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Using Certification as a Tool to Develop Sustainability in Project Management

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Abstract: Sustainability is a field of growing interest in Project Management (PM). Literature on Sustainability in PM is abundant at a theoretical level; however, it is necessary to explore hands-on approaches for designing models and practices. The purpose of this study is to introduce management systems as a practical tool for Sustainability in PM. Management system certifications are used as an indicator of the implementation of Sustainability practices, and thus, the impact of Sustainability on the success of projects is analyzed. The methodology for this study includes the analysis of the correspondence between Sustainability and five recognized management system standards (ISO 9001, ISO 14001, ISO 50001, UNE 166002 and OHSAS 18001) and experimental research based on data delivered by CDTI (Center for Industrial Technological Development) including relevant and objective information about R&D&I Projects in the energy sector. This study analyzes the impact of four variables (duration, budget, year of funding and certifications to management systems) on the success of the project. The conclusion is the significant positive impact of having management system certifications on the success of company projects analyzed in the Spanish energy sector, which may be of interest to PM practitioners in order to consider Sustainability as a factor for success.

Keywords: sustainability tools; sustainability practices; sustainability indicator; success factor; project success

1. Introduction

1.1. Sustainability in PM

Sustainability objectives have affected all areas of an organization to a greater or lesser extent in recent years. Literature is abundant and diverse, and approaches Sustainability in Project Management (PM) from different perspectives, including the theoretical concept and the definition of models and tools together with practical considerations.

Articles at a conceptual level discuss the concept of Sustainability as an abstract issue. Most of them refer to the classic Three P concept (People, Planet, Profit) coined by Elkington in 1997 [1], which establishes the three pillars of sustainability (social, environmental, economic), that are inter-related and influence each other [2,3]. The approach of the concept of Sustainability to the field of PM has come to the attention of researchers in recent years. In the line of the theoretical relationship between Sustainability and PM, Tharp et al. [4] include a review of the PM aspects that can be addressed by Sustainability considerations: the management of human resources, procurement, risks and communications. Okland [5] reviews the treatment of Sustainability in PM standards (PRINCE2, PMBok Guide and ICB International Competence Baseline 3.0), concluding that there is a paucity of this discipline in the proposed frameworks. In 2016, the subject matter of the IPMA conference [6] was "PM and Sustainability", and the 2017 edition [7], focusing on "PM and Success", suggested Sustainability and Success as a fertile area of research. The IPMA Project Excellence Baseline [8] also refers to Sustainability in PM, relating excellence in projects to economic, social and environmental attitudes. In 2017, Silvius [9] carried out a systematic literature review, and presented Sustainability as a new school of thought in PM. In this work, Silvius analyzed three criteria that define the essence of the school of thought: content (shared vision and common methods and tools), community (significant publication base, number of leading authors and presence at events) and impact (integration into practice and standards). Silvius states that literature describing the practice of Sustainability in projects is still limited. As regards integration into standards, Silvius refers to the IPMA Individual Competence Baseline version 4 [10] and Projects Integrating Sustainability Methods—PRiSM (based on ISO 21505 "Project, program and portfolio management—Guidance on Governance") as examples of how PM standards begin to incorporate explicit considerations on Sustainability. The conclusion is that impact is enough to consider Sustainability a new school of thought in PM. However, its integration into standards is relatively recent, and adoption by the market is not yet a reality, as Silvius [9] states. At this point, the approach of current research allows Sustainability aspects to be analyzed through consolidated standards, as explained later in this article.

Recent publications are alert to the need to bring sustainability considerations into PM practice. It is essential to identify instruments for the real application of Sustainability in PM [11–13], in order to make theoretical proposals a reality. In 2017, Aarseth et al. [14] presented a systematic literature review and described strategies used by project stakeholders to support sustainability goals. One of their findings is the need to consider sustainability in the early stages of the project.

As regards the definition of models and tools for Sustainability in PM, references are found for specific sectors or applications. For example, Fernández-Sánchez et al. [15] propose a methodology to identify and classify sustainability indicators in construction projects. Banishemi et al. [16] explore the integration of sustainability through the definition of success factors within this sector. El-Haram et al. [10] also address practical aspects for construction projects, such as metrics and tools related to sustainability. In the mining and mineral sector, several authors support the development of a practical PM framework that includes sustainability considerations [17–20]. On a global scale, regardless of the sector, Gareis et al. [11] suggest a model for Sustainable Development and PM based on the process-oriented principles of Sustainable Development (holistic approach, long-term orientation, large spatial and institutional scale, reduction in risk and uncertainty, consideration of values and ethics, participation) and five objects for consideration in PM (project objectives, project scope and schedule, project resources, income, costs and risks, project organization, culture, personnel, infrastructure, project context). Silvius et al. [21] also present a checklist including economic, environmental and social aspects, for integrating sustainability in PM on a global scale. Martens and Carvalho [22] carry out an exhaustive review that concludes with a synthesis of the literature on sustainability in PM, including references since 1999. 26 models of Sustainability in PM proposed between 1999 and 2014 are reviewed. All of them focus on the classic triple bottom line of sustainability (economic, environmental, social), and describe aspects and dimensions of sustainability in projects. After this work they summarize the content of the models researched in a set of three dimensions (economic, environmental and social), including 23 variables (8 of them in the economic dimension, 8 in the environmental dimension and 7 in the social dimension) that explain Sustainability in projects.

