

Article

# New Approach for Managing Sustainability in Projects

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**Abstract:** Despite the work done to date, project sustainability management (PSM) is still at an embryonic stage. The existing literature considers sustainability as a transversal aspect to be incorporated into the traditional management functions (scope, time, cost, quality, etc.). This article proposes sustainability as a key aspect of project management, with three essential components: principles, processes and competences. Regarding principles, the principle of sustainable development should be added to those generally suggested. As for processes, seven are proposed for (1) planning sustainability management; (2) establishing a sustainability breakdown structure; (3) defining the sustainability objective; (4) identifying project alternatives to achieve it; (5) planning and (6) implementing the sustainability strategy; and (7) monitoring and control. The main interrelationships between these processes and those of project initiation, planning, implementation, control, and closure are also analysed. In addition, the competences that the project manager should have in this field are identified, as well as the main criteria to take into account in order to adapt PSM processes to the characteristics of the project and the organisation. Finally, the results of a Delphi analysis carried out to validate these proposals are presented.

**Keywords:** sustainability; project management; processes; competences



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## 1. Introduction

### 1.1. General Aspects: Objective

Sustainable development and integral or global sustainability are two topics that have gained enormous popularity in recent years. Their meaning [1,2] goes beyond purely environmental aspects, including also economic, social and ethical issues. Consequently, companies are increasingly under social pressure to incorporate sustainability in their business activities [3–5]. Nevertheless, conventional practices are not adequate for sustainable project management [6]. In fact, the main standards and guidelines (PMBOK (Project Management Body of Knowledge), IPMA (International Project Management Association) ICB (Individual Competence Baseline), among others) hardly deal with sustainable development.

In this sense, academia has begun to pay attention to how to integrate sustainability principles into project management [5], with the aim of preserving natural resources and, at the same time, generating positive impacts on the society and economy [4]. It is important to note that this is not a trivial task [7,8], since sustainability can be seen as a counter-objective to conventional project management where short-term economic profitability is often the main priority [9]. Furthermore, life-cycle economic, social and environmental aspects are usually competing objectives, which makes it necessary to find a compromise solution among them [3]. This makes the implementation of sustainability in management

systems even more difficult [7,10]. There are significant problems, barriers and obstacles, of very different types, to achieve sustainable project management [11–18].

Notwithstanding the above, some authors have conducted research on sustainability in project management, although all of them have taken a different approach from the one adopted in this study. By way of example, Brook and Pagnanelli [19] developed a framework for integrating sustainability in project portfolio management processes. The authors considered a case study in the automotive industry. In a similar line, Marcelino-Sádaba et al. [9] proposed a new conceptual framework with the aim of assisting project managers in dealing with sustainable projects. Carvalho and Rabechini [8] developed a new model for project sustainability management, adopting both project and product approaches. More recently, Sabini et al. [3] studied the potential impacts of sustainability on conventional project management practices at micro (individual), project and macro (entire project environment) levels. Some authors researched the role that project managers play at the time of addressing sustainability issues [20,21]. In particular, Silvius and de Graaf [20] identified the main factors that make project managers to discuss about sustainability issues with the project board. They used the Theory of Planned Behaviour (TBA) as the starting point for their study. In Reference [21], Silvius and Schipper also used TBA to carry out a similar study. In this case, the authors analysed the main factors that lead project managers to include sustainability issues in their projects. In this connection, Toljaga-Nikolic et al. [22] determined the skills and knowledge that managers must have to achieve sustainable project management in public and private sectors.

On the other hand, Dobrovolskiene et al. [23] proposed a new index to assess the sustainability of real estate projects. The authors included the technological dimension, in addition to the three usual ones. A simple additive weighting approach was adopted to aggregate the criteria selected by the authors. A new sustainability index was also constructed in Reference [4] to help decision makers in terms of resource allocation and project portfolio selection. This new tool was primarily conceived for the construction industry. In this line, the reader can find in Lima et al. [24] a comprehensive literature review of sustainability issues in the civil engineering sector. Similarly, Goel et al. [25] performed a systematic literature review on sustainability integration at the time of managing construction projects. With a broader approach, Armenia et al. [5] carried out a literature review on the integration of project management and sustainability. They also identified the most relevant factors for such integration.

It is important to note that many of the existing studies manage the goal of sustainability by focusing almost exclusively on the environment and, in particular, on environmental life cycle analysis (LCA). In other cases, life cycle costing (LCC) is also analysed. To the best of the authors' knowledge, after reviewing the existing literature so far, sustainability is addressed by adopting a transversal approach. In other words, authors propose modifications to conventional management functions (scope, time, cost, etc.), instead of devising a new managerial function to establish a sustainability objective for the project and meeting it. This, at best, leads to small sustainability improvements to projects and products [26]. Therefore, general conclusions of the current state of knowledge are not flattering [27–29]. These are the reasons why the approach proposed here is necessary.

Many aspects of the current situation, in many fields and sectors of industry, are due, among other reasons, to the absence of a project sustainability management approach, especially on the part of financial institutions, promoters, and legislating bodies. The lack of ethics in corporate decisions in the financial business has also played a major role. It should not be forgotten that ethics is an essential component of sustainability. All this is caused by the lack of long-term corporate policies that are truly aligned with sustainable development.

The objective of this article, aimed at researchers and practitioners, is to define proposals, within the framework of project management, on how to establish, control and, in general, manage the project's sustainability objective, in order to ensure its fulfilment. By adopting the proposals here presented, it will be possible not only to obtain more sustainable deliverables (products, services or processes) but also to integrate sustainability in the

management of processes. In other words, sustainability integration will be achieved at the level of both content and processes [20,25]. Consequently, there will be practical implications for the society, environment, and also for the organisations adopting the proposals. More sustainable project deliverables and management practices should lead to: more efficient use of resources, raw materials and energy (less consumption and, consequently, less negative impacts on the planet), stakeholder participation in the decision-making processes, and secure and quality jobs creation (employee-friendly companies), among many other positive impacts [18]. All of this without losing sight of most companies' main objective: to be economically profitable. In this connection, companies are likely to increase their profits. There are several reasons for that. On the one hand, lower resource and energy consumption will result in a cost reduction. Furthermore, the integration of sustainability issues will also provide a reputational benefit compared to companies that follow the traditional model, generating an increase in sales and revenues [18]. In fact, the companies that are more likely to survive and to achieve business success in the future will be those that effectively integrate sustainability [22].

On the other hand, not all the practical implications for the companies are positive. There can be important differences among large, medium and small-sized organizations, since they do not have the same level of resources and, therefore, the same capacity to make the necessary changes. Furthermore, project management is a very complex subject in itself, so the introduction of new procedures may not be welcomed by many project managers and organisations. In this context, a cultural change is needed, in which universities must be the driving force for knowledge generation [30,31]. Therefore, we believe that studies like the one presented here are necessary to help the development and entrenchment of a mind-set to consider sustainability aspects in project management, providing a guarantee for our future [22].

The proposals are applicable to any type of project. However, given the professional background and experience of the authors, some of the reflections and examples included here refer to the construction sector. On the other hand, although most of the aspects discussed may be applicable in an agile approach, they have been conceived in a traditional, predictive project management context. Analysing potential differences between the two approaches, for sustainability purposes, is beyond the scope of this paper.

As previously mentioned, the significance of the proposals included here is due, firstly, to the need to correct the current situation of important environmental impacts, unfortunate social differences, and short-term economic approaches.

Today, increasingly, most public and private organisations meet their corporate objectives through programmes and projects. This is particularly clear in some sectors, such as construction. Since programmes and project portfolios are nothing more than sets of projects, the need and interest to work at the project level is evident. Now is the time to prepare for the future by encouraging a holistic approach to sustainability in project management professionals.

However, it should be kept in mind that the project manager will not be able to do much if there is no clear commitment to sustainability on the part of programme managers, project portfolio managers and, above all and especially, corporate management. More precisely, the key lies in the top management of the promoter. Although this article considers the framework of project management, the aspects of sustainable programme and portfolio management are also outside the scope of this paper.

### *1.2. Methodological Aspects*

There are different approaches for establishing useful standards, processes or models managing projects. Some, such as the PMBOK [32], have traditionally been based on knowledge areas (integration, scope, time, cost, etc.) and on the use of management processes for each one. In turn, within each process, they define (1) potential inputs to be employed; (2) methods, techniques, models, and tools to be used; and (3) outputs to be

generated. Others, such as the ICB [33] have focused more on the competences that the project manager must acquire in order to succeed in his or her mission.

