law 38/2003 and to ensure common criteria in its application, Royal Decree 887/2006, of 21 July 2006, approving the Regulations of Law 38/2003, of 17 November, General Law on Subsidies, was published in the Official State Gazette on 25 July 2006. This Regulation is structured in five Titles, one preliminary and four more, which contain 103 articles describing in detail the application of the requirements foreseen in the Law. Of the 103 articles of the Regulation, for the purposes of the study addressed in this paper, the focus is on 7 articles that are directly related to the singularities of R&D projects and deal with aspects such as the assessment criteria for project proposals, beneficiaries' commitments, the possibility of modifying resolutions, the content of supporting accounts, the consequences of altering the conditions of the subsidy and reimbursements for non-compliance, and the procedures for making modifications and justifying the projects in an appropriate manner.

Figure 1 shows the articles of Law 38/2003 and its Regulations, identified as relevant from the point of view of R&D project management, which have a particular impact at different points in the life cycle of the project, a life cycle that includes the project ideation phase (pre-project), the phase of preparation of the aid application/proposal (application), the development of the activities foreseen in the project (execution), and the project's closure and accountability to the granting body (justification and post-project).

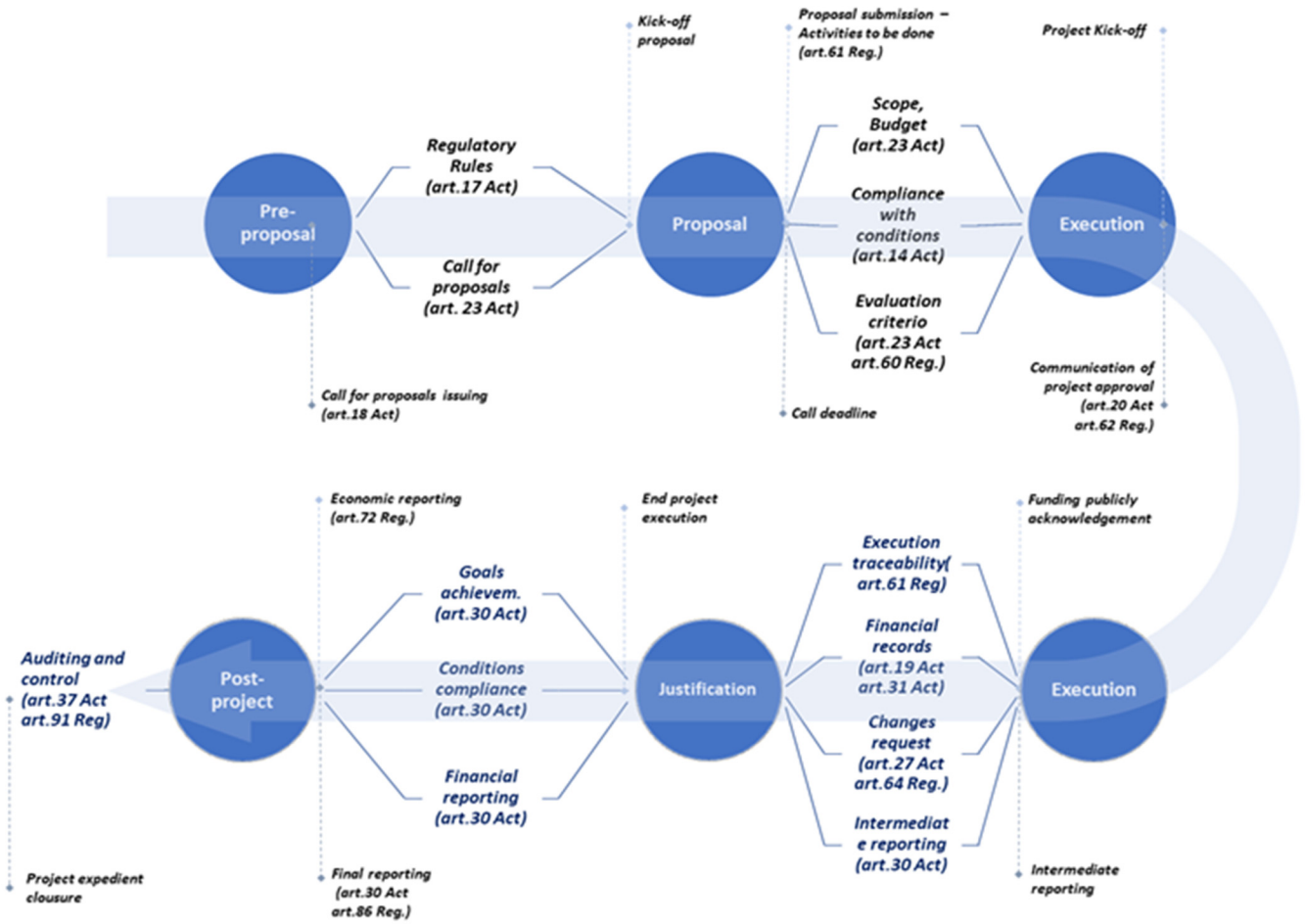


Figure 1. Project life cycle and key elements of Act 38/2003 and its Regulations.

3.1.3. Legislation Applicable to R&D Projects Funded by Spanish Public Administrations

A Spanish private company or entity can receive public grants from four levels of the Administration: European (European Commission), national (State Administration),

regional (autonomous communities and provincial councils, where applicable), and local (municipalities) (Coca et al. 2022).

In the specific case of Spain, grants directly awarded by the European Commission to Spanish companies or entities are not subject to Articles 107, 108, and 109 of the Treaty on the Functioning of the European Union which define the regulation of State aid at the EU level. However, the rest of the grants awarded at the national level are governed by the General Subsidies Act 38/2003, regardless of whether they are granted by the State Administration, autonomous communities, provincial councils, or local administrations. National subsidies for R&D are therefore subject to the provisions of the aforementioned Act.

Through the review and analysis conducted in this research on the sixty-nine articles that comprise the General Subsidies Act, it has been determined that eleven of them are directly related to project management aspects of R&D. Additionally, the Regulations of the Subsidies Act (BOE 2003b) which clarify aspects related to Act 38/2003 and ensure common criteria in its application have been also analyzed. Out of the one hundred three articles of the Regulations, seven of them are directly related to the singularities of R&D projects.

Figure 1 depicts the impact of the identified articles, both in Act 38/2003 and its Regulations, throughout the life cycle of an R&D project.

As shown in Figure 1, the identified articles have a significant impact on various stages of the project life cycle. The life cycle includes the project ideation phase (pre-project), preparation of the funding proposal (proposal), project deployment (execution), and closure and accountability to the granting authority (justification and post-project).