In summary, the literature review shows the relevance of Sustainability in PM and identifies the need to provide instruments for its real application in order to make the theoretical proposals a reality [23]. This is the area on which the first part of this work focuses, contributing with the proposal for management system certifications as a tool for implementing Sustainability in PM. To this end, the compendium drawn up by Martens and Carvalho with contributions from relevant authors has been used as a basis in this research.

1.2. Project Success

Project success is one of the most current topics in recent literature around PM [24]. The concept of success is ambiguous, and authors tend to propose a multidimensional approach in order to explain it [25]. In this context, the classic definition for project success, based on the iron triangle (scope, time and cost) has evolved, and many other dimensions for success have been recognized. Shenhar et al. [26] identify efficiency, impact on customer, impact on team, business success and preparation for the future as criteria for project success. Low et al. [27] consider criteria such as modern needs, future demands, expectations of stakeholders and regulations. The PM literature agrees in the identification of two aspects: project success factors and project success criteria [28–32]. Jugdev et al. [28] describe project success factors as "elements of a project that can be influenced to increase the likelihood of success" and success criteria as "measures by which we judge the successful outcome of a project." In other words, success factors refer to how success is achieved, and success criteria refer to what success means. Following a review of project success literature, Westerveld [32] developed the "Project Excellence Model," which links critical success factors and success criteria. Westerveld's success factors are defined in six areas in his model, including leadership and team; policy and strategy; stakeholder management; resources; contracting and PM. The final factor mentioned includes scheduling, budget, organization, quality, information and risks. In this model, the criteria for success are: project results (including time, cost and quality/scope) and appreciation of the client; project staff; users; contracting partners and stakeholders. Some authors affirm that, when important projects fail, the investigation focuses on the technical reasons when the problem is often rooted in management failure [33], thus encouraging management systems to be improved. Others research the effects of PM on project success demonstrating a significant and positive relationship [34]. Recently Serrador and Turner (2015) showed that project efficiency (meeting cost, time, and scope goals) correlates moderately strongly to the overall success of the project (meeting wider business and company goals defined by key stakeholders) [35]. Other researchers highlight that project success is best judged by the stakeholders, in particular by the the main sponsor [36].

Sustainability has also been considered as a success factor. Ika et al. [37] recognize it, together with relevance, efficiency, effectiveness, and impact. Carvalho et al. [38], Mir et al. [39] and Shenhar et al. [40] also include Sustainability as one of the aspects that brings about project success.

1.3. Sustainability, Management Systems and Project Success

In this scenario, this research has two goals. First one is determining if management system standards under study can be considered as a tool for Sustainability in PM. Second one is analyzing if the use of these standards in the organizations has an impact on the success of projects.

After the literature review, it is clear that tools for the practice of Sustainability in PM are required, and this is the focus of the first part of this work. The study presents several management system certifications as a tool for Sustainability, basing on the correspondence between aspects of sustainability presented by Martens and Carvalho and the ISO 9001 management system standards (quality management systems) [41], ISO 14001 (environmental management systems) [42], ISO 50001 (energy management systems) [43], UNE 166002 (R&D&I management systems) [44] and OHSAS 18001 (occupational health and safety management systems) [45] are analyzed.

At this point, it is important to recognize that these standards refer to the organization level, and not exactly to the project level: however, certification in a company has a direct influence on the performance and management of projects. Despite the temporary nature of projects, there is a strong link between project management and organizational performance, as described by the main project management frameworks (PMBoK, Prince2). Projects exist and operate in environments that have an influence on them [46]. Therefore, we assume that management system policies and strategies in an organization as a whole directly affect its projects. As an example, PMBoK refers to the need to incorporate sustainability practices in project management if there is an organizational policy on this issue and highlights the importance of management systems imposed by organizations to carry out projects. In addition, when referring to Project Quality Management (chapter 8 PMBOK) they consider the influence that the quality management system (including policies, procedures and guidelines) may have on the Quality Management Plan of the project.

In the second part of this study, the authors analyze the impact of Sustainability on project success, in the context of the proposal of Sustainability as a factor for success. This is based on the idea that considered management systems are a tool for Sustainability, and the certification of the corresponding standards has been taken as an indicator of Sustainability. Since certification is given by the competent external companies, it is guaranteed that information on management systems used in the companies in the study is true and impartial. To this end, objective information about projects in the energy sector in Spain is analyzed. The result is an analytical assessment of the impact of Sustainability in PM for the projects in the study. Furthermore, the influence of other variables (duration, budget, year of application for the funding) on the success of the project is evaluated.

2. Materials and Methods

2.1. Management Systems as Tools for Sustainability in PM

The study aims to analyze the correspondence between the standards and Sustainability aspects considered in PM. After the literature review, the proposal (based on the framework proposed by Martens and Carvalho [20]) explores the link between the variables in the economic (8), environmental (8) and social (7) dimensions, and five relevant management system standards (ISO 9001, ISO 14001, ISO 50001, UNE 166002, OHSAS 18001). A brief remark for each standard is included in the following paragraphs.

ISO 9001 is the international standard that establishes requirements for a quality management system in an organization. It is based on the seven quality management principles: leadership, engagement of people, process approach, improvement, evidence-based decision-making and relationship management. According to ISO, over one million companies and organizations in over 170 countries are certified to ISO 9001.