Some, which are of great general usefulness, especially in cases of limited knowledge or experience on the part of the project manager, are based on activities to be carried out and their interrelationships, in the form of activity graphs, or flowcharts, including clear descriptions of the mission or purpose of each activity, the techniques or tools to be used, and the results to be obtained (e.g., [34]). The usefulness is even greater when the method is adaptable to the size and complexity of the project, and the maturity of the organisation carrying it out, among other aspects [35].

In fact, some process-focused standards have been evolving, complementing their methodological guidelines with flowcharts of interrelationships between sub-processes, and providing certain recommendations on how to adapt their processes to different types of projects and organisations (see, for example, [32]).

It seems that the evolution will continue. For example, the Project Management Institute (PMI) [36], wants to frame its process approach with:

- A generic vision aimed at any type of project approach, whether traditional (predictive), agile, or hybrid (combination of them).
- The concept of performance domain, defined as a group of interrelated activities that are critical to achieve the desired results of the project (planning, team, stakeholders, uncertainty, among others).
- Principles to be applied, which are not prescriptive, and which describe a fundamental truth, rule or value, that increases the probability of success in achieving the expected results. The Project Management Institute considers the following to be appropriate principles for project management:
  - Be a diligent, respectful and committed steward;
  - Build a project team within a framework of accountability and respect;
  - Engage stakeholders to understand their interests and needs;
  - Focus on value;
  - Employ holistic thinking;
  - Lead by motivating, influencing, guiding, and learning;
  - Adapt the project approach according to its context;
  - Achieve quality in management processes and project results;
  - Addressing complexity by using knowledge, experience and learning;
  - Manage opportunities and threats;
  - Be adaptable and resilient;
  - Manage change appropriately to achieve the desired future state.

The authors of this paper believe that the most useful methodologies are those that bring together all the aspects referred to in this section. They also consider that it is necessary to go further, by adopting a new approach.

The existing literature considers sustainability as something transversal to the traditional project management processes (integration, scope, time, cost, etc.). This paper considers that, although still cross-cutting, sustainability should be a key core aspect of project management. To apply the appropriate management processes to ensure that the scope, time, cost and quality objectives are met, is not enough. There must also be a sustainability objective, with its corresponding management processes.

The ideas discussed up to this point constitute the essential foundations of this article. Due to the limited space available in this type of publication, it is not possible to include much detail here. However, Sections 3.2 and 3.3 refer to the main inputs and outputs of project sustainability management (PSM) processes, and the main tools and techniques to be used. In addition, Section 3.3 includes the essential ideas to generate potential process flowcharts, since it includes the main interrelationships between the PSM processes and the other project management processes.

Finally, in the medium to long term, the authors of this paper consider that a complete paradigm change is necessary, accepting that sustainable development should be the

essential principle of project management, above all others. Consequently, the project's sustainability objective should be prioritised over the other ones.

## 2. Materials and Methods

Three of the authors have extensive experience in project management, and all of them teach or have taught energy and construction engineering subjects, in which they have included sustainability aspects (sustainable design, sustainability assessment and optimisation). Three of them started to do so more than 20 years ago. In 2014, two of the authors decided to incorporate sustainability into the subject of project management, as part of a Masters degree in Industrial Engineering. After analysing the state of the art at the time, they realised that the approach advocated was always cross-cutting, incorporating aspects of sustainability into traditional project management processes (scope, time, cost, etc.). However, they addressed their teaching by establishing a set of processes to define and meet the project's sustainability objective. In 2015 they published their first ideas in this regard [37]. Since then, these ideas have evolved through (1) consultation of the literature on the subject; (2) ongoing reflection by lecturers in their teaching activity; (3) questions and discussions with students, many of whom are both studying and working; (4) feedback from private sector professionals; and (5) various research activities on sustainability carried out with the other two authors of this article. In 2021, it was found that the state of the art was still focused on cross-cutting issues, and it was considered appropriate to disseminate the new proposals more widely, as they had already reached a certain level of maturity.

In order for the proposals to have a greater capacity to influence the professional community, they have been written in such a way that they can be integrated into the two most widely used certification standards: the PMBOK [32] and the IPMA ICB [33].

Finally, to carry out a first validation, a Delphi analysis has been carried out. Two iterations have been made. Opinions and evaluations were obtained from 17 people, with (minimum, average, maximum) professional or academic experience of (7, 25, 50) years in project engineering and management. The university education of these experts is varied (BE Product Design; BSc Electrical, Mechanical, and Industrial Engineering; MSc and PhD Industrial Engineering; BSc, MSc and PhD Chemical Engineering; BSc, MSc and PhD in Civil Engineering; BSc, MSc and PhD in Agricultural Engineering; MS in Project Management; MS in Environmental and Occupational Risks; MBA). All of them have more than one university degree. Seven of them are or have been certified as project management professionals, by either the PMI or the IPMA.

They worked in agricultural, rural development, equipment manufacturing, construction (building, industrial plants, public infrastructures), urban planning, energy, information technology, organisational change, educational, and R&D&I projects, both domestically and internationally. Some of them also worked in engineering and project management consultancy.

The positions of these people throughout their professional career in the private sector are also varied, including project engineer, consultant, senior researcher, project manager, Engineering and Consultancy Manager, Supply Chain Manager, Operations Manager, Managing Director and CEO positions. As for the ones in academia, these persons currently hold the positions of Associate or Full Professor, and almost all of them have previous experience in the private sector.

After a full explanation of all the aspects covered in this work, the respondents answered questions related to the likelihood that the top management would support these ideas in their organisations, and to the feasibility of implementing these proposals. They also evaluated the approach as a whole. In all cases, a discussion took place in which the interviewees brought a variety of opinions and ideas, many of which have been summarised in this article.

### 3. Methodological Foundations for Sustainability Management

#### 3.1. Introduction: The Need for an Appropriate Methodological Approach

It is increasingly common, for projects of different types, to establish a sustainability objective. Subsequently, the designer identifies the conditions that must be met to achieve it, and establishes a design, technical specifications and budget to achieve that objective. An example of this, in construction projects, is setting a LEED (Leadership in Energy and Environmental Design) or Envision certification target [38,39].

Sustainability can be measured in other ways, by means of environmental [40–42], social [43–45] and economic [46–49] life cycle assessment (LCA), together with the subsequent integration of the results of the LCAs, using an appropriate multi-criteria decision support method [50]. The corresponding integration variable can have different names. In the case of a certification system, this variable takes semantic values (Level A, B, C or D; or LEED platinum, gold or silver). In other cases, it takes a numerical value. In general, this type of variable will be referred to here as the Sustainability Index (SI), be it a number or a semantic label.

As with time or cost, one of the problems often faced by the project manager in the early stages of the project, when estimating the potential SI of a project, is related to the uncertainty affecting the value that sustainability indicators will eventually take.

Inevitable project changes can lead to a product not being manufactured, a work not being executed, or a service not being provided as planned. This can be detrimental to the final SI. In these cases, it is sometimes possible to implement corrective measures to increase the SI. With all of the above, the need for an adequate methodological approach, integrated with the rest of the project management activities, is evident.

All that has been said in this section is applicable to different types of projects, and to the products obtained from these projects. The following is a summary of seven processes that should help any project manager to define and meet the project's sustainability objective.

Since there are nowadays a significant number of people certified as project management professional, this article has been structured according to the current versions of PMI's PMBOK and IPMA's ICB, in order to achieve a more practical approach.

#### 3.2. Project Sustainability Management Processes

The mission of project sustainability management (PSM) is to set a sustainability objective for the project, and to meet it. The main PSM processes for any project should be as summarised below. For brevity, when mentioned in the rest of the article, these processes are assigned the codes PSM1 to PSM7, where PSM stands for Project Sustainability Management, and the number corresponds to the ordinal of the process, although there may be overlaps between some of the processes.

##### 3.2.1. PSM1 Process: Plan the Project Sustainability Management

This involves generating the sustainability management plan (SMP), which will be incorporated into the project management plan along with the other subsidiary ones (scope, time, cost, quality, etc.; [32]). The SMP will define how the sustainability objective will be managed, based on the requirements (needs, expectations, objectives) set by the promoter and stakeholders. This includes, among other things, establishing which assessment method(s) will be used. Different methods exist for different types of projects, and even for a certain type of project, such as construction ones, there is a variety of models and (if used) certification systems. On the other hand, the SMP should include planning for the monitoring and control function.