The articles related to regulatory bases (Article 17 of the Act) and the call for proposals (Articles 18 and 23 of the Act) are particularly relevant during the pre-project phase, which corresponds to the project ideation stage before applying for funding. These articles are crucial to verify if the project is aligned with the motivation and requirements defined in these guidelines.

During the preparation phase of the application proposal, the key articles to be considered are those concerning the technical and economic scope defined by the beneficiary for the project. These articles will later serve as the documentary basis on which the aid will be granted and the subsequent justification of the project activities upon completion (Articles 14 and 23 of the Act and Article 61 of the Regulations). Additionally, the articles related to the evaluation criteria, which will be used to assess all project proposals, are also relevant (Article 23 of the Act and Article 60 of the Regulations). From the perspective of this study's objectives, the importance of these articles lies in their connection to project change management, as modifications to the granting conditions that could alter the scores obtained in the evaluation according to the defined criteria cannot be requested.

During the execution phase, there are two main sets of articles to consider. On the one hand, there are those related to aid granting (Article 20 of the Act and Article 62 of the Regulations), which establish the conditions under which the project has been approved and subsequently must be justified. On the other hand, there are the articles concerning the recording of technical aspects (Article 61 of the Regulations) and economic aspects (Articles 19 and 31 of the Act) of the executed activities, the monitoring of project progress by means of interim justifications (Article 30 of the Act), and change management (Article 27 of the Act and Article 64 of the Regulations).

Regarding the technical and economic justification of the project, the main article to consider is the one related to justifications for public subsidies (Article 30 of the Act), along with the article including the description of the required justification report (Article 72 of the Regulations) and the treatment of modifications in execution compared to what is established in the aid granting resolution, when these modifications have not been requested within the project development period (Article 86 of the Regulations).

Finally, during the post-project phase, in which the granting authority reviews the documentation and evidence of project execution once it has been completed and justified, the articles related to verification and control must be considered (Article 37 of the Act and Article 91 of the Regulations).

3.1.4. Flexibility of Legislation Regarding Changes in R&D Projects

The common denominator of all the identified articles is their impact on change management throughout the project life cycle. In a context of risk and uncertainty inherent in R&D activities, flexibility and adaptability to change are required as solutions to address these challenges.

Article 17.3.l of the General Subsidies Act describes the circumstances that may lead to the modification of the approval resolution for a project grant. Additionally, Articles 61 and 64 of the Regulations of the Act state that the commitments expressed by the beneficiary during the application phase, which are linked to the approval of the grant, can be modified both during the award process and project execution. However, it should be noted, as indicated in Article 27 of the Act, that any modification to the grant resolution cannot alter the object, conditions, purpose, or evaluation of the project according to the established assessment criteria.

Furthermore, according to Article 19, paragraph 4 of the Act, changes in the conditions under which the grant was awarded may lead to modifications in the grant resolution, in accordance with the regulations governing the grant, namely its regulatory bases.

Despite the apparent flexibility of Act 38/2003 and its Regulations regarding the request for modifications and change management, there are references in the literature that highlight the difficulties in addressing change management in projects funded through public R&D programs. This behavior is observed both in Spain (Fouz Varela et al. 2020; Martínez and Comino López 2018; Arroyo-Vázquez et al. 2019) and in other countries (Mote et al. 2011; Kuchta et al. 2017). These difficulties seem to be unavoidable, as a previous study (Mazzola and Gambina 2024) has confirmed the lack of efficiency linked to the relocation of funds away from their original objectives.

3.2. Research Methodology

3.2.1. Data Source and Sample

To analyze, from a practical standpoint, how change management is addressed in R&D projects subject to the Spanish General Subsidies Act, a selection of aid programs has been made based on a representative sample. General conclusions can be inferred from the evidence extracted from the analysis. Figure 2 schematically represents the process followed for the triage and selection of the regulatory bases on which this study was focused.

The sample for analysis was defined based on a search for calls for proposals conducted on the National Subsidies Database (Ministerio de Hacienda 2023), applying the following filters to ensure comparability and reliability of the results:

- Programs managed by the State Administration. This allows us to exclude the complexity of the regional legislation that could qualify the application of national regulations. Search filter: "Estado" in the field called "Administración".
- Programs with at least one call for proposals in 2021 or 2022. This ensures that they are recent programs that are representative of the current situation. Search filter: "from 1 January 2021 to 31 December 2022" in the field called "fecha de registro".
- R&D&I grants, subsequently extracting the specific records related to "R&D projects". Search filter: "Investigación, Desarrollo e Innovación" in the "finalidad (política de gasto)" field.

Out of the initial search results yielding 276 records, a triage process was conducted based on ten categories: "R&D projects" (58), "innovation initiatives" (10), "scholarships, training, and employment" (58), "entrepreneurs" (5), "equipment" (5), "direct grants" (90), "technological modernization" (5), "awareness and communication" (5), "awards" (20), "other" (20).

Out of the 58 records categorized as "R&D projects", 3 correspond to grants not subject to the General Subsidies Act. These are aids awarded by the Center for Technological Development and Innovation (Ministerio de Ciencia, Innovación y Universidades 2023) as soft loans, and they were not taken into account in this study. According to the twenty-sixth additional provision of the Act, this type of subsidy provided by the state public sector

under private law is governed by specific regulations. Specifically, these three grants are those of CDTI's own financial instruments for the years 2021 and 2022 (Ministerio de Hacienda 2021; Ministerio de Hacienda 2022), as well as the grants for Personalized Advanced Medicine, jointly issued with the Carlos III Institute (ISCIII) (Centro para el Desarrollo Tecnológico y la Innovación 2022).