The ISO 14000 family of standards deals with the management of environmental responsibilities in organizations. ISO 14001 pursues the balance between the environment, society and the economy: it can be clearly recognized that this standard is absolutely in line with sustainability. According to ISO, there are more than 300,000 certifications to ISO 14001 around the world.

ISO 50001 establishes requirements for energy management systems, and refers to the energy performance of a company, that includes energy efficiency, energy use and energy consumption. UNE 166002, the standard for R&D&I management systems, establishes requirements for the definition and development of R&D&I policies, the establishment of goals, the technology transfer and the technological innovation process. Finally, OHSAS 18001 specifies requirements for occupational health and safety management for an organization, in order to control risks and improve performance.

2.2. Correspondence between Management System Standards and Sustainability Variables

This section presents an exhaustive study of the correspondence between sustainability variables as defined by Martens and Carvalho [22], grouped in three dimensions (economic, environmental and social) and management system standards. Table 1 shows a summary.

Table 1. Correspondence summary.

	Sustainability Variables	ISO 9001:2015	ISO 14001:2015	ISO 50001:2011	UNE 166002:2014	OHSAS 18001:2007
Economic	Financial and economic performance	O				
	Financial benefits	O				
	Cost management	O				
	Customer relationship management	O				
	Involvement of stakeholders	O			O	
	Business ethics					
	Innovation management				O	
	Organizational culture management				O	
Environment	Natural resources		O			
	Water		O			
	Energy		O			
	Air		O			
	Eco-efficiency		O			
	Management of environ. impacts		O	O		
	Environmental policy management		O	O		
	Env. commitment and responsibility		O	O		
Social	Labor practices	O				O
	Relationships with the local community					O
	Management of human rights	O				
	Stakeholder engagement	O				
	Relationships with society				O	
	Responsibility with products and services	O				O
	Relationships with suppliers and Contract	O				

The analysis reveals a strong correspondence between management system standards and sustainability. 22 of the 23 sustainability variables identified by the model considered are addressed by at least one of the five standards. On this basis, certifications to these standards are considered in this research as an indicator of the implementation of Sustainability in PM practice, thus allowing an objective assessment of the impact of Sustainability on project success, in other words, the consideration of Sustainability as a factor for success.

Appendix A includes Tables A1–A3 with the detailed relationship between the standards sections and the variables from the model by Martens and Carvalho. Table A1 shows how the economic variables in their model have a clear correspondence to requirements contained in the ISO 9001:2015 and UNE 166002:2014 management systems. For example, it can be seen that the 04 variable in the economic dimension of the model, which is "Customer relationship management", is addressed by several sections in ISO 9001:2015 (5.1.2 Customer focus, 6.1 Actions to address risks and opportunities, 8.2 Requirements for products and services and 9.1.2 Customer satisfaction). The same is detailed in Tables A2 and A3 for environmental and social variables. The environmental sustainability variables have a strong link with the ISO 14001:2015 and UNE 166002:2014 standards (Table A2). The social dimension corresponds to requirements established in ISO 9001:2015 and OHSAS 18001:2007 standards (Table A3). As already mentioned, the tables show which sections in the standards refer to which variables in the model.

2.3. Sustainability as a Success Factor in a Project (an Empirical Analysis)

2.3.1. Sample Description

The study of Sustainability as a project success factor is based on the analysis of an extensive database provided by the Center for Industrial Technological Development (CDTI). CDTI is a Public Business Entity under the auspices of the Ministry of Economy, Industry and Competitiveness, which promotes innovation and the technological development of Spanish companies, and channels requests for funding and support for the R&D&I projects of Spanish companies at national and international levels. The database contains information from 157 projects in the energy sector with a budget of €135 M in total, developed by 130 different companies. Economic funding has been granted to these projects by the CDTI between 2010 and 2012, and the implementation time ranges from 12 to 38 months. Analyzed data correspond to projects carried out between 2011 and 2017. The sample in the study is the totality of the database (157 projects). All data have been provided by the CDTI.

The delivery of reports including relevant data (financial situation and state of progress, among others) is one of the milestones that beneficiary companies must meet throughout the life cycle of the projects. Consequently, information contained in the database is provided to the CDTI directly by companies.

For each project, the information available includes:

- Year of the financial grant (between 2010 and 2012);
- Area: two possible values: IDI (R&D&I projects) and LBC (CDTI's bank credit line);
- Typology: this concept refers to the IDI area, and can be AEI (Technology Cooperation between SMESs), CID (Cooperation projects on R&D), CIE (Cooperation between International Enterprises), CIEN (Strategic Consortium Program on National Corporate Research), EEA (Financial mechanism of the European Economic Space), ID (Individual R&D projects), NE (Neotec), NE2 (Neotec 2), LIC (Direct Innovation Line), LIG (Global Innovation Line), PI (Integrated projects);
- Budget: projects are classified in four ranges: less than €350,000, between €350,000 and €700,000, between €700,000 and €1.4 M and more than €1.4 M,
- Duration: which ranges from 0 to 5 years;
- State: projects can be cancelled (overridden by the company after the Administrative Council's approval), virtually finished (already finished in financial terms, even if it is not physically completed), delayed (the project has suffered delays in the initial planning), normal development (the project develops normally), charges (reimbursement of the money is ongoing), finished (the project is completed and the money reimbursed), or consultancy (the company is currently in legal advice);
- Sector: energy.