Until now, in construction projects, a very frequent approach has been to apply a single method and model to the whole, as is the case with BREEAM (Building Research Establishment Environmental Assessment Methodology) [51–53] or LEED. The appearance of the sustainability assessment models of the Spanish structural concrete and steel Codes [54–58] has opened a new path, in which different models could be applied to the different construction subsystems, establishing a partial sustainability objective for each one.

Using a single model makes the assessment easier, but the depth of the assessment is reduced. The use of partial models increases the assessment and management work, but provides the opportunity to go into greater detail, which should lead to more sustainable projects and products.

The main contents of the SMP can be the following:

- Management methodology.
- Internal procedures that will be used, or ad hoc descriptions of the management processes to be employed.
- Assessment methods or model(s) to be used including, among other possibilities:
  - Use of Life-Cycle Assessment (LCA) techniques (Environmental Life-Cycle Assessment, Life-Cycle Costing, Social Life-Cycle Assessment), or other different assessment methods.
  - Possibility of using different models for the different phases of the project life cycle. For instance, it is possible to use LCA techniques only in certain advanced phases of the project, or at its end, employing simpler methods in earlier phases.
  - Main environmental, social, economic and technical/functional indicators to be used. The assessment models can be as comprehensive as possible, or simple models can be employed, following the Pareto Principle, concentrating on key indicators: e.g., energy consumption, CO<sub>2</sub> emissions, employment generation, fatal or severe accidents, investment cost and operating cost. As anticipated, these models can be extended at later stages of the project.
  - Measurement units for each indicator (e.g., kg CO<sub>2eq</sub> per m<sup>3</sup> of material, or kg CO<sub>2eq</sub> per m<sup>2</sup> of constructed building, among other possibilities).
  - Multi-criteria method for indicator integration (AHP (Analytic Hierarchy Process), ASPID (Analysis and Synthesis of Parameters under Information Deficiency), ELECTRE (Elimination Et Choix Traduisant la REALité or Elimination and Choices Translating Reality in translation), MACBETH (Measuring Attractiveness by a Categorical Based Evaluation TechNique), MIVES (Modelo Integrado de Valor para una Evaluación Sostenible, Spanish acronym of Integrated Value Model for Sustainability Assessment), PROMETHEE (Preference Ranking Organization Methods for Enrichment Evaluations), TOPSIS (Technique for the Order of Prioritization by Similarity to Ideal Solution), VIKOR (Vİsekriterijumsko KOMPromisno Rangiranje: Multicriteria Optimization and Compromise Solution), or among others [59–68]).
- If applicable, certification model(s) to be used (e.g., in construction: BREEM or LEED, among others).
- In case of using different models for different parts of the project: how to integrate assessments to obtain the project's Sustainability Index (AHP, ASPID, ELECTRE, MACBETH, MIVES, or PROMETHEE, among others).
- Assessment software to be used (e.g., for LCA: GaBi (Ganzheitliche Bilanz or Holistic Balance in translation), OpenLCA, or SimaPro, among others [69–71]).
- Databases to be employed (e.g., among others for LCA: EcoInvent or GaBi, for instance [72–74]).
- Use of consultants or organisations specialised in sustainability.
- If applicable, certification bodies to be involved (e.g., in construction: BREEM or LEED, among others).
- Precision level. Accuracy of indicator estimates in each moment of the project life cycle (e.g., +/−10%, +/−20%, −10%/+30%).
- Estimates of contingency reserves to be used (see below).
- If applicable, potential use of sustainability optimisation methods, to meet or exceed sustainability objectives to be set.

- Systems or sub-systems to be optimised.
- Potential methods to be used (conventional, genetic algorithms, simulated annealing, among others [75–78]).
- Monitoring and control:
  - Data to be collected.
  - Control thresholds: deviations allowed before corrective decisions are made.
  - Frequency, formats and contents of reports.

### 3.2.2. PSM2 Process: Create the Sustainability Breakdown Structure (SBS)

On the one hand, projects can have sub-projects. On the other, the product of a project usually has different subsystems. For example, a building comprises structures, façades, roof, and services, among others. If partial sustainability assessment models are applied to each subsystem or part of a project, a breakdown structure must be developed now, in order to be able to define the project's sustainability objective in the next process (PSM3), as well as potential sub-objectives.

This can also apply when certification systems are used. For example, BREAM and LEED have different assessment models for new buildings and for renovations, for different building types, and for urban developments. In a project where there is both retrofit and new construction, and different building types, there can be an SBS for certification purposes. However, if one certification scheme is to be used, there is only one project product, and the sustainability of the project management processes is not to be assessed, the PSM2 process is not necessary.

If it exists, it is desirable that an SBS includes the appropriate breakdown of sub-systems, its weight, and the assessment model to be used for each sub-system. A simple example, for a building project, might be as follows:

1. PE001 building project. Sustainability Index of the Building (SIB).
  - 1.1 Foundations and structure—18%
    - 1.1.1 Concrete—60%—EHE-08 model [54]
    - 1.1.2 Steel—40%—EAE model [58]
  - 1.2 Envelope—40%
    - 1.2.1 Roof—30%—Ad hoc model #1
    - 1.2.2 Façade—70%—Ad hoc model #2
  - 1.3 Building services—40%
    - 1.3.1 Hot water—15%—Ad hoc model #3
    - 1.3.2 Air conditioning—65%—Ad hoc model #4
    - 1.3.3 Lighting—20%—Ad hoc model #5
  - 1.4 Engineering and project management processes—2%—Ad hoc model #6

In addition to this breakdown, each aspect listed in the SBS can have its own breakdown in terms of environmental, social and economic sustainability.

Note that the SBS in this example focuses on the subsystems that most influence the building's sustainability. To identify these, a sensitivity analysis, e.g., by consulting existing literature, is appropriate to identify the subsystems that have the most influence on sustainability. For instance, as previously alluded, the assessment can focus on material and energy consumption, CO<sub>2</sub> emissions, employment generation, fatal and severe accidents, and investment and operational costs. Following the Pareto Principle, such simplifications facilitate the task of PSM. The more complex the product and the project are, the more advisable this is.

Weights should be established as objectively as possible. Thus, in the example of SBS just proposed, the following should be considered:

- The sensitivity analysis mentioned above. For example, statistics show that the largest energy consumption in buildings is in heating and air conditioning [79–83].



- The capacity of each subsystem to consume or save energy, and to generate or avoid pollutant emissions. Thus, for example:
  - Foundations and structures do not generate significant impacts beyond their construction.
  - The opposite is true for energy services. On the one hand, they must be highly efficient. On the other, they must use low-polluting energy sources. Ideally, they should have their own renewable energy generation subsystems (geothermal, micro-wind, solar thermal, photovoltaic), in the concept of near-zero energy buildings.
  - In the same way, envelopes (roof, façade, partitions) with adequate thermal insulation will allow significant energy savings and avoid pollutant emissions from the heating and air-conditioning system, throughout the life cycle of the building. In particular, openings in the façade and roof (doors and windows; in general, glazed areas) have a major influence on thermal insulation and lighting. It should also be noted that envelopes have a very-important influence on sound insulation (which can be considered as a social aspect), throughout the whole life cycle of the building. Again, roof and façade openings are of particular importance in this matter.
  - Normally the façade has a larger surface area than the roof, and therefore a greater influence on thermal (and acoustic) insulation.
  - Finally, the engineering and project management processes usually have a very-low impact compared to the manufacturing and construction processes.

The reader should note that the above comments are incomplete. There has been little discussion of social aspects, e.g., employment generation is, more than ever, a key issue.

### 3.2.3. PSM3 Process: Define the Sustainability Objective

Following the above processes, it is necessary to establish the sustainability objective for the project as a whole and, if appropriate, partial objectives for each sub-system or part of the project. These objectives can be quantitative, e.g., maximum CO<sub>2</sub> emissions and energy consumption; or minimum Sustainability Index of the project, calculated using a multi-criteria method. They can also be expressed in the form of qualitative levels, typical of certifications, e.g., BREAM Fair, Good, Very Good, Excellent and Exceptional; or A, B, C, D, E levels, etc. It is usually advisable to set realistic but challenging targets, above what would be acceptable to the client. This difference will constitute the appropriate reserve for contingencies. As a result of this process, the sustainability objective stated in the project charter will be confirmed or modified.