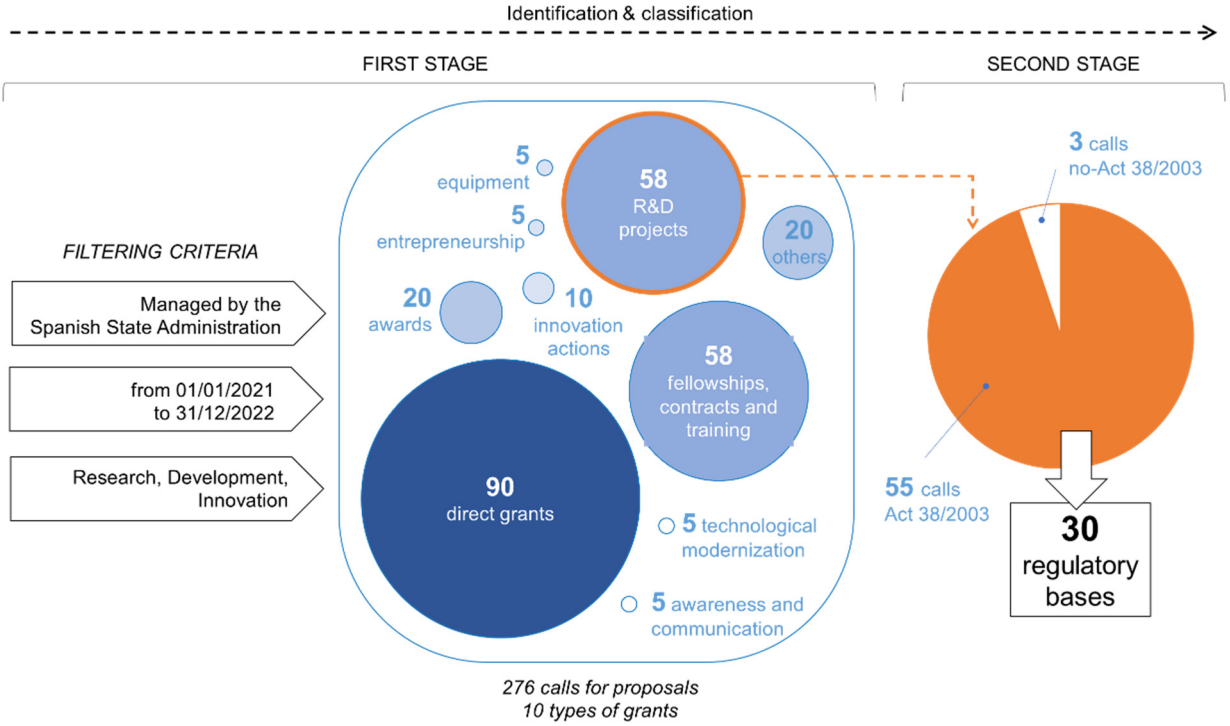


Figure 2. Triage of results obtained from the query in the National Subsidies Database (BDNS).

Out of the remaining 55 calls for R&D projects, 39 correspond to calls from different years with the same regulatory bases. As a result, out of these 55 R&D calls, 30 regulatory bases apply for this study.

Furthermore, according to Section 17.3.l of Act 38/2003, it is ultimately the regulatory bases that define what types of modifications can be requested by the beneficiary to change the conditions of the grant. Thus, the analysis focuses on the sample of the 30 identified regulatory bases, which are detailed below in Table 1, organized around the eight ministries and sixteen granting authorities that issued them.

Table 1. Selected regulatory bases for this study and their relation to the ministry and granting authority.

Ministry	Regulatory Base ID	Granting Authority	R&D Programs
MCINN	CIN/1360/2021	Spanish State Research Agency (AEI)	Digital and Ecological Transitions
MCINN	CIN/1412/2021	Health Institute Carlos III (ISCIII)	Health Strategic Projects (PERTE)
MCINN	CIN/1502/2021	Spanish State Research Agency (AEI)	Public–Private Collaboration
MCINN	CIN/373/2022	Centre for the Development of Technology and Innovation (CDTI)	Science and Innovation Missions; Aeronautic Technology Programme; Videogaming Programme
MCINN	CIN/417/2022	Spanish State Research Agency (AEI)	Proofs of Concept
MCINN	CIN/533/2022	Spanish State Research Agency (AEI)	Strategic Lines
MCINN	CNU/1308/2018	Centre for the Development of Technology and Innovation (CDTI)	Science and Innovation Missions; Sustainable Automotive Technology Programme; Aeronautic Technology Programme

Table 1. *Cont.*

Ministry	Regulatory Base ID	Granting Authority	R&D Programs
MCINN	CNU/320/2019	Spanish State Research Agency (AEI)	Proofs of Concept; Strategic Lines
MINECO	ECE/1301/2019	Red.es	Artificial Intelligence and Digital Technologies
MINECO	ETD/503/2021	Spanish Statistical Office (INE)	Scientific Research in the Spanish Statistical Office
MINECO	ETD/653/2022	State Secretariat for Telecommunications and Digital Infrastructures (SETELECO)	Immersive contents, Metaverse, and Web3
MINECO	ETD/668/2021	State Secretariat for Digitalization and Artificial Intelligence (SEDIA)	Artificial Intelligence Missions
MINECO	ETD/805/2022	State Secretariat for Telecommunications and Digital Infrastructures (SETELECO)	UNICO Broadband Programme
MINECO	ETD/806/2022	State Secretariat for Telecommunications and Digital Infrastructures (SETELECO)	UNICO Sectorial Programme
MINCOTUR	ICT/1117/2021	Directorate General of Industry and SME	Innovative Business Groups (AEIs)
MINCOTUR	ICT/474/2022	Directorate General of Industry and SME	Innovative Business Groups (AEIs)
MINCOTUR	ICT/713/2021	Directorate General of Industry and SME	Activa Financing—Connected Industry 4.0
MINCOTUR	ICT/738/2022	Directorate General of Industry and SME	Agri-Food Strategic Projects (PERTE)
MINCOTUR	ICT/789/2021	Directorate General of Industry and SME	Strategic projects for the pharma industry and the health products sector; innovation and sustainability for the manufacturing industry
MINCOTUR	IET/1009/2016	Directorate General of Industry and SME	Innovative Business Groups (AEIs)
MITECO	ARM/1498/2009	National Parks Agency (OAPN)	Scientific Research on the National Parks Network
MITECO	CSN 02/07/2021	Nuclear Safety Council (CSN)	R&D and Innovation projects
MITECO	CSN 25/04/2022	Nuclear Safety Council (CSN)	R&D and Innovation projects
MITECO	TED/1014/2021	Spanish Biodiversity Foundation	Bioeconomy
MITECO	TED/1016/2021	Spanish Biodiversity Foundation	Biodiversity
MITMA	TMA/702/2020	Spanish Ports Agency	Ports 4.0
MITMA	TMA/977/2021	Spanish National Geographic Institute	National Cartographic System
CONSUMO	CSM/472/2022	General Secretariat for Consumer Affairs and Gambling	Research on gambling disorders
CYD	CUD/691/2022	National Sports Council	Research in Health Benefits Physical Activity and Sports Medicine
SANIDAD	SND/722/2022	Government Delegation for the National Drugs Plan	Research projects on addictions

Abbreviations: Ministry of Science and Innovation (MCINN), Ministry of Economic Affairs and Digital Transformation (MINECO), Ministry of Industry, Tourism and Trade (MINCOTUR), Ministry for Ecological Transition and Demographic Challenge (MITECO), Ministry of Transport, Mobility and Urban Agenda (MITMA), Ministry of Consumption (CONSUMO), Ministry of Culture and Sports (CYD), Ministry of Health (SANIDAD).