Two fields have been added to the original database for the purpose of this research:

- Success. As has already been said, the concept of success is ambiguous, and not always defined in the same way [25]. In this case, success is considered and analyzed by CDTI after the information provided by companies regarding their financial performance. This information is translated into a "state" value, again by CDTI independent assessors. Then, the "success" variable has been created by the authors directly from the state of the project. For the purpose of this research, projects in the "cancelled" or "consultancy" state have been considered as unsuccessful. These states correspond to projects that were terminated once the funding had been awarded ("cancelled") and to projects that are subject to legal proceedings after experiencing economic problems during the life cycle ("consultancy"). On the other hand, the remaining states correspond to projects that are performing as planned, even when they may be in different phases of progress in the time of the study. This definition of success has two implications. First one is that it is guaranteed that the success assessment, has been done by impartial agents (CDTI assessors), who are independent from the companies and apply an agreed criteria for all the projects under study. Second relevant implication to be recognized is that assessment of the success is partial. The evaluation of the success of a project is a complex question, and many factors/dimensions/constructs can be taken into account, as we describe in the literature review (Section 1.2). Moreover, some project success criteria (long-term criteria) can only be evaluated time after the project is closed, and require additional data. Unfortunately, these data are not available at the moment and are out of the scope of this research. This is identified as a limitation of the results in Section 4.

- Management system certifications. For each of the companies involved in the energy sector projects, the standards for which they were certified have been identified. This information has been collected by means of two methods: searching the companies' websites (as a first approach) and personal calls (as a second approach). The complexity and cost of compiling this information has been one of the reasons why the study has been restricted to the energy sector. The standards considered are ISO 9001, ISO 14001, OHSAS 18001, UNE 166002, ISO 500001, and regulations related to the specific activity of the company (for example, ISO 3834-2, for fusion welding). The fact that a company has a certification in one of these standards means that management system requirements are met and also that it is supervised and supported by an external auditor. Since information that has been added to the database regarding management systems corresponds to certifications by competent and recognized companies, there is a guarantee that it is true and impartial.

Figure 1 shows a numerical description of the sample. Figure 1a provides the distribution of the duration in which, for simplicity, the data has been grouped into 4 categories (0–12, 13–24, 25–36, >36 months). The duration of the projects is shown in months. The minimum duration of the projects analyzed is 12 months and the maximum is 38 months. Forty percent of the projects have a duration of 24 months. The other sixty percent is distributed uniformly between 12 and 38 months.

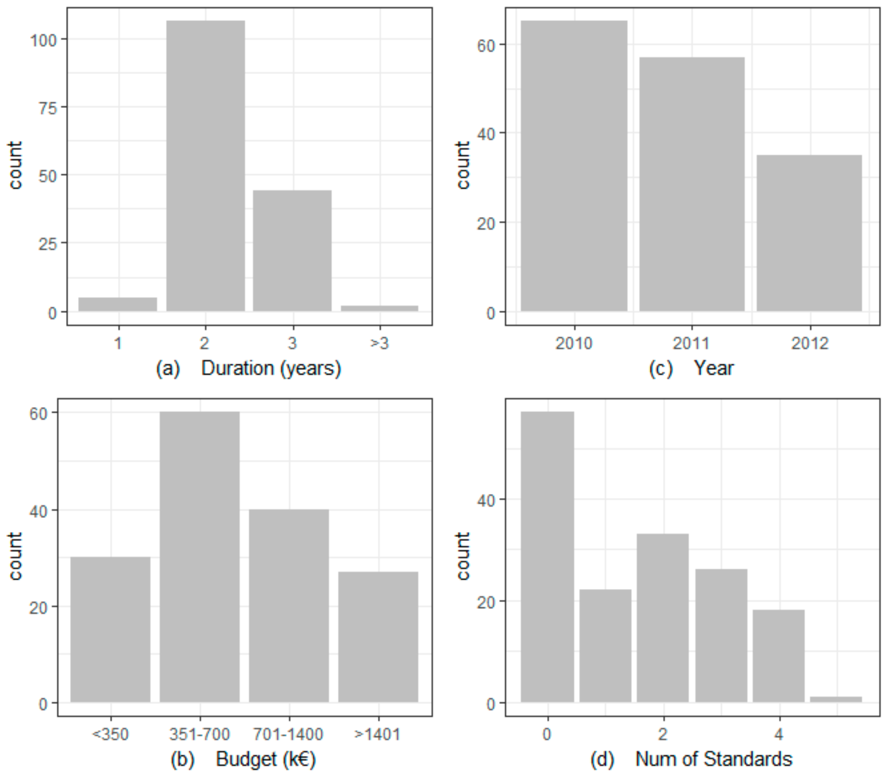

Figure 1. Number of projects classified according to the variables: duration, budget, year of application and number of certifications.

Each project is classified into four categories based on the budget. The number of projects in each category is shown in Figure 1b. Most projects have a budget of between €350,000 and €700,000. As expected, there is a positive correlation between budget and duration variables. Table 2 provides the joint distribution of these two variables.

Figure 1c provides the bar diagram corresponding to the year of application for grant of the project. Most of the projects started the year following their application. Finally, Figure 1d shows the distribution of the projects according to the number of standards (ISO 9001, ISO 14001, OHSAS 18001, UNE 166002, ISO 500001) in which the company is certified. 57 companies do not have any certification. There is only one company with five certifications.

Table 2. Number of projects in the database according to duration and budget.