### 3.2.4. PSM4 Process: Identify Design Alternatives

To meet the same sustainability objective, there are different ways of designing a product or providing a service. It is therefore necessary to identify design alternatives that could be used or implemented. Different conceptual designs of a system or sub-system, or different detailed designs, or different products (brand, model) for the same element can be identified. In the case of project management processes, for instance, project meetings can be face-to-face or virtual, which implies different environmental, social and economic impacts.

### 3.2.5. PSM5 Process: Define the Sustainability Strategy

This process involves assessing the different alternatives identified in the previous process, comparing them, and making decisions. Assessments can be done in the ways already discussed in PSM1 (e.g., environmental, social and economic LCA).

If appropriate, as discussed in PSM1, this will be the moment to carry out optimisation simulations, for the same purpose. In other words, the assessment may or may not be accompanied by optimisation processes. Normally the latter will only be carried out in large and complex projects, in very mature organisations. However, even in these

circumstances, it may not be possible to go beyond assessment, given the difficulty of optimisation processes (see, for example, [84,85]).

Where there are design variables over which one has control, it may be feasible to optimise. It may also be feasible in other cases where, for a given subsystem, the combination of alternatives or sub-alternatives that most contributes to sustainable development is sought. This is the case, for example, for subsystems that can be manufactured or built by combining products from different brands. The best combination of brands and models should be found.

If it is possible to define optimisation variables, in some cases it is appropriate to carry out two or three preliminary designs, with their corresponding assessment. After that, the best alternative will be optimised. In other cases, both can be done simultaneously, in an automated way. This depends on the optimisation technique chosen, the number of variables, and the objective function (whether there are continuous variables, discrete variables, or both).

In an optimisation problem, decision variables can be treated as such, or different scenarios can be established for them. For example: suppose one variable is the type of material used in a product. This variable is discrete. Therefore, a single optimisation problem can be posed, in which the material is a discrete variable. On the other hand, the optimisation problem can be posed in several phases, in each of which the same material is always used. In this case, several optimisation processes have to be performed, each with a different material. This has advantages and disadvantages.

It is important to note that, sometimes, optimisation processes lead to solutions that cannot be implemented in practice. For example, when there are no commercial products that exactly meet the specifications resulting from the optimisation process. Therefore, after optimisation, an adaptation to the market reality must be addressed. The important thing is to generate a set of feasible and sufficiently satisfactory alternatives and not strictly optimal solutions.

When only assessments are carried out, the strategy to be followed to achieve the stated objective will have to be established, using some of the design alternatives identified in PSM4. When optimisation processes are also carried out, some of the elements of the initial strategy will be improved evolutions of the alternatives identified in PSM4. In both cases, the remaining options can be established as reserve alternatives, to be used in case of project changes.

### 3.2.6. PSM6 Process: Implement the Sustainability Strategy

Once the project planning is completed, the execution processes begin, and the strategy set out in PSM5 will be implemented. The control processes (PSM7) will start shortly after the beginning of this one. For more details, see Sections 3.2.7 and 3.3.3.

### 3.2.7. PSM7 Process: Monitor and Control

As anticipated, changes in the environment, or scope modifications, can make the project management plan no longer feasible, thus damaging the final Sustainability Index (SI). It is necessary to monitor, if not all, then the variables that have the greatest influence on the SI. That is, the indicators that most influence the results of applying the assessment model(s) employed.

Changes can occur at any time. Therefore, the monitoring and control process must be continuous, throughout the entire project life cycle. It is necessary to know, always, whether the initial strategy is being successfully implemented, or not. The project team (owner, designer, project manager, sustainability experts) should make periodic projections, re-estimating the SI, in order to make effective decisions in a timely manner. Projections will also need to be made when major events occur that affect the sustainability strategy. In both cases, when opportune, this may include new optimisation calculations. Conservative projections of the potential final SI are recommended. As a general rule, any assumptions that raise the value of the SI and have little chance of being met should be avoided.

When events occur that jeopardise the achievement of the sustainability objective, measures must be taken to bring the project back in line with it. Typically, alternative designs or strategies to those previously identified in PSM4 will be employed. If necessary and feasible, new designs or strategies, not previously identified, can be used or implemented.

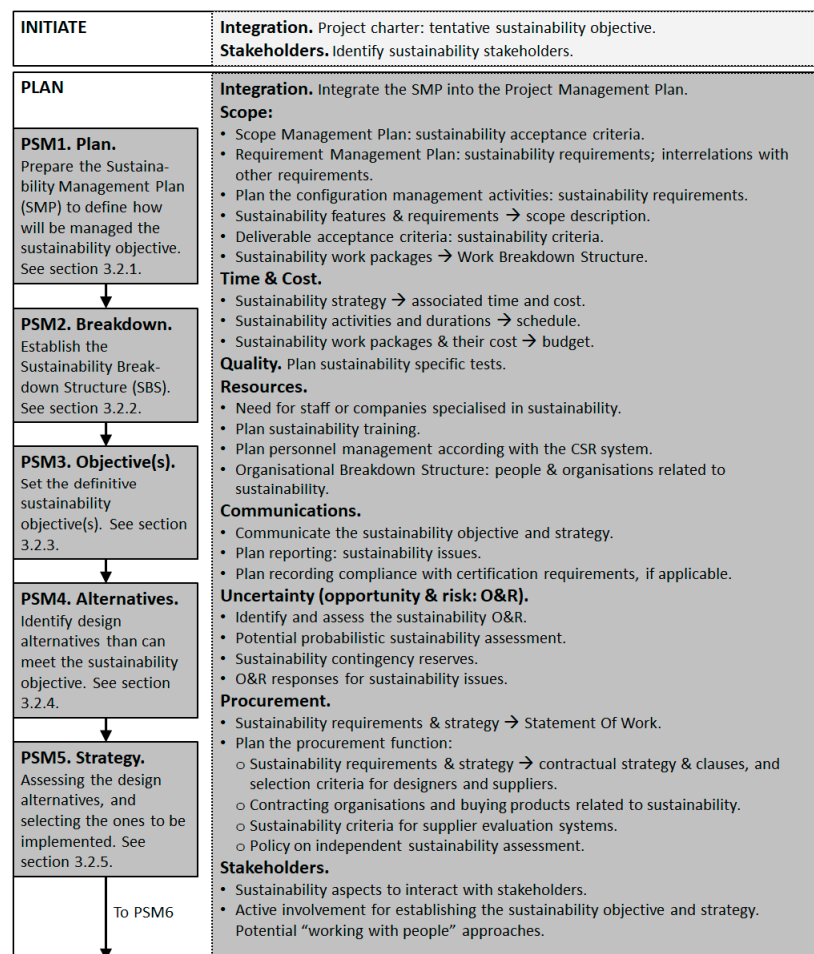
As part of this PSM7 process, it is very important to formally document all aspects of project sustainability that have actually occurred, for use in the closure processes (e.g., to establish lessons learned) and, where appropriate, in the certification process.

When the project is finishing, in order to feed its closure processes, a final sustainability assessment will have to be made, as built, manufactured, or implemented, or according to the service finally provided. In addition, if applicable, all the necessary documents to obtain certifications will have to be compiled, and the appropriate steps will have to be taken to ensure it.

In many cases, from the point of view of the owner, monitoring and control can continue throughout the life cycle of the product, until its decommissioning, in order to assess the actual SI at each moment, and the final SI, when the product’s life-cycle is over.