3.2.2. Study Variables

The purpose of this research is to study the level of flexibility in the granting conditions of R&D aids awarded to Spanish beneficiaries, behind the scenario of potential changes represented by the project management triangle or iron triangle. This study focuses on flexibility in four areas: the three vertices of the iron triangle, i.e., objectives, resources, and time, and a fourth domain related to the agility of the administrative process.

A total of seven study variables have been defined for each of the analyzed regulatory bases. The Analytic Hierarchy Process (AHP) methodology has been adapted to the context of this study, taking into account the four areas abovementioned. These four blocks serve as a framework for organizing the seven identified variables.

On the one hand, four of them are directly related to the three vertices, namely the project scope change (SC), resource costs including team change (TC) and budget change (BC), and project timeline characterized by workplan change (WC).

On the other hand, some authors state that there are other factors than the traditional factors of cost, time, and quality/scope in the iron triangle that are crucial for a project's success. They propose the addition of extra criteria (Pollack et al. 2018) such as information systems and benefits for stakeholders and the organization (Atkinson 1999).

As shown in Figure 3, we propose the completion of the project triangle with the fourth block related to the flexibility of the administrative process. This block includes three other variables, bringing the total up to seven: accommodation of possible changes (change authorization, CA) and deadlines for submitting change requests (deadline for change requests, DCR) and for the managing entity to respond to the request (deadline for response to changes, DRC).

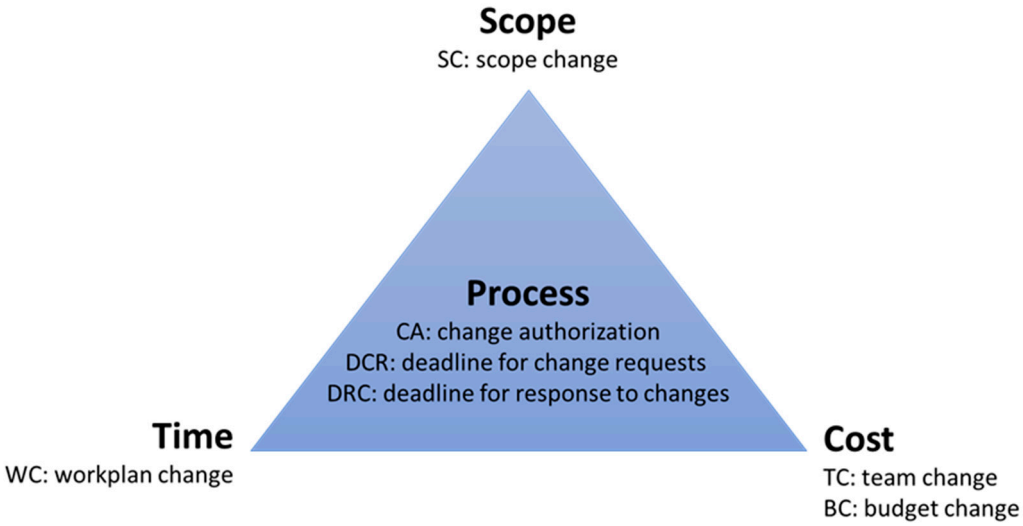


Figure 3. Representation of the study variables within the Lamers iron triangle logic for project management.

To facilitate subsequent analysis, a Likert-type scale with four values was established for all qualitative variables. As explained in Table 2, the design of this scale is based on the definition of two levels, 3 and 4, representing high-flexibility scenarios, and two levels, 1 and 2, corresponding to low-flexibility scenarios facing changes. Flexibility criteria were defined for each level of each analyzed variable, considering their unique characteristics. The specific criteria for each level of flexibility were established based on the characteristics of changes observed in each variable and the values assigned by the authors of this research. These criteria are considered expert judgments, informed by our extensive experience as practitioners and academics in the field.

Most studies make use of Likert scales with either 5 or 7 levels. There is no absolute consensus regarding whether a 7-point or 5-point scale is a better choice, and some contradictory results have been found. Previous research recommended the use of 7 levels for most of the cases (Weijters et al. 2010), while another more recent study (Revilla et al. 2013) in the context of agree–disagree, which is similar to our problem, stated that providing 5 answer categories would be a more effective option than 7 or 11.

It is well documented that the removal of a central point can significantly affect the results obtained from Likert scales, as it prevents respondents from utilizing a midpoint (Guy

and Norvell 1977). Considering this information and the precedent set by other researchers, we have opted to employ a 4-point Likert scale in this study (Nee and Yunus 2020).

Table 2. Likert-type scale used for the analysis of study variables.

	Low Flexibility		**High Flexibility**	
	1	**2**	**3**	**4**
CA	Only certain changes. Authorization required	All types of changes. Authorization required	Certain changes do not require prior authorization	Authorization is not required for a majority of changes
DCR	Not defined	At least 1 month before the project execution deadline	Less than 1 month before the project execution deadline	Just before the project execution deadline
DRC	Not defined	Less than 6 months	Less than 3 months	Less than 1 month
SC	Not allowed	Only under certain circumstances	Yes, but no detailed procedure for justifying	Yes, with a detailed procedure for justifying
BC	Not allowed	Only under certain circumstances and subject to approval	Only under certain circumstances without authorization for some of them	Yes. No limitations
TC	Not allowed	Only under exceptional circumstances	Only under certain circumstances	Yes. No limitations
WC	Not allowed	Yes, with a variable deadline depending on the remaining execution time	Yes, with a defined maximum extension. Only one change is allowed	Yes, with a defined maximum extension. Multiple changes are allowed

Abbreviations: CA: change authorization; DCR: deadline for change requests; DRC: deadline for response to change; SC: scope change; BC: budget change; TC: team change; WC: workplan change.

Therefore, and from the point of view of the authors, choosing a four-level Likert scale has several advantages in research. First, it eliminates the neutral option, reducing indecision and providing more decisive answers. In addition, a four-point scale facilitates the interpretation and analysis of results, allowing more direct and understandable conclusions. Finally, in our opinion, a four-point scale is appropriate for capturing general trends without complicating the analysis as its simplicity facilitates the comparability of results between different regulatory bases. In conclusion, the implementation of a four-level Likert scale can be especially beneficial in obtaining a clear and effective assessment in the framework of the present research.