Duration Interval (Months)	Budget Intervals (k€)			
	0–350	**351–700**	**701–1400**	**>1401**
0–12	5	0	0	0
13–24	19	49	30	8
25–36	6	10	10	18
>36	0	1	0	1

2.3.2. Statistical Research Method

This research aims to establish the influence of four variables (duration, budget, year of application for the funding and management system certifications) on the success of the project. Taking the available information into account, the simplest way to study it is through the analysis of the chi-square test applied to the contingency tables. Specifically, in the problem that concerns us, the chi-square test allows us to test whether the probability of success (or failure) of a project depends on each of the variables. For example, if the success of the project depends on the budget. The chi-square test is a well-known technique. A precise explanation can be found in many statistics textbooks ([47] is a highly recommended reference). Basically, it consists of comparing the frequencies observed in a table made up of rows and columns with the values that would be expected if the two variables were independent. In Appendix B, the contingency tables and the chi-square tests are provided for the fundamental comparisons of this work (management system certifications). Calculations for the remaining variables considered (duration, budget, year or funding) have been made in the same way; however the tables have not been included in this article for clarity and simplicity.

In order to study the joint effect of explanatory variables on the success of the project, a logistic regression model has been used. The analysis indicates a high multicollinearity among the regressors, which greatly complicates the interpretation of the results. In addition, the number of observations (157) is too low to take into account the simultaneous effect of all categorical factors. Taking this into account, it has been preferred to use the chi-square independence test, which is simple and easy to interpret. The tests performed show a surprising and interesting result; of all the explanatory variables studied, the ones that are most important for explaining project success are those associated with certifications. The statistical analysis carried out has an exploratory character. The results obtained show indications that must be corroborated by subsequent studies based on a larger and random sample.

3. Results

The analysis tests the influence of the four variables considered (duration, budget, year of application for the funding and management system certifications) on the success of the project. Of the 157 projects analyzed, 114 were completed successfully. The remaining 47 have been considered as unsuccessful (27.4%), according to the success criteria adopted. Figure 2 shows the number of projects that were successfully completed based on the aforementioned four variables.

Applied to the aforementioned variables, the chi-square test indicates that the success of the project does not depend on the duration of the project (p-value = 0.3068); it does not depend on the year of application (p-value = 0.3743); and does not depend on the budget (p-value = 0.06147). However, it depends very significantly on the number of certifications of the company (p-value = 0.0004998). These results can be observed in the bar diagrams in Figure 2. The observed proportion of successful projects is much greater in companies with more than two certifications than in companies with one or none. The p-value corresponding to the budget variable is very close to the level of significance usually used (alpha = 0.05). According to this, there are indications that the success of the project is more likely for projects with high budgets. In any case, of all the variables studied, the one that shows a clear and significant association with the success of the project is the number of certifications.

Next, the effect of the five certifications considered in the success (or failure) of the project is studied one by one. The chi-square test in a table with two rows and two columns (which is the case in question, see Appendix B), coincides with the comparison of two proportions. In this case, it coincides with the proportion of success in the projects with a standard or without a standard. Table summarizes the results obtained for the five standards studied. The first row shows that 37.4% of the projects developed by non-certified companies in ISO-9001 failed, while this percentage is reduced to 21.4% for certified companies. The reduction is significant from the statistical point of view. The p-value of the chi-square test of equality of proportions is 0.031, less than the usual significance level (alpha = 0.05).