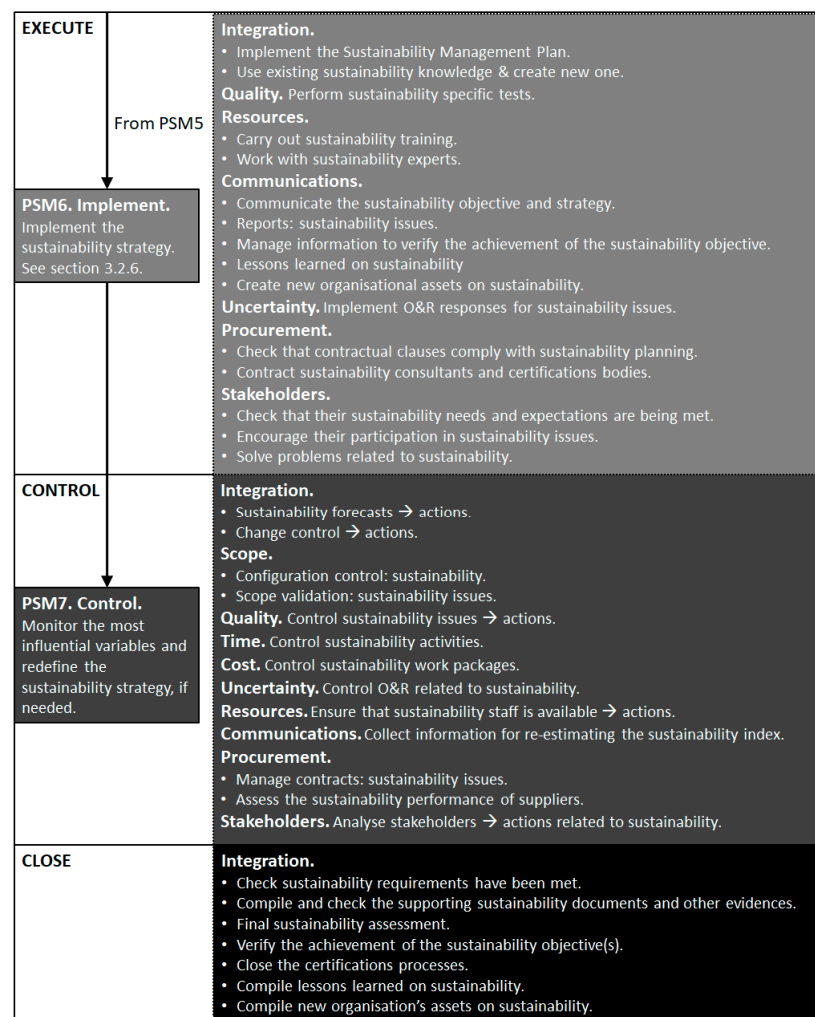
### 3.3. Interrelations with Other Project Management Processes

Depending on the organisational structure of the project, the project manager will lead the PSM processes alone, or with the help and supervision of a functional manager. In the following, the main interrelations of the seven PSM processes with the other project management processes are summarised. Figure 1 presents the seven PSM processes and summarises the main interrelationships.



(a)

Figure 1. Cont.



(b)

**Figure 1.** (a,b) PSM processes and main interrelations with the other project management processes.

### 3.3.1. Initiation Processes

Regarding project *integration* management [32], initiation processes include developing and approving the project charter. It may happen that sustainability aspects are not yet addressed in the initiation processes. In some cases, however, the project charter may reflect the initial wishes of the promoter or sponsor with regard to sustainability. The latter is the most appropriate, because in this way all participants will be aware of the promoter's initial intentions. Later, in the PSM3 process (defining the sustainability objective), the initial objective will be validated, or a different one will be established, after the appropriate analysis process.

The other process to be carried out belongs to the *stakeholders'* area. They must now be identified. This involves finding out who are the potential internal and external people and organisations that can influence sustainability issues, both for and against. Examples of stakeholders are, among others, green lobby groups, environmentalists, academic experts, sustainability certifying bodies, financial managers, and those involved in the corporate social responsibility (CSR) of the organisation. After knowing their expectations, their sustainability requirements should be collected and considered in the PSM planning process (PSM1). Therefore, if a stakeholder register exists, it should capture their sustainability requirements, needs and expectations, as well as possible overlapping or compatible positions.

### 3.3.2. Planning Processes

PSM1 to PSM5 are included in the planning process group [32]. They include (PSM1) initial PSM planning tasks, until an initial version of the PSM plan is created; (PSM2) defining a first version of the SBS; (PSM3) establishing the project's sustainability objective; (PSM4) identifying design alternatives; and (PSM5) defining the sustainability strategy. These processes often require the assistance of sustainability experts. In the case of construction, this will be done with the assistance of the architects and engineers who will carry out the design, supported by appropriate sustainability experts, if necessary.

In terms of the *integration* of project management processes, the project management plan (PMP) must be developed, which will incorporate, among others, the Sustainability Management Plan (SPM), already discussed in Section 3.2.1.

For *scope* purposes, when preparing its management plan, in the section corresponding to the procedures for checking and final formal acceptance of the project deliverables, the acceptance requirements affecting sustainability must be taken into account, paying special attention to this when certification systems are to be used.

In turn, the requirements management plan should include the sustainability ones.

- These requirements can affect project cost and time, among other aspects. It is therefore important to analyse the interrelations between the sustainability requirements and other demands, needs or constraints, to ensure compatibility.
- Product configuration management activities are always important, but even more so when the project includes sustainability certification. In order to achieve it, it will be necessary to demonstrate that the requirements imposed by the certification system have been met. Of particular importance, therefore, are the ways of measuring the fulfilment of product requirements: compliance metrics and the basis for their use.
- On the other hand, when defining the project scope:
- The sustainability features and requirements to be fulfilled should be included in the description of the scope of the deliverables, detailing what was previously stated in the project charter and in the requirements documentation. Often, these features and requirements will be progressively detailed as the project progresses.
- Similarly, the deliverable acceptance criteria should include the conditions to be satisfied in terms of sustainability.
- The project's work breakdown structure (WBS) should include all aspects related to sustainability. For example, if the product is to be certified, there will be a work package for the tasks to be performed by the certification body. The same will apply if a consultancy company is to be contracted to provide support in the management of the sustainability objective.

Finally, configuration management must control, among other issues, the sustainability aspects of the project's product.

As for *time and cost*, the different sub-processes for generating the project budget and schedule must take into account the project sustainability strategy (PSM5). In turn, budget and schedule should include any specific PSM work packages or activities (e.g., if it is sufficiently important, the definition of the sustainability strategy).

In terms of *quality*, when establishing its management plan, there may be project deliverables and processes, related to sustainability, that need to be checked for quality. For example, in the construction of houses according to the Passivhaus (passive house in translation) standard [86,87], it will be necessary to perform tests to detect air penetration through doors and windows and thus assess the permeability of the building envelope (BlowerDoor Test; [88,89]).

Regarding the *resources* needed to carry out the project:

- When planning its management:
  - Consideration should be given to the needs for staff or companies specialised in sustainability, as well as their roles, authority, responsibility, and knowledge and experience needed.

- In addition, given the current state of sustainability management, it may be necessary to include training activities in this field.
- Any issues related to staff monitoring, participation, performance, and needs, or to personnel recognition and reward systems, should be in accordance with the organisation's CSR system.
- In addition, at the time of estimating resource needs, the organisational breakdown structure (OBS) should include the companies, institutions and individuals related to PSM.

With regard to project *communications*, it is important to plan to whom, when and how the project's sustainability objective (PSM3) and strategy (PSM5) will be communicated. In addition, communications planning must ensure that project reports (periodic, exception, final) include appropriate PSM sections, defining their structure and content. Where appropriate, it is extremely important to plan the recording of compliance with the certification requirements, through either documentation or images (photography, video).

In *uncertainty* management (*risks and opportunities*), there are many interrelations with PSM. For example, in a building project, the pollutant emissions and energy consumption that the project will cause, among many other aspects, will not necessarily be known with certainty. This is also true for other types of project (e.g., manufacturing, information technology, or many projects for providing a service). As a result, there is uncertainty about the final value of a large number of parameters to be assessed, and in some cases this uncertainty may last until the project is completed, even if it is gradually reduced by that time. In addition, the actual impacts caused by using the project's product (e.g., in a building, its services: electricity, water, ventilation, heating, air conditioning), which cannot be known until the work is completed, may vary throughout the life cycle of the building. Therefore:

- When planning, it should be made clear that opportunities and threats affecting the achievement of the sustainability objective will need to be managed.
- As always, the use of quantitative analysis will depend, among other things, on the complexity and relative size of the project, its budget and timeframe, the organisational culture (maturity), and whether the project is of a strategic nature, or not. If employed, quantitative analysis should be carried out using the soundest techniques for doing so.
  - It is advisable, in any type of project, to carry out a simple sensitivity analysis.
  - If the project is of a strategic nature, or is of great complexity and relative size, it is advisable to use stochastic simulation (Monte Carlo), in a similar way to what would be done with project time, cost and return on investment (ROI).
  - The base model (or models) to which these techniques are to be applied is the chosen quantitative sustainability assessment model, e.g., environmental, social and economic life cycle analysis, with the corresponding multi-criteria method (MCM) for aggregating indicators.
  - In case of using stochastic simulation, when planning the uncertainty management, it has to be decided if only uncertainty is to be taken into account in the estimation of indicators. If it is considered that there is relevant subjectivity in the estimation of the weights of these indicators, and other parameters used in the sustainability assessment model, these variables can also be considered as probabilistic.
- As mentioned above, the concept of contingency reserves, traditionally used for time and cost, is applicable here, although there is a clear difference. For schedule and cost purposes, these are amounts of time and money to be added to the duration and cost estimates for each activity and work package. As with a potential ROI objective, the reverse is the case here: the sustainability objective will be more demanding than the sustainability level that would be acceptable to the client. Thus, the risks may lead to failure to meet the sustainability objective, but project failure will be avoided, as an acceptable level of sustainability will be achieved.