3.2.3. Flexibility Index (FI)

A flexibility index (FI) was created to obtain an aggregated view of the flexibility of each regulatory base. The FI combines the four blocks of variables calculated for each regulatory base. As mentioned earlier, the structuring of the 4 blocks is derived from the AHP methodology. Subsequently, a 25% weight is assigned to each block to adapt the flexibility analysis to the framework established around the iron triangle, reflecting the equal importance of all the blocks in the context of this study.

$$FI = 0.25 \times (PROCESS + SCOPE + COST + TIME), \quad (1)$$

where the following definitions hold:

PROCESS = MEAN (CA, DCR, DRC);
SCOPE = SC;
COST = MEAN (TC, BC);
TIME = WC.

4. Results

4.1. Flexibility Distribution

Figure 4 summarizes the data collected from the analysis conducted on the 55 selected calls, focusing on the 30 related regulatory bases. A diagram representing the relative frequencies of the values adopted for each of the seven variables as well as the FI gives us information about the distribution of the flexibility for each regulatory base.

ID regulatory bases	Likert scale	Process flexibility			Project management triangle				FI	Pie chart	
					Scope	Cost		Time			
		CA	DCR	DRC	SC	TC	BC	WC			
ARM/1498/2009	1								3.17		14.3%
	2										28.6%
	3										14.3%
	4										42.9%
CIN/1360/2021	1								2.38		28.6%
	2										28.6%
	3										28.6%
	4										14.3%
CIN/1412/2021	1								3.33		14.3%
	2										14.3%
	3										14.3%
	4										57.1%
CIN/1502/2021	1								2.50		28.6%
	2										14.3%
	3										42.9%
	4										14.3%
CIN/373/2022	1								3.25		14.3%
	2										14.3%
	3										28.6%
	4										42.9%
CIN/417/2022	1								2.38		28.6%
	2										28.6%
	3										28.6%
	4										14.3%
CIN/533/2022	1								2.50		28.6%
	2										14.3%
	3										42.9%
	4										14.3%
CNU/1308/2018	1								2.13		28.6%
	2										28.6%
	3										42.9%
	4										0.0%
CNU/320/2019	1								2.38		28.6%
	2										28.6%
	3										28.6%
	4										14.3%
CSN 02/07/2021	1								3.42		14.3%
	2										0.0%
	3										28.6%
	4										57.1%
CSN 25/04/2022	1								3.42		14.3%
	2										0.0%
	3										28.6%
	4										57.1%

Figure 4. *Cont.*

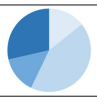
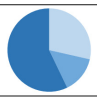
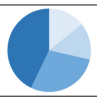
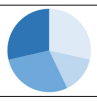
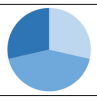
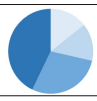
ID regulatory bases	Likert scale	Process flexibility			Project management triangle				FI	Pie chart	
					Scope	Cost		Time			
		CA	DCR	DRC	SC	TC	BC	WC			
CSM/472/2022	1								2.96		14.3%
	2										14.3%
	3										28.6%
	4										42.9%
CUD/691/2022	1								2.29		28.6%
	2										14.3%
	3										28.6%
	4										28.6%
ECE/1301/2019	1								2.75		14.3%
	2										42.9%
	3										14.3%
	4										28.6%
ETD/503/2021	1								2.58		28.6%
	2										28.6%
	3										0.0%
	4										42.9%
ETD/653/2022	1								2.63		14.3%
	2										42.9%
	3										28.6%
	4										14.3%
ETD/668/2021	1								3.58		0.0%
	2										28.6%
	3										14.3%
	4										57.1%
ETD/805/2022	1								2.92		14.3%
	2										14.3%
	3										28.6%
	4										42.9%
ETD/806/2022	1								2.92		14.3%
	2										14.3%
	3										28.6%
	4										42.9%
ICT/1117/2021	1								2.50		28.6%
	2										14.3%
	3										28.6%
	4										28.6%
ICT/474/2022	1								2.50		28.6%
	2										14.3%
	3										28.6%
	4										28.6%
ICT/713/2021	1								2.96		0.0%
	2										42.9%
	3										28.6%
	4										28.6%
ICT/738/2022	1								3.04		0.0%
	2										28.6%
	3										42.9%
	4										28.6%
ICT/789/2021	1								2.96		0.0%
	2										42.9%
	3										28.6%
	4										28.6%
IET/1009/2016	1								3.25		14.3%
	2										14.3%
	3										28.6%
	4										42.9%
SND/722/2022	1								2.29		28.6%
	2										14.3%
	3										14.3%
	4										42.9%
TED/1014/2021	1								3.17		14.3%
	2										28.6%
	3										14.3%
	4										42.9%

Figure 4. *Cont.*

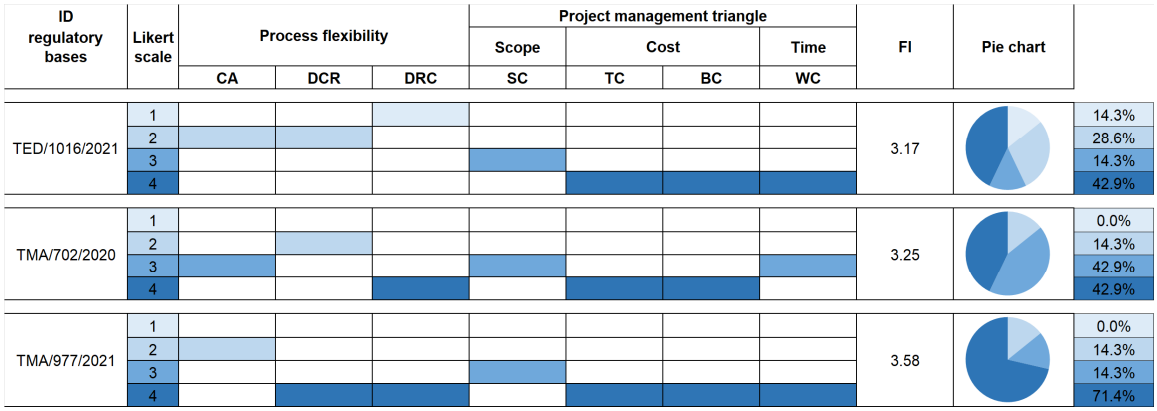


Figure 4. Results of the distribution of the degree of flexibility for each regulatory base. Abbreviations: CA: change authorization; DCR: deadline for change requests; DRC: deadline for response to change; SC: scope change; BC: budget change; TC: team change; WC: workplan change; FI: flexibility index.