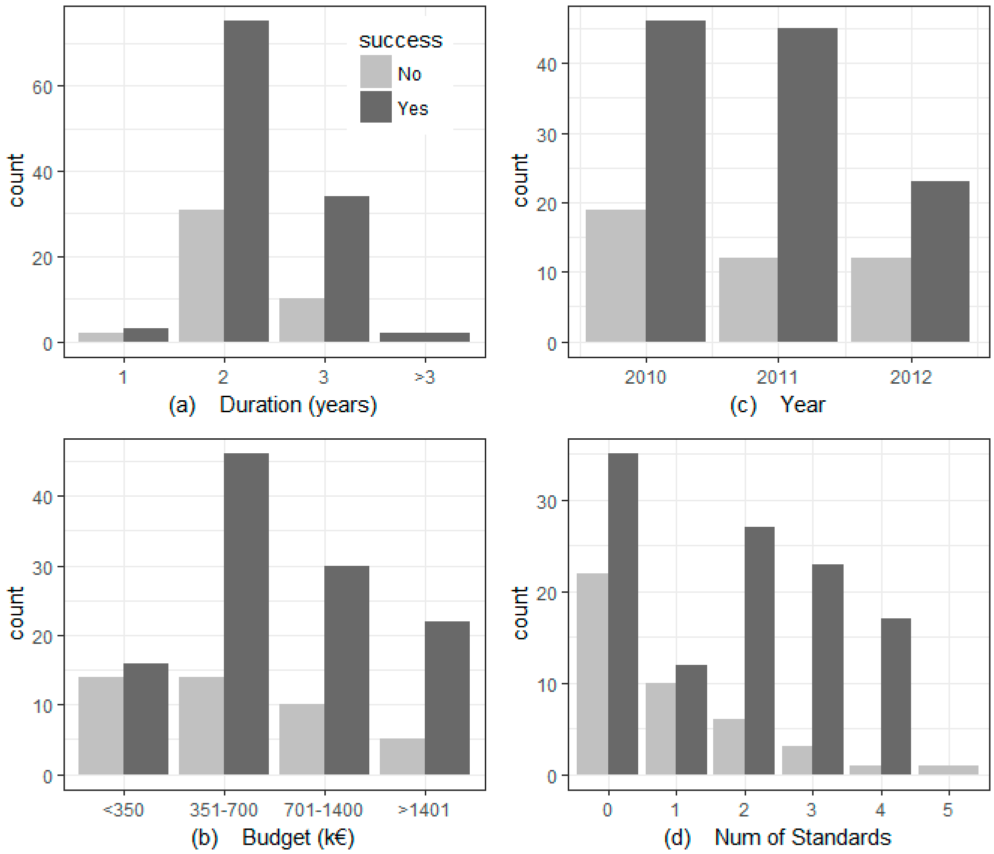

Figure 2. Project success observed based on the variables: duration, budget, year and number of certifications.

It can be seen (Table 3) that in all cases, for any standard, the fact of being certified reduces the proportion of failures. In three of the cases, the difference is statistically significant (ISO 9001, ISO 14001 and OHSAS 18001). In the other cases (ISO 5001 and UNE 166002), the difference is large, but, due to the small number of certified companies, the differences are not significant. The relevant conclusion drawn from these results is that the probability of failure is significantly lower in the projects carried out by certified companies.

Table 3. Failure probability by standards.

Standard	No Certified	Certified	*p*-Value
ISO 9001	37.4%	21.4%	0.03
ISO 14001	41.0%	13.9%	0.000
ISO 50001	28.6%	10.0%	0.203
UNE 166002	29.1%	12.5%	0.203
OHSAS 18001	32.5%	12.5%	0.014

The first row in Table 3 shows that 37.4% of the projects developed by non-certified companies in ISO 9001 have failed, while this percentage is reduced to 21.4% for certified companies. The reduction is significant from the statistical point of view. The *p*-value of the chi-square contrast of equality of proportions is 0.031, less than the usual significance level; alpha = 0.05.

For ISO 14001, Table 3 highlights that the percentages of the failed projects with and without the standard (13.9% with regard to 41%), is significantly different (more significant than in the previous case). In this case, the chi-square statistics are very high (14.496) and the *p*-value obtained in this case that is 0.00, less than 0.05, meaning that certification to ISO 14001, focused on the environmental management in the energy sector, also increases the probability of successful projects.

As for the ISO 50001 analysis, if just the chi-square indicator is taken into account, there is no significant difference between companies with and without certifications in terms of project success, since the calculated value is 1.624 (quite low) and the result of the *p*-value indicator is 0.203, (more than 0.05). Consequently, these two factors reveal that the impact of ISO 50001 is not significant. However, it is important to note that the available sample is relatively small (only 10 projects out of 157), which may directly affect the results.

As regards R&D&I management system, results are a quite low chi-square statistic (1.986) and *p*-value 0.159 (higher than 0.05), which may be regarded as a non-relevant difference between the success of projects in certified and non-certified companies. Therefore, from this point of view the difference of having the UNE 166002 certificate or not is not significant.

For ISO 50001 and UNE 166002 there is a common consideration to be made. In both cases the number of projects is small (10 and 16 projects respectively, out of 157). Available data suggest that if we increased these numbers the results would vary towards a significant relevance for these standards.

Last, as detailed in Table 3, the percentage of failed implemented projects in companies having the standard OHSAS 18001 is significantly lower than in those companies that do not have this certificate (12.5% as opposed to 32.5%). The probability of success is higher than the ISO 9001 but lower than the ISO 14001. This has been confirmed by the chi-square indicator, which is 5.983 (high) and the *p*-value obtained in this case that is 0.014, less than 0.05, meaning that OHSAS 18001 certification, focused on the health and safety management in the energy sector, increases the probability of successful projects.

All the details of the analysis carried out for each of the standards are provided in Appendix B.

4. Discussion and Conclusions

This research has addressed two questions regarding Sustainability in PM: the possibility of considering management system standards as a tool for the practice of sustainability and the identification of Sustainability as a success factor in PM.

Section 2.2 has addressed the first question. The analysis has shown a clear relationship between the management systems standards and Sustainability. The standards ISO 9001, 14001, 50001, UNE 166002 and OHSAS 18001 cover the three considered dimensions (economic, environmental and social). Requirements and recommendations established by these standards can be used by professionals in order to implant sustainability practices in their companies and projects.

This conclusion is a contribution to the present need to bring sustainability considerations in PM into practice. Moreover, the fact that these standards have a strong correspondence with Sustainability dimensions also suggests that certifications can be used as an objective indicator of the implantation of sustainability aspects in PM.

Regarding the relationship between Sustainability and success in projects, the article illustrates how organizational aspects of the company help achieve the objectives of the projects it develops. Specifically, it shows how companies that are more aligned with sustainability objectives are more successful in the development of their projects. The methodology of the work carried out does not serve to demonstrate the existence of a cause and effect relationship between sustainability and project success, but it does show a clear association between the two concepts. The conclusions of the work have been obtained after the analysis of 157 research projects financed by the CDTI, (a Spanish public institution) developed by companies in the energy sector. The alignment of a company towards sustainability goals has been measured by studying the standards in which the company is certified. Although it is not a perfect way to measure the company's involvement with sustainability, it is an objective, real and verifiable indicator of this attitude.