- Finally, there are clear interrelationships between the uncertainty response planning process and the PSM4 and PSM5 processes. On the one hand, some of the design alternatives identified in PSM4 may be preventive responses to risks that threaten the sustainability objective, and will therefore be selected for immediate implementation as part of the sustainability strategy. Other alternatives will remain as corrective responses, or B Plans, to be used at a later stage, if necessary.

As for *procurement* management:

- When defining the work to be carried out (statement of work: SOW), as always, the contents and level of detail will depend on the product to be purchased, manufactured or built, the client's needs, and the type of contractual strategy chosen (organisation, price and awarding method). However, there is now a new aspect to take into account: sustainability. Both the design and the product specifications must comply with the sustainability requirements (PSM1) and strategy (PSM5). In addition, it must be made clear which documents, deliverables or intermediate products must be approved by the client or its representatives and, if applicable, by the certification body.
- In establishing the procurement management plan, it will be necessary to:
  - Consider the interrelations with PSM. In particular, the consequences of the sustainability requirements (PSM1) and strategy (PSM5) on the contractual strategy and on the clauses of the various contracts to be signed. Thus, among other things, certain contractual strategies in which the most important time and cost risks are transferred to the supplier, can be detrimental to the achievement of the sustainability objective, resembling what happens with quality.
  - If necessary, prepare contract drafts to be signed between the promoter and the companies that will advise him on sustainability, and between the client and the certification body.
  - Always take the sustainability requirements (PSM1) and strategy (PSM5) into account, when establishing the criteria for the selection of designers, contractors and other vendors, as well as in the tender documents for contracting these suppliers.
  - Take sustainability aspects into account within the supplier evaluation systems, establishing appropriate metrics for their assessment. At the end of the project, these aspects should also be taken into account when preparing or updating the organisation's lists of approved suppliers.
  - In cases where one or more suppliers offer a product or service for which they guarantee a certain non-certified level of sustainability, it may be necessary to establish a policy on independent estimates of sustainability. This information can then be used in the evaluation of proposals.

Finally, in terms of *stakeholder* management, planning will need to take sustainability aspects into account when developing approaches, strategies and actions to effectively interact with stakeholders. Pursuing environmental, social and economic sustainability objectives can be a positive way of gaining stakeholder support. Potential "working with people" approaches [90] can be very helpful for achieving the sustainability objective.

It can be beneficial to plan PSM (PSM1) with the active involvement of the key stakeholders, including potential negotiation processes. The project's sustainability objective, to be defined in PSM3, should reflect the overall vision of all participants and other stakeholders, as far as possible. This also applies to the definition of the project's sustainability strategy (PSM5). Sometimes, objective and strategy can be redefined iteratively, based on a collaborative consensus with the key stakeholders.

### 3.3.3. Execution Processes

Regarding *integration*, the execution processes include the management of project work and knowledge [32]. With respect to the former, it is about implementing the project management plan to meet the project objectives. It involves, therefore, carrying out the

necessary activities to meet these objectives, generating the appropriate deliverables. On the other hand, project knowledge management involves, both, using existing knowledge (lessons learned and organisational assets) and creating new knowledge (lessons and assets) to achieve project objectives and contribute to organisational learning.

All this must be done interacting with the PSM6 process, which is part of the execution group, and which is intended to implement the sustainability strategy defined in PSM5. PSM6 may require the assistance of sustainability experts to check that those who design, manufacture or build the product of the project do so in accordance with the sustainability strategy. This also applies when the project is intended to provide a service.

In terms of *quality*, the activities referred to in the previous section will have to be carried out. As for *resources*, where appropriate, sustainability experts should be assigned to the project, integrated into the project team, and managed appropriately. If required, the training activities mentioned in the previous section will have to be carried out.

As far as the *communication* management is concerned, it should include all aspects of sustainability. For example, project reports should have the corresponding sustainability section. Of particular importance is the creation, collection, storage and final disposal of information on compliance with sustainability requirements and strategy, in order to be able to verify the achievement of the sustainability objective, at the end of the project. This is even more so if the project product is to be certified. The compilation of lessons learned in sustainability is also key. Sometimes, in pioneering projects, this will serve to create organisational assets to be used in subsequent projects, e.g., formal, written project sustainability management procedures, or sustainability models used in the current project, which can be used in future projects of the same type.

In the area of *uncertainty*, there are clear interrelations between PSM6 and the process for implementing risk and opportunity responses, in accordance with what has already been said in the previous section.

As regards *procurement* management, supplier contracts shall be checked to ensure that they comply with the sustainability planning carried out. In particular, they must include what has been decided in processes PSM3 and PSM5 (sustainability objective and strategy). If necessary, sustainability consultancy companies and certification bodies will be contracted.

Finally, with regard to *stakeholders*, it will be necessary, throughout the project life cycle, to check that their sustainability requirements and expectations are being met, encouraging their participation and resolving potential incidents and conflicts of interest.

#### 3.3.4. Control Processes

PSM7, according to its name, is included in the group of control processes [32]. It should be performed throughout the project life cycle, beginning shortly after the start of the PSM6 process. It will be done with the help of the project management team, designers and, if necessary, sustainability experts.

In terms of *integration*, the aim is to periodically analyse the project's progress data in order to establish forecasts on the achievement of the project's objectives. Where needed, actions must be identified and implemented to ensure compliance. In addition, it is necessary to perform integrated change control, analysing, approving (or rejecting) and managing changes that affect the project management plan, project documents, or deliverables. It should be checked whether the requested changes have an effect on sustainability. If the effect is negative, ways to address it should be established, using the fallback alternatives identified in PSM4. If positive, things can be left as they are. If broadly positive, other sustainability constraints can be relaxed as a way to favour the achievement of other project objectives (ROI, time, cost, or quality).

For the *scope* control, whether the configuration of what is being done is in line with what was planned regarding sustainability, should be checked. At least:

- At the end of the initial design the potential Sustainability Index (SI) will be estimated.
- At the end of the procurement activities another estimate of the SI will be made.



- Periodically, throughout the remainder of the project life cycle, the SI will be re-estimated based on the actual configuration of the project product, or components thereof, that have been completed at each point in time. This will be done deterministically and, where appropriate (see Section 3.3.2), by means of probabilistic simulation.

These estimates will be incorporated into project reports, as well as decisions made to bring the project back in line with the sustainability target, where necessary.

In manufacturing and construction, configuration management is of particular importance, in order to collect all documentations proving that sustainability requirements have been met. Otherwise, even if they have been satisfied, many of them cannot be effectively demonstrated, will not be taken into account in potential certification processes, and this may reduce or eliminate the likelihood of achieving a certification, and therefore of meeting the project's sustainability objective.

When validating the scope, the arrangements for formal receipt and acceptance of deliverables, once they have been produced, will include validation of the sustainability aspects. This will normally be done after the appropriate *quality* control processes, as mentioned above.

On the other hand, the *time* and *cost* control will deal with the activities aimed at achieving the sustainability objective, and *uncertainty* control will include monitoring threats and opportunities for that achievement.

In terms of *resources*, it should be ensured that staffing for sustainability issues is available as planned and, if necessary, corrective actions should be taken.

As far as *communication* control is concerned, special care will have to be taken with sustainability information, which should allow re-estimation of the SI throughout the project life cycle, and estimation of the final SI.

With regard to *procurement*, the management of the various contracts will ensure that the necessary measures are put in place to achieve the desired sustainability level. On the other hand, the use and creation of knowledge on the assessment of suppliers' sustainability performance is important.

Finally, with regard to monitoring *stakeholder* activity, where necessary, changes or adjustments to strategies and plans will have to be made to involve them in the project for the benefit of the sustainability objective, among other aspects.