There is a clear pattern according to which there is more propensity for flexibility in the aspects related to the changes in budget, team, and workplan, as well as in the variable corresponding to change authorization. On the other hand, a lack of flexibility is clear for deadlines that apply in the administrative process for requesting changes. This can be also observed in an analysis of the statistical measures shown in Table 3. It reveals that variables related to the change management process (CA, DCR, DRC) and the scope change (SC) exhibit mean values below 3, indicating a lack of flexibility, while changes in budget, team, and workplan show values above 3. Lastly, the data on changes in scope do not reveal a clear pattern, with very distributed frequencies for the four Likert scale values. Nonetheless, the mean of this variable, below 3, shows a lack of flexibility in this area.

Table 3. Variables' basic statistical measures.

	Process Flexibility			**Project Management Triangle**			
				Scope	**Cost**		**Time**
Variable	CA	DCR	DRC	SC	BC	TC	WC
Mean	2.8	2.5	1.8	2.4	3.7	3.1	3.3
Standard deviation	0.4	0.9	1.1	1.0	0.5	1.1	1.2

Abbreviations: CA: change authorization; DCR: deadline for change requests; DRC: deadline for response to change; SC: scope change; BC: budget change; TC: team change; WC: workplan change.

Additionally, the standard deviations for most variables are close to or greater than 1, indicating moderate dispersion considering the Likert scale values ranging from 1 to 4. Only the variables of change authorization (CA) and budget change (BC) have deviations below 0.5, indicating that values tend to concentrate around their respective means and suggesting some homogeneity in their treatment across the fifty-five calls and thirty analyzed regulatory bases.

Regarding the "flexibility index" (FI), it has to be noted that only 40% of cases (12 out of 30 regulatory bases) present FI values exceeding 3. Thus, there is a majority of regulatory bases with FI values corresponding to low flexibility.

4.2. Principal Component Analysis and Correlations Analysis

Principal component analysis (PCA) is an effective linear technique for dimensionality reduction (Boukichou-Abdelkader et al. 2022; Lam and Lee 1999). A PCA has been conducted to determine whether the dimensionality of this study could be reduced by identifying certain variables that would be sufficient to explain the data in the results. A widely used approach is to evaluate the proportion of cumulative explained variance and select the minimum number of components from which the increase ceases to be substantial.

Figure 5 shows the variance (percentage) explained by each of the new variables with respect to the total of the previous variables, as well as the relationship between the original variables and the two principal components, i.e., those that account for the highest percentage of variance.

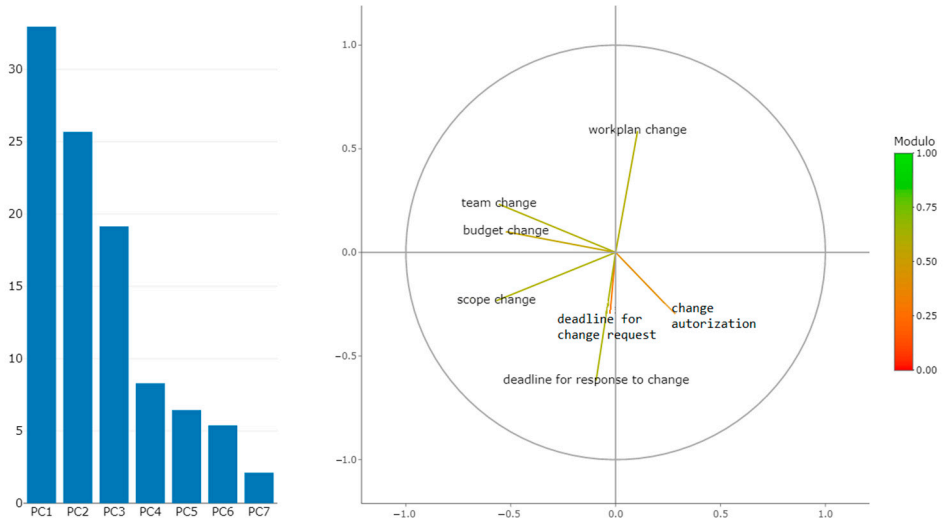


Figure 5. Observed variance for each of the seven study variables (**left**); plot of principal component analysis (**right**).

Figure 6 shows the cumulative variance of each of the study variables. Since there is no small number of variables (2–3) that significantly explain (more than 90%) of the observed variance, it is appropriate to retain all seven variables for further correlation and clustering analyses.

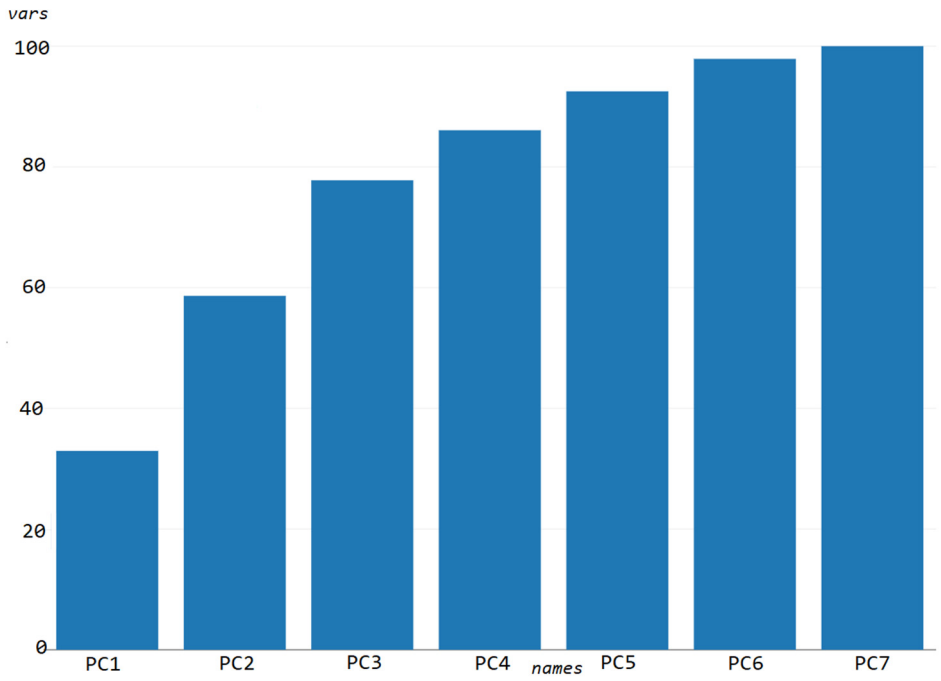


Figure 6. Cumulative variance.

4.3. Pearson Correlation

The Pearson correlation coefficient (r) ranging from −1 to +1 is an index of the degree of linear relationship between two variables. The correlation can be interpreted as weak,

moderate, and strong medium for values 0.3–0.5, 0.5–0.7, and above 0.7, respectively, positive or negative (Franke 2010). If the absolute value of r is less than 0.3, it is considered to represent no correlation or a very weak correlation.