Statistical analysis shows that certifications have a positive impact on project success. In the same study, it is observed that the probability of success of a project does not depend on its budget or duration. The analysis performed allows us to show a result that we found surprising and interesting. Of all the variables studied, the ones that are most important to explain the project success are the variables associated with the certifications. This conclusion is limited to the analyzed sample, which refers to projects in the energy sector in Spain granted by CDTI between 2010 and 2012. There is a varied sample of projects, made by very different companies, with different budgets and complexities. The evaluation of the projects is homogeneous and very objective. In this sense, the available data are very useful for the exploratory analysis carried out. Care must be taken when extrapolating the results obtained to other contexts than those analyzed; however, the authors find the results illustrative enough to affirm that sustainability aspects can be considered as a success factor. This may encourage companies to improve their results by incorporating sustainability considerations into their operative frameworks through certification tools.

In this context, it must be taken into account that success has been evaluated by the observation of a single criteria, related to the economic performance of the project in the moment when the analysis has been done. This is an objective truthful indicator, but other criteria (such as stakeholders satisfaction, appreciation by clients, appreciation by project personnel) have not been consider, which is a limitation of the research.

Another limitation of this work is the fact that Sustainability implementation as a success factor has been restricted to the existence of certifications to the considered management systems as an indicator. Other standards or management frameworks out of the scope of this research may also include references to the practice of Sustainability. However, in order to base the study on precise true information (guaranteed by external certifications in our case), it has been necessary to focus on a limited set of standards.

Future research lines could also be based on the analysis of projects from other sectors (different from the energy sector), to determine whether the impact of certifications also has such a clear impact on project success or not.

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Appendix A

This appendix contains Tables A1–A3, in which all the sustainability variables per dimension are presented with the correspondence to the sections in the selected standards.

Table A1. Correspondence between economic dimension and management systems standards.

Economic Sustainability Variables	ISO 9001:2015	UNE 166002:2014
Econ01 Financial and economic performance	8.5 Production and service provision	
Econ02 Financial benefits from good social and environmental practices	9.1.3 Analysis and evaluation	
Econ03 Cost management	7.1.5 Monitoring and measuring resources	
Econ04 Customer relationship management	5.1.2 Customer focus 6.1 Actions to address risks and opportunities 8.2 Requirements for products and services 9.1.2 Customer satisfaction	
Econ05 Participation and involvement of stakeholders	4.2 Understanding the needs and expectations of interested parties	4.2 Interested parties approach
Econ06 Business ethics		
Econ07 Innovation management		4.1 Organization and its context approach 4.3 R&D&I management system
Econ08 Organizational culture management		Econ08 Organizational culture management

Note to Table A1: ISO 14001:2015, ISO 50001:2011 and OHSAS 18001:2007 do not have a clear correspondence to economic Sustainability variables.

Table A2. Correspondence between environmental dimension and management systems standards.

Environmental Sustainability Variables	ISO 14001:2015	ISO 50001:2011
Environ01 Natural resources	Leadership 5.2 Environmental policy 6 Planning 6.1 Actions to address risks and opportunities 6.2 Environmental objectives and planning to achieve them	
Environ02 Water	6 Planning 6.1 Actions to address risks and opportunities	
Environ03 Energy	6 Planning 6.1 Actions to address risks and opportunities	
Environ04 Air	6 Planning 6.1 Actions to address risks and opportunities	
Environ05 Eco-efficiency	6 Planning 6.1 Actions to address risks and opportunities	
Environ06 Management of environmental impacts	4.4 Environmental management system 6 Planning 6.1 Actions to address risks and opportunities 6.2 Environmental objectives and planning to achieve them	4 Energy management system requirements 4.5 Implementation and operation
Environ07 Environmental policy management	4.4 Environmental management system 5.2 Environmental policy 6 Planning 6.1 Actions to address risks and opportunities 6.2 Environmental objectives and planning to achieve them	4 Energy management system requirements 4.3 Energy policy 4.4 Energy planning

Table A2. *Cont.*

Environmental Sustainability Variables	ISO 14001:2015	ISO 50001:2011
Environ08 Environmental commitment and responsibility	4.4 Environmental management system 6 Planning 6.1 Actions to address risks and opportunities 6.2 Environmental objectives and planning to achieve them 7.3 Awareness	4 Energy management system requirements 4.2 Management responsibility

Note to Table A2: ISO 9001:2015, UNE 166002:2014 and OHSAS 18001:2007 do not have a clear correspondence to economic Sustainability variables.

Table A3. Correspondence between social dimension and management systems standards.

Social Sustainability Variables	ISO 9001:2015	UNE 166002:2014	OHSAS 18001:2007
Social01 Labor practices	7.1.4 Environment for the operation of processes 7.1.6 Organizational knowledge 7.2 Competence		4 OH&S management system requirements 4.2 OH&S policy 4.4 Implementation and operation
Social02 Relationships with the local community			4.2 OH&S policy
Social03 Management of human rights	7.1.2 People		
Social04 Stakeholder engagement	7.3 Awareness		
Social05 Relationships with society		4.1 Organization and its context approach 5.4 Innovation culture	
Social06 Responsibility with products and services	9.1 Monitoring, measurements, analysis and evaluation 10. Improvement		4.3 Planning 4.3.1 Hazard identification, risk assessment and determining controls
Social07 Relationships with suppliers and contractors	8.4 Control of externally provided processes, products and services		

Note to Table A3: ISO 14001:2015 and ISO 50001:2011 do not have a clear correspondence to economic Sustainability variables.