### 3.3.5. Closing Processes

Project closing processes aim to achieve the completion of all project activities (or phase activities, in the case of large phased projects). In general [32], closure processes only concern the *integration* area. However, when closing each contract, it will be necessary to check that the appropriate sustainability requirements have been met. On the other hand, when closing the project, all supporting sustainability documentation must be compiled and checked, final assessments must be carried out, the achievement of the sustainability objective (PSM3) must be verified and, if applicable, the certification processes must be closed. The lessons learned register should capture all new sustainability knowledge gained. Finally, new sustainability-related procedures, models, databases or software applications should be incorporated into the organisation's asset pool.

### 3.4. Project Manager Competences

In order to adequately address PSM, the project manager must have a set of knowledge, competences and experience. An individual competence is the application of a person's knowledge and skills to achieve the desired results. The IPMA ICB [33,91] considers three competence areas:

- Perspective, contextual or environmental ones. They allow considering the constraints external to the project, both external and internal to the organization. It involves understanding the reasons that move people, organisations and societies to carry out projects. They include methods, tools and techniques for interacting with the environment.

- Personal ones, necessary to successfully manage a project, including those needed for interpersonal relationships.
- Professional practice ones, related to the methods, processes, tools and techniques specific to project management (management of scope, time, cost, etc.).
- All ICB perspective competences are required for PSM. They are the following:
  - PP1. Organisational strategy.
  - PP2. Organizational governance, structure and processes.
  - PP3. Compliance with legislation, regulations and standards.
  - PP4. Individual and group interests, and the use of power.
  - PP5. Organisational and societal culture and values.

All of them are necessary for PSM planning (PSM1) and for establishing the sustainability objective (PSM3). For instance, culture and values (PP5) influence the social approach of the project. This implies, among other issues, a better understanding of human resource management and health and safety aspects, which are also influenced by legislation (PP3). PP5 also implies a good understanding of CSR aspects. The same applies to environmental issues, which should, at least, comply with current legislation and corporate environmental strategy and policies.

To implement the project's sustainability strategy (PSM6), competences PP2 (structure and processes) and PP3 (legislation, regulations and standards) can be useful.

Although the ICB includes some sustainability aspects in competence PP3, the authors consider that this is not sufficient, because there are PSM issues not included in legislation, regulations or standards. This needs to be addressed by means of a new professional practice competence, which will be referred to below.

In sufficiently large organisations, the PP2 competence is key for the project manager to understand what is meant by managing project portfolios and programmes, in which his or her project may be included.

The personal competences proposed by the ICB are as follows:

- PS1. Capacity for self-reflection and self-management.
- PS2. Personal integrity: acting in accordance with one's own values and ethical and moral principles.
- PS3. Interpersonal communication skills.
- PS4. Ability for interpersonal relationships, to participate in project activities and to encourage the participation of others.
- PS5. Leadership skills.
- PS6. Teamwork capabilities.
- PS7. Conflict and crisis resolution skills.
- PS8. Inventiveness, imagination, creativity.
- PS9. Negotiation skills.
- PS10. Results orientation.

All of them are necessary for PSM. The most important ones are competences PS2, 4, 8 and 10. PS2 (personal integrity) will facilitate sustainability planning (PSM1) and the adequate establishment of the sustainability objective (PSM3). Finally, PS2 is essential to stand firm in the implementation of the sustainability strategy, and in its control (PSM6 and 7).

PS4 (interpersonal relationships) is required for processes PSM1, 4, 5, 6 and 7. For example, it is necessary to understand the sustainability requirements of the promoter and stakeholders, and to plan PSM in collaboration with them (PSM1).

PS8 (inventiveness, imagination, creativity) is needed, both when defining design alternatives (PSM4) and when establishing alternative strategies to solve problems caused by project changes (PSM6).

Finally, PS10 (results orientation) is essential to achieve the fulfilment of any of the project objectives and thus the sustainability one (PSM1 to PSM7). It should be noted that results-orientation includes problem-solving skills, especially needed (i) to identify different design alternatives (PSM4) that can lead to the fulfilment of the sustainability

strategy (PSM5); (ii) to implement this strategy (PSM6); and (iii) to put in place alternative measures to those initially planned, as part of monitoring and control (PSM7).

The ICB's professional practice competences include those related to the PMBOK knowledge areas (integration, scope, time, cost, etc.). However, the ICB separates the integration management aspects among themselves (perhaps in order to give them greater importance). In particular, it considers separately the competences related to (i) conception of the project approach; (ii) project requirements, benefits, and objectives; (iii) project organisation; and (iv) change management. On the other hand, the ICB includes in the same competence the aspects that in the PMBOK are part of (i) information and communications management, and (ii) project organisation (see [33]).

From the authors' point of view, as already mentioned when dealing with the PMBOK, one more competence should be added to ICB professional practice competences, namely managing the sustainability objective, including aspects that have been dealt with when describing the PSM processes.

In the same way as in PMBOK, there are interrelationships (cross-cutting) among the professional practice competences (e.g., between time and cost), and there will also be interrelationships between them and the sustainability competence.

Section 3.3 discussed the interrelationships between PSM and the various current PMBOK processes (integration, scope, cost, time, etc.). Although the ICB refers to the competences needed to professionally address these processes, what has been said in Section 3.3, together with what has been included in Section 3.2 (PSM processes) reflects the professional competence needs required for PSM, and it is not necessary to go into this again.

### 3.5. Tailoring PSM Processes to Project and Organisational Characteristics

Up to this point, everything related to the sustainability management processes, their interrelationships with the rest of the project's managerial functions, and the competences required for PSM, has been covered. All of the above may be an excessive methodological deployment for many projects, or for specific organisations. An adequate methodological framework must also establish criteria to determine the simplifications to be made in each case [35].

Throughout this article, some criteria for simplifying PSM have already been indicated, for example, when it has been said that in certain cases it is not necessary to carry out the PSM2 process, and additionally, when discussing the possibility of carrying out stochastic simulations to estimate the Sustainability Index in early phases of the project, taking uncertainty into account (Section 3.3.2), or the potential use of probabilistic methods to reduce subjectivity when estimating the weights of the sustainability indicators.

In addition to the above, possible simplifications to PSM processes will be established mainly taking into account:

- The project uncertainty level. The higher it is, the less simplifications should be made (+/−), as the probability of achieving the project objectives is lower.
  - On the one hand, certain types of projects have a higher uncertainty level than others. For example, in general, construction projects have a lower level of uncertainty than IT (Information Technology) ones, and the latter than research and development (R&D), or organisational change projects.
  - On the other, for a given industry, some projects have more uncertainty than others.
- The relative size of the project (+/−), which can be measured in different ways. For example, the project budget can be divided by the company's market capitalisation. The organisation can classify its projects according to this ratio; for example, we could say that the project is small, medium or large, respectively, if it is in the order of 1/100, 1/10, or 1.
- The project complexity (+/−), which can be direct or indirect.

- The direct one is derived from the concepts of differentiation and interdependence: the greater the number of sub-systems or components of the project's product, and the greater the number of interrelationships between them, the greater the complexity. The same is true for the number of organisations involved in the project, and the number of stakeholders.
  - Indirect complexity results from other factors that tend to produce higher levels of interdependency; complicated, convoluted, intricate elements or interrelationships, or uncertainty about their actual behaviour. An example of this, among many others, is a schedule with many overlaps between activities (fast tracking).
- Whether the project is of a strategic nature (less simplifications), or not.
  - The organisational maturity (+/−), in general (e.g., according to the Berkeley model), and specifically in terms of sustainability [92,93].
  - The time, budget and resources for PSM (+/−).
  - The motivation and attitudes of the project team and the organisation's management (+/−).
  - Whether PSM is implemented early in the project or not. The later the start, the less likely it is to reach high sustainability levels and therefore the less simplifications should be made.

In any case, in order to decide on the simplifications to be made, it is necessary to study the complete PSM process reflected here, and to analyse the problems that may arise when implementing each of its sub-processes, as well as its advantages.

In another vein, certain types of projects may require specific principles, sub-processes, inputs, outputs, methods, techniques, models, or competencies (see, for instance, [90] for development cooperation projects).