A value less than 0 indicates that there is a negative correlation, i.e., the two variables are inversely associated. The closer it is to −1, the greater the strength of the inverse relationship. That is, when the value in one is very high, the value in the other will be very low. A value greater than 0 indicates that there is a positive correlation. In this case, the variables would be associated in a direct sense.

The analysis of Pearson correlation coefficients for the seven variables presented in Table 4 reveals a scenario primarily characterized by a lack of correlation between the variables, with some exceptions of moderate positive correlation (SC and BC; SC and TC; BC and TC), weak positive correlation (DCR and DRC; SC and DRC) and weak negative correlation (SC and WC; DRC and WC).

Table 4. Pearson correlation coefficients.

	CA	DCR	DRC	SC	BC	TC	WC
CA	1.00	−0.26	0.12	−0.14	−0.29	−0.28	−0.28
DCR	−0.26	1.00	**0.33**	0.06	0.06	−0.25	−0.04
DRC	0.12	**0.33**	1.00	**0.31**	0.05	−0.18	**−0.44**
SC	−0.14	0.06	**0.31**	1.00	**0.51**	**0.67**	**−0.38**
BC	−0.29	0.06	0.05	**0.51**	1.00	**0.57**	0.05
TC	−0.28	−0.25	−0.18	**0.67**	**0.57**	1.00	0.04
WC	−0.28	−0.04	**−0.44**	**−0.38**	0.05	0.04	1.00

Abbreviations: CA: change authorization; DCR: deadline for change requests; DRC: deadline for response to change; SC: scope change; BC: budget change; TC: team change; WC: workplan change.

From the analysis of the exceptions, it can be observed that a moderate correlation exists between variables related to three (scope, budget, and resources) out of the four types of changes that can be made in the project. This indicates that regulatory bases that tend to provide flexibility in making changes in one of these variables generally exhibit flexibility in at least one of the others as well. In the case of changes in the timeline, there is only a certain weak negative correlation with the variable related to changes in scope.

Furthermore, it is also observed that the levels of flexibility in terms of necessary timelines, both for requesting changes and obtaining responses from the managing body, are weakly correlated.

4.4. Analysis by Granting Authority

Table 5 shows the arithmetic averages for each of the seven variables analyzed, resulting from grouping the regulatory bases according to the granting authority that manages them. Applying the same analysis criteria as above, it can be seen that just over half of the managing bodies analyzed (9 out of 16) have a flexibility index higher than 3.

Furthermore, it can be observed only one of the granting authorities in the top five of flexibility belongs to one of the two ministries that manage the largest number of grants and the highest state R&D budgets (MICINN and MITYC). The next body of one of these two ministries appears in the tenth position (Directorate General of Industry and SME) with an FI below 3. Moreover, it is remarkable that three bodies in this top five (Spanish National Geographic Institute, Nuclear Safety Council, and General Secretariat for Consumer Affairs and Gambling) manage grants in which businesses are not identified as beneficiaries. Instead, they only allow public entities and private non-profit organizations.

Table 5. Analysis of variables based on the granting authority.

Granting Authority	Comp. Particip.	CA	DCR	DRC	SC	BC	TC	WC	FI
Spanish National Geographic Institute (MITMA)	No	2.00	4.00	4.00	3.00	4.00	4.00	4.00	3.58
State Secretariat for Digitalization and Artificial Intelligence (MINECO)	Yes	3.00	2.00	2.00	4.00	4.00	4.00	4.00	3.58
Nuclear Safety Council (MITECO)	No	3.00	4.00	1.00	3.00	4.00	4.00	4.00	3.42
General Secretariat for Consumer Affairs and Gambling (CONSUMO)	No	3.00	4.00	3.00	2.00	4.00	1.00	4.00	3.33
Health Institute Carlos III (MICINN)	Yes	2.00	4.00	1.00	3.00	4.00	4.00	4.00	3.33
Spanish Ports Agency (MITMA)	Yes	3.00	2.00	4.00	3.00	4.00	4.00	3,00	3,25
Spanish Biodiversity Foundation (MITECO)	No	2.00	2.00	1.00	3.00	4.00	4.00	4.00	3.17
National Parks Agency (MITECO)	No	2.00	2.00	1.00	3.00	4.00	4.00	4.00	3.17
Red.es (MINECO)	Yes	3.00	2.00	1.00	2.00	4.00	2.00	4.00	3.00
Directorate General of Industry and SME (MITYC)	Yes	3.00	2.00	1.67	2.50	4.00	3.50	3.00	2.93
State Secretariat for Telecommunications and Digital Infrastructures (MINECO)	Yes	3.00	2.00	2.33	3.33	3.67	3.33	2.00	2.86
Spanish Statistical Office (MINECO)	Yes	2.00	4.00	1.00	1.00	4.00	2.00	4.00	2.83
Centre for the Development of Technology and Innovation (MICINN)	Yes	3.00	2.00	1.00	2.00	3.50	3.00	3.50	2.75
Government Delegation for the National Drugs Plan (SANIDAD)	Yes	3.00	4.00	4.00	2.00	4.00	1.00	1.00	2.67
Spanish State Research Agency (MICINN)	Yes	3.00	2.00	1.00	1.00	3.00	2.40	4.00	2.50
National Sports Council (CYD)	Yes	3.00	4.00	4.00	3.00	2.00	1.00	1.00	2.42

Abbreviations: CA: change authorization; DCR: deadline for change requests; DRC: deadline for response to change; SC: scope change; BC: budget change; TC: team change; WC: workplan change; FI: flexibility index. Ministry of Science and Innovation (MICINN), Ministry of Economic Affairs and Digital Transformation (MINECO), Ministry of Industry, Tourism and Trade (MINCOTUR), Ministry for Ecological Transition and Demographic Challenge (MITECO), Ministry of Transport, Mobility and Urban Agenda (MITMA), Ministry of Consumption (CONSUMO), Ministry of Culture and Sports (CYD), Ministry of Health (SANIDAD).

5. Discussion

The uniqueness of R&D projects is primarily linked to the inherent risk and uncertainty in R&D (Shin et al. 2018), which is manifested in the final results potentially differing from the initially expected outcomes. Project management, defined by the well-known "iron triangle" (Lamers 2002), establishes a scenario where changes throughout a project's execution can occur in terms of scope, resources employed, and time required for completion. The combination of these three variables influences the success of the project's execution.