Appendix B

This Appendix B describes the calculations made to compare the proportions of success (or failure) for each of the standards in terms of having or not having the certifications.

For each one of the considered standards, results are presented in a table and a plot. Some different elements can be found inside the table:

- Count: number of real projects, those are the projects that the database shows as successfully accomplished or not.
- Expected count: number of theoretical projects, which means that the statistical software establishes the relationship between the final percentage of all the successful projects and not successful projects and the real percentage in each case (if comply with the standard or not). From this relationship of percentages, the software establishes how many projects should theoretically be successfully implemented.
- % within (standard): percentage of real projects over the total number of real projects.
- Residual: difference between the number of real project and theoretical projects.

Appendix B.1 ISO 9001

Results of the statistical analysis for ISO 9001 are summarized in Table A4. Values obtained for chi-square statistic (4.658) and *p*-value (0.031, lower than 0.05) suggest that ISO 9001 certification has a positive impact on project success.

Table A4. ISO 9001 certification and project success.

			Success		Total
			NO	YES	
ISO-9001	No	Count	22	37	59
		Expected Count	16.2	42.8	59.0
		% within ISO-9001	37.3%	62.7%	100.0%
		Residual	5.8	−5.8	
	Yes	Count	21	77	98
		Expected Count	26.8	71.2	98.0
		% within ISO-9001	21.4%	78.6%	100.0%
		Residual	−5.8	5.8	
Total		Count	43	114	157
		Expected Count	43.0	114.0	157.0
		% within ISO-9001	27.4%	72.6%	100.0%

chi-square indicator = 4.658; *p*-value = 0.031.

Appendix B.2 ISO 14001

Results of the statistical analysis for ISO 14001 are summarized in Table A5. Values obtained for chi-square statistic (14.496) and *p*-value (0.00, lower than 0.05) suggest that ISO 14001 certification has a positive impact on project success.

Table A5. ISO 14001 certification and project success.

			Success		Total
			NO	YES	
ISO-14001	No	Count	32	46	78
		Expected Count	21.4	56.6	78.0
		% within ISO-14001	41.0%	59.0%	100.0%
		Residual	10.6	−10.6	
	Yes	Count	11	68	79
		Expected Count	21.6	57.4	79.0
		% within ISO-14001	13.9%	86.1%	100.0%
		Residual	−10.6	10.6	
Total		Count	43	114	157
		Expected Count	43.0	114.0	157.0
		% within ISO-14001	27.4%	72.6%	100.0%

chi-square indicator= 14.496; *p*-value = 0.000.

Appendix B.3 ISO 50001

If we only pay attention to the chi-square indicator, there is no significant difference between companies with and without certifications in terms of project success, since calculated value is 1.624 (quiet low) and the result of the *p*-value indicator is 0.203, (higher than 0.05). See Table A6.

Table A6. ISO 50001 certification and project success.

			Success		Total
			NO	YES	
ISO 50001	No	Count	42	105	147
		Expected Count	40.3	106.7	147.0
		% within ISO 50001	28.6%	71.4%	100.0%
		Residual	1.7	−1.7	
	Yes	Count	1	9	10
		Expected Count	2.7	7.3	10.0
		% within ISO 50001	10.0%	90.0%	100.0%
		Residual	−1.7	1.7	
Total		Count	43	114	157
		Expected Count	43.0	114.0	157.0
		% within ISO 50001	27.4%	72.6%	100.0%

chi-square indicator = 1.624; *p*-value = 0.203.

Appendix B.4 UNE 166002

In this case, (Table A7), results are a quite low chi-square statistic (1.986) and *p*-value 0.159 (higher than 0.05), which reveals no significance for the UNE 166002 as a success factor.

Table A7. UNE 166002 certification and project success.

			Success		Total
			NO	YES	
UNE 166002	No	Count	41	100	141
		Expected Count	38.6	102.4	141.0
		% within UNE 166002	29.1%	70.9%	100.0%
		Residual	2.4	−2.4	
	Yes	Count	2	14	16
		Expected Count	4.4	11.6	16.0
		% within UNE 166002	12.5%	87.5%	100.0%
		Residual	−2.4	2.4	
Total		Count	43	114	157
		Expected Count	43.0	114.0	157.0
		% within UNE 166002	27.4%	72.6%	100.0%

chi-square indicator = 1.624; *p*-value = 0.203.

Appendix B.5 OHSAS 18001

Results of the statistical analysis for OHSAS 18001 are summarized in Table A8. Values obtained for chi-square statistic (5.983) and *p*-value (0.014, lower than 0.05) suggest that OHSAS 18001 certification has a positive impact on project success.

Table A8. OHSAS 18001 certification and project success.

			Success		Total
			NO	YES	
OHSAS-18001	No	Count	38	79	117
		Expected Count	32.0	85.0	117.0
		% within OHSAS-18001	32.5%	67.5%	100.0%
		Residual	6.0	−6.0	
	Yes	Count	5	35	40
		Expected Count	11.0	29.0	40.0
		% within OHSAS-18001	12.5%	87.5%	100.0%
		Residual	−6.0	6.0	
Total		Count	43	114	157
		Expected Count	43.0	114.0	157.0
		% within OHSAS-18001	27.4%	72.6%	100.0%

chi-square indicator= 5.983; *p*-value = 0.014.

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