#### 4. Delphi Analysis. Research Results

Section 2 has summarised the characteristics of the Delphi analysis carried out. With regard to the assessment made by the respondents, they consider, firstly, that the (minimum, average, maximum) probability that the top management will support this type of process (real support, including the needed resources) in the largest organisations with the highest project management maturity, is of the order of (50%, 75%, 90%). They estimate that these figures may be in the order of (10%, 38%, 80%) in small organisations (e.g., small and medium sized-sized enterprises (SMEs)) with the lowest project management maturity. Please note that some respondents have answered with a range of values, and in these cases the average of that range is used. On a different note, the variability found, in general, and particularly when discussing small organisations, is due to the fact that the number of such organisations is much larger than that of large companies and institutions, and their characteristics can be very varied, even in advanced countries. In addition, each interviewee has responded according to his or her own real experiences. These comments apply to the remaining assessments, as well as to the comments of the interviewees, which are included below.

Secondly, if the top management supports these proposals (real commitment including the needed resources), they believe that the (minimum, average, maximum) feasibility of their application in the largest projects, carried out by the largest organisations with the highest maturity, is of the order of (50, 74, 95), being 0—no feasibility (total impossibility), and 100—feasibility without any potential problem. At the other end, using the appropriate simplifications discussed here, they estimate these figures to be in the order of (8, 37, 70) for small projects carried out by small organisations with the lowest maturity.

Thirdly, they have also estimated the potential usefulness and effectiveness of the complete set of proposals made here with a number from 0 to 100. The (minimum, average, maximum) rating was (55, 76, 85). All assessments have been made in the context of advanced countries, and each interviewee has made the assessment according to his or her knowledge and experience in recent times. Finally, the main comments they made were as follows:

- As for the likelihood of top management supporting this approach:
  - Probability can be (very high), because of corporate image issues.
  - It can be (high, but not very high), because of the inertia that often exists in quite a few organisations.
  - In small companies with non-professionalised management (e.g., some family-owned SMEs) things are much more difficult.
  - A sustainable project is more profitable in all respects, in the short and long term.
  - Probably, in the long term, the companies that will continue to exist will be those that have a real sustainability strategy.
  - Certain issues can put pressure on organisations to move in this direction. For example, emission costs per ton of pollutant, national waste recovery targets, or occupational accidents.
  - The role of governments is very important; they must send clear and positive messages; for example, issues such as taxes for feeding electricity into the grid, in the case of buildings that generate their own renewable energy, send a pernicious message.
  - It is important that governments and experts are aware that social sustainability is the key to everything. At the moment, many of these people only focus on the environment (which is also necessary), but they forget that social differences are growing and can reach limits that lead to revolts, revolutions or, simply, very serious consequences on the economy, if the majority of the population can only buy the basic necessities. If we solve social sustainability, it will be easier to solve the rest of the problem.
- With regard to feasibility:
  - In large organisations (be it a product or a service), if the project can be carried out with little or no subcontracting, allowing maximum control over design and production, the feasibility is likely to be very high. At the other end, the atomisation of subcontracting greatly diminishes the feasibility.
  - As in other matters, one thing is top management support, and another the full implementation of these proposals, because in many cases what matters is the corporate image as a marketing tool, but not sustainability.
  - Support that does not involve commitment and resource allocation can only lead to failure.
  - In the same way that has happened with other topics, such as the management of project uncertainty, everyone will gradually enter into it, but not completely, with the difference that sustainability makes things much more complicated than uncertainty management, because it includes issues beyond the mere business.
  - In SMEs, the feasibility is lower than in large companies, because they tend to have lower profit and less availability of expert staff, they struggle to survive, and in small projects is difficult to have budget and time for almost anything more than what is being done today.
  - In terms of the sustainability of the project management processes (e.g., face-to-face or on-line meetings?) there is still a long way to go, even in large organisations.
  - Progress on sustainability has been extremely slow for 40 years, but is now starting to be taken seriously.
  - The final change will only come when the majority of funders, sponsors, promoters and clients demand it.
  - Tailoring is essential; these proposals are extremely interesting, but the practical implementation should be as simple and paperless as possible.
- With respect to the potential usefulness and effectiveness:
  - Will be (very high) as long as it is supported by top management and properly implemented. However, it is doubtful that these ideas will be implemented in

reality as explained here, at least at the short and even medium term. A major, if not drastic, change in business culture is needed to break the inertia of current habits.

- It will be (high, but not very high), because today project management is already complex enough to add new things that, besides, are not simple.
- These proposals, if properly supported and intelligently tailored to each organisation and project, can be very effective.
- For maximum usefulness and effectiveness, this must be integrated into the corporate culture, and more specifically with the internal quality, safety and environmental systems, with appropriate support from top management.
- The effectiveness of these approaches can be highly variable; among other things, it depends very much on the culture of each place (region, country) and organisation.
- For sustainability to have a real impact on organisations, a major debate is needed to generate more knowledge, and then wide dissemination to decision-makers in institutions and companies; training at all levels will be one of the keys. There are still many difficulties for achieving a real change of mentality, which will surely come about gradually.

Other comments and suggestions have been incorporated into the proposals presented here, enriching them.

## 5. Conclusions, Limitations, and Future Developments

This article has summarised the proposals of the authors to date, in terms of the components that an appropriate methodology for managing sustainability in projects should have.

Given that the results of the Delphi analysis are favourable, we can state that, firstly, the purely cross-cutting approach of adding sustainability aspects to existing project management processes (integration, scope, time, cost, etc.) must be abandoned. Sustainability management should be a key management function.

Secondly, there are three essential components to consider: (i) principles, (ii) processes and their adaptation to different cases, and (iii) competences. As for the principles proposed by some sources (e.g., [36]), the principle of sustainable development should be added, and ideally this principle should prevail over the others.

Regarding processes, a new knowledge area is proposed, specific to project sustainability management (PSM). It should have seven processes: (1) planning PSM; (2) defining a sustainability breakdown structure; (3) establishing the sustainability objective; (4) identifying alternatives to meet it; (5) planning and (6) implementing the sustainability strategy; and (7) carrying out the appropriate monitoring and control. The interrelationships (cross-cutting) between these processes and the other initiation, planning, implementation, control, and closure ones, should also be considered. The proposals made here should also be taken into account in order to simplify these processes in small, low complexity projects developed by low maturity organisations, among other cases.

Concerning the competences of the project manager, although there are proposals (e.g., [33]) including some aspects related to sustainability, it is necessary to go further. A new professional practice competence on managing the project's sustainability objective should be defined along the lines described here.

All of the above is a basis for enriching the current standards on the subject ([32,33], among others).

Regarding the results of the Delphi analysis, firstly, the probability that the top management will support these ideas is in the order of 75% for mega-organisations with the highest project management maturity. In small organisations (e.g., SMEs) with the lowest project management maturity, these figures may be in the order of 35%, but with a higher variability. Secondly, if the top management supports these proposals, the feasibility of their application in major projects carried out by the largest organisations with the highest

maturity, is of the order of 70, being 0—no feasibility, and 100—feasibility without any potential problem. At the other end, using the suitable simplifications discussed here, these figures could be in the order of 35 for small projects carried out by small organisations with the lowest maturity. External help could be used in these cases. Thirdly, the potential usefulness and effectiveness of the complete set of proposals made here is in the order of 75. Finally, the comments made by the interviewees are of great interest; the reader can find them in the previous section.

With respect to future developments, the processes suggested here should be developed, identifying the possible (1) inputs to be used; (2) methods, techniques, models, and tools to be employed; and (3) outputs to be generated. In addition, detailed flowcharts of PSM activities should be generated, setting out clear descriptions of the mission or purpose of each one, the techniques or tools to be used in it, and the results to be obtained. Methodological simplifications for small, low complexity projects developed by less mature organisations, among other potential cases, will also need more in-depth study. In addition, it will be necessary to define how to assess the competences related to the management of the project's sustainability objective.

On the other hand, it will be necessary to analyse the differences that may exist between PSM in a traditional approach and that which should be carried out in an agile or hybrid approach to project management. On this basis, it will be necessary to make additions and modifications to the proposals reflected here.

Moreover, it is paramount to analyse the changes that need to be made in the way organisations, project portfolios and programmes are managed, because this is key to facilitating an adequate PSM.

After all this has been done, it must be discussed with project and corporate managers, and with other decision-makers including promoters, design companies, contractors, suppliers, certification bodies, and other stakeholder organisations, through extensive campaigns of interviews, surveys or Delphi analyses. Based on this, the previous results will have to be revised, leading to a final version.

Finally, it is essential that companies and public bodies experiment with the corresponding ideas, observe the results obtained, and improve them progressively, on a continuous basis.

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