The Spanish General Subsidies Act potentially allows for modifications to the grant conditions in any of the three vertices of the mentioned triangle. However, this flexibility has an important limitation defined in Article 86 of its implementing regulation, stating that modification requests can only be considered if they do not alter the purpose and approval conditions of the grant. This nuance poses problems, particularly with changes that could modify the project's evaluation score based on the assessment criteria outlined in the regulatory bases of the grant programs.

Flexibility with changes has two dimensions. On the one hand, there is flexibility regarding which specific aspects can be changed according to the three vertices of the iron triangle (scope, equipment, budget, time). On the other hand, there is flexibility in the

administrative process, i.e., the need or not to seek prior authorization for changes. Indeed, depending on the response deadlines or the dates set in the regulations for requesting modifications, project decisions may be conditioned by the administrative deadlines and may simply not match the operational deadlines at the project execution level. Nevertheless, changes in scope are the most problematic, as they are linked to the purpose and conditions of the projects.

In the research described in this study, fifty-five calls for proposals and thirty regulatory bases of R&D grant programs published in 2021 and 2022 by the Spanish Government were analyzed through a search and filtering process on the National Subsidies Database (BDNS). From the point of view of the authors, the use of a reduced time framework (years 2021 and 2022) was required mainly due to two reasons: on the one hand, calls from the year 2020 had a really different behavior due to the effect of the COVID-19 pandemic, and on the other hand, the changing characteristics of calls and regulations year by year make the comparison with calls from years before the pandemic not useful.

The present research focuses on beneficiaries that are private entities because the differences between public and private sectors may introduce significant complexity in the extraction of conclusions. For instance, public organizations typically recognize only the personnel expenses for non-civil servant staff (known as marginal costs), while private entities are recognized for all types of personnel expenses, including both existing employees and newly hired staff.

From the conducted analysis, it is concluded that the changes in scope (SC) as well as in aspects related to the administrative process (CA, DCR, DRC) are the least flexible aspects concerning change management in R&D projects subjected to the Spanish General Subsidies Act. Furthermore, the behavior observed in the analyzed grants is not homogeneous, with standard deviations exceeding 1 in five of the seven analyzed variables on a Likert scale ranging from 1 to 4.

On the other hand, a flexibility index (FI) has been set up to provide an aggregate analysis of flexibility in each of the programs. Only in 40% of the cases (12 of the 30 regulatory bases) is there a clear tendency towards flexibility, with FI values above 3. Considering the managing body of the grant, it was observed that just over half of the different bodies analyzed (9 out of 16) have an FI above 3. Also, the managing bodies identified as the most flexible do not belong to either of the two ministries with the most State aid and budgets for R&D projects (the Ministry of Science and Innovation and the Ministry of Industry, Tourism and Trade). Furthermore, the regulatory bases published by these bodies, which are more flexible, do not include companies among their beneficiaries in many cases, thus showing a control bias in the case of aid aimed at companies and industrial research and technological development activities.

The analysis of Pearson's correlation coefficients also showed that there is no strong correlation between any of the seven variables analyzed. However, a moderate correlation was found between the variables linked to the scope and cost vertices of the iron triangle, indicating that those regulatory bases that show greater flexibility in one of these aspects will also tend to be flexible in the rest of them.

This issue associated with change management is specific to projects funded through grants regulated by the Spanish General Subsidies Act. Such issues do not exist in other grants outside this regulatory framework, for example, those granted by the European Commission, specifically the R&D grants under the Framework Programs for Research and Innovation (currently Horizon Europe).

Furthermore, the lack of certainty when facing changes leads to missed opportunities for achieving greater efficiency in ongoing projects. Also, for projects in the design phase, it implies a loss of ambition or disruption. These limitations not only affect the beneficiaries but also the entire society as they involve public funds allocated to R&D activities, recognized as drivers of economic development and societal well-being.

6. Conclusions

This study presents the impact of change management in R&D projects, emphasizing the need for flexibility and adaptability throughout the project life cycle. It highlights the challenges faced in addressing change management within public R&D programs, both in Spain and in the framework of the European Union. Furthermore, the research methodology section discusses the data sources and samples analyzed, shedding light on the managing bodies of grants and their varying levels of flexibility. It points out the lack of strong correlation between variables, except for a moderate correlation related to the scope and cost vertices of the iron triangle.

This document underscores the specific issues related to change management in projects funded under the Spanish General Subsidies Act, contrasting them with grants outside this regulatory framework, such as those provided by the European Commission. It also touches upon missed opportunities for efficiency and innovation due to uncertainties surrounding changes in ongoing projects.

According to the results achieved in the present research, there are several key points derived from the analysis of Spanish regulations on public subsidies for R&D projects and the challenges associated with flexibility in their management. They are as follows:

Firstly, the present study demonstrates that the Spanish legal framework, specifically the General Subsidies Law 38/2003 and its regulations, introduces a series of restrictions that make the flexible management of R&D projects financed with public funds difficult. Rigidity regarding changes to scope, budget, and deadlines is a significant limiting factor. Although the legislation allows modifications under certain circumstances, these cannot alter the original objectives of the project or affect the evaluation of the criteria under which the grant was awarded.

Also, the analysis performed by the authors reveals that, although certain aspects such as changes to the team or budget can be managed with some flexibility, modifications related to the project scope are usually much more restrictive. This rigid framework is particularly problematic in R&D projects, as the very nature of these projects involves a high level of uncertainty and the need to adapt the plan as results develop. The lack of flexibility to modify the scope prevents projects from being able to dynamically adjust to maximize their impact or improve their efficiency.

The interest in the research performed encourages authors to keep on working in this research line. From our point of view, the most promising lines of future research would be, first, a more in-depth exploration of the flexibility in public funding as a solid understanding of the current situation would help to perform proposals for future improvements. While this study highlighted the rigidity of the Spanish General Law on Subsidies, future research could investigate comparative approaches to flexibility in other EU Member States. Identifying best practices in legislative frameworks that successfully balance control and adaptability in publicly funded R&D projects could contribute to obtaining a better legal environment for innovation.

Another promising line of research would be the spatial distribution of public R&D funding and its implications for regional innovation. There is a challenge related to the concentration of funds in wealthier regions, which could exacerbate regional disparities. Our future studies could explore mechanisms to better align funding strategies with territorial cohesion objectives, ensuring that less developed regions in Spain can benefit from growth driven by innovation.

Finally, further research could also focus on the collaborative intersection between public funding and the private sector. Given that R&D projects often involve complex partnerships between public institutions and private firms, future research could study how public funding influences the dynamics of such collaborations, including how it affects risk-sharing, resource allocation, and the long-term sustainability of joint ventures in innovation.